Poster 001: Tin Ring Splint Treatment for Osteoarthritis of the Distal Interphalangeal Joints

Category: Hand

Treatment
Level 4 Evidence

Kaoru Tada, MD

Hypothesis
Though splinting for osteoarthritis (OA) of the distal interphalangeal (DIP) joint shows good results, adherence to splints is not good due to their appearance and inconvenience. To improve adherence, we made a tin ring splint which looks attractive and is easy to wear. We report here the results of pain reduction and satisfaction with this splint.

Methods
We enrolled 30 patients with painful OA of the DIP joint of the fingers in this cohort study. A tin ring splint was made with tin alloy that contains a small amount of silver. The splint is circular to fix the DIP joint, with an open dorsal side to prevent irritating the spur of the DIP joint. Three sizes of the splint were prescribed depending on the size of the involved fingers. Patients were instructed to wear the splint freely when they felt pain. The numeric pain scale (NPS) and Hand 20 (Ref 1) for functional evaluation and range of motion of the DIP joint were assessed at baseline and after one month. Additionally, data were collected on time to symptom relief and satisfaction related to usability and appearance of the splint. Differences between baseline and one month were compared by the Wilcoxon signed ranks test.

Results
The NPS scale showed significant pain improvement from 57.2±4.3 at baseline to 31.3±4.4 at one month (p<0.001). Hand 20 and range of motion were not changed significantly. Most patients responded that symptoms were relieved 10 to 20 days after treatment. Satisfaction related to usability was 78.0±3.8%, and appearance was 75.0±3.9%.

Summary Points
• Tin ring splint quickly reduced pain after about two weeks.
• Moderate variability and superior esthetics of tin alloy were thought to be main factors for the high satisfaction related to usability and appearance.
• This splint could be one choice for conservative treatment of OA of the DIP joint.
Bibliography
**Poster 002: The necrotic diabetic hand might be one of the terminal complications of diabetes mellitus**

*Category: Hand*

**Evaluation/Diagnosis ; Treatment; Prognosis/Outcomes**

**Level 4 Evidence**

**Jeonghwan Kim, MD**

**Hypothesis**

The manifestations of diabetes were already well reported, such as limited joint mobility, Dupuytren’s contracture, and trigger finger, however, the necrosis of hand in the patients with diabetes mellitus (DM), which might be similar that of foot, was not known yet. We wanted to know that the necrosis of hand in diabetes might be the one of terminal complications of DM.

**Methods**

From 2014 Jan to 2015 August, we recruited patients with DM which showed necrosis of their hands. Patients with history of using vasopressors were excluded. Finally, five patients were enrolled. Four patients were male, and mean age was 64 years old. Mean duration of DM was 21 years, and mean HbA1C was 8.4. The blood glucose level of all patients was not successfully controlled by medications. Therefore, all patients were treated with insulin injection.

**Results**

Clinical manifestations and extent of necrosis of hand were diverse, such as necrosis of dorsal skin of hand, necrosis of single digit, and necrosis of whole hand. Only two patients had history of trauma, such as prick by needle or wood branch. The other three patients showed very poor glucose control [HbA1C > 9.0] and they had other complications, such as DM nephropathy, DM retinopathy, and DM foot. They were already got hemodialysis and amputations of both legs. Only one patient with skin defect of dorsal hand was successfully treated with flap surgery and skin graft. Other four patients were treated by amputations. All three patients with poor glucose control were died within a year from hand amputation.

**Summary Points**

- We found that clinical manifestations of necrotic DM hand were a little bit similar to those of DM foot. This condition might be one of the terminal vascular and neuropathic complications of DM.
- In accordance with the longer survival of DM patients by the development of DM medications and management of other complications, hand surgeons should know about this condition, and should make the prevention and treatment protocols.
Bibliography
Poster 003: Extended subtotal fasciectomy for Dupuytren’s disease (Prevention of recurrence after the surgical treatment)

Category: Hand

Treatment;Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
In Dupuytren contracture, partial (selective) fasciectomy is frequently used with low complication rate, but reoperation is required sometimes due to unexcised fascial which may lead to recontract. We extended the extent of the excision of palmar fascial structures, from the diseased to normal looking adjacent fascial structures, so called “extended subtotal fasciectomy”. We report the results of the procedure with very low recurrence rate.

Methods
Forty-one patients with Dupuytren’s contracture treated by extended subtotal fasciectomy were reviewed retrospectively. Extended subtotal fasciectomy is to excise the diseased fascia with adjacent grossly normal fascia additionally. Mean follow up period was 45.9 months. Seventy-nine fingers were involved (middle finger: 11, ring: 32, little: 26). MCP joint was always involved in all cases, and PIP joint was involved in 15 cases. Preoperative flexion and final residual contractures have been reviewed.

Results
Preoperative flexion contractures were 43 degree in PIP joint and 32.9 degree in MCP joint. In 10 cases, patients had residual contractures of 9 degrees in average and if we include total number of cases, mean residual contracture was 2.3 degrees in average. Four patients had small wound problems and that was healed with simple and regular wound dressing. We did not have a patient who needed reoperation.

Summary Points
• Partial fasciectomy is a simple surgical treatment for Dupuytren’s contracture, but it has relatively higher rate of recurrence.
• We recommend the extended subtotal fasciectomy to prevent the recurrence from the remained normal or normal looking diseased fascial structures.
Bibliography
Poster 004: Is opponensplasty necessary procedure for octogenarians with severe carpal tunnel syndrome?

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 3 Evidence

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Hypothesis
As many elderly patients with carpal tunnel syndrome have advanced disease and difficulty with finger grasp, surgeons sometimes perform opponensplasty with carpal tunnel release to restore finger grasp, however, the efficacy of opponensplasty in elderly patients with severe carpal tunnel syndrome is not clear. We retrospectively evaluated the outcome of opponensplasty in patients over 80 years compared with that for carpal tunnel release alone.

Methods
All patients older than 80 years who underwent surgery for carpal tunnel syndrome in the past 5 years in our institution were reviewed. We surveyed patients with Bland classification grade 5 or 6, based on a nerve conduction study. All patients received preoperative information on opponensplasty, and could decide whether or not to have the procedure. The patients were divided into 2 groups: patients who underwent carpal tunnel release alone (group O) and patients who had opponensplasty with carpal tunnel release (group T). We evaluated subjective symptoms, sensory thresholds and pinch strength pre- and postoperatively. We also administered the Hand20 questionnaire for patient-based outcomes. Patients were followed for at least 1 year.

Results
We reviewed 34 wrists of 26 patients. The mean age was 83 years old. Twenty-eight wrists were assigned to group O and 6 to group T. Preoperatively, 7 wrists had nocturnal pain that was relieved postoperatively; however, all but 3 patients had residual numbness. Pulp pinch strength improved more in group O than in group T; the average change in pinch strength was 2.2 kg in group O and 3.1 kg in group T (p<0.05). The pre- to postoperative difference in the Hand20 score was 27 points in group O and 24 points in group T, which was not significant. The pre- to postoperative difference in the score for item No. 18 on the Hand 20 questionnaire about
inconvenience in daily life was not significantly different: 2.1 in group O and 1.0 in group T. Moreover, no patients in group O were willing to undergo opponensplasty after the initial operation.

**Summary Points**
- Elderly patients who underwent surgery tended to have residual wrist numbness even after 1 year.
- Although patients who underwent opponensplasty regained more pinch strength than patients with carpal tunnel release alone, the scores for patient-based outcomes did not differ between the 2 groups.
- Octogenarians with severe carpal tunnel syndrome can gain pain relief with carpal tunnel release alone, and that opponensplasty is not a required procedure.

**Bibliography**
Poster 005: Functional Tests vs Patient-Reported Outcomes in Predicting Thumb CMC Arthritis Progression: a Prospective, Longitudinal Study

Category: Hand

Evaluation/Diagnosis; Prognosis/Outcomes
Level 3 Evidence

Grant Received from: National Institute of Arthritis and Musculoskeletal and Skin Diseases (R01 AR059185); 2011, 2016

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Hypothesis
Functional tests have a higher association with the progression of carpometacarpal (CMC) osteoarthritis (OA) than patient-reported outcomes at 1.5 and 3 year follow-up.

Methods
We recruited 91 subjects with early symptomatic and radiographic thumb CMC OA and 46 asymptomatic healthy control subjects in a multi-site prospective, longitudinal case-control study. Demographic information, comprehensive history, plain film radiographs, functional test assessments (standardized Jamar grip strength, lateral key pinch, 3 finger pinch, 2 finger pinch, customized pinch, lateral grasp, and jar twist) and patient-reported outcome questionnaires (Australian/Canadian Hand Osteoarthritis Index –AUSCAN - and Patient Rated Wrist & Hand Evaluation - PRWHE) were collected on all 137 subjects. Grade and progression of CMC OA was determined radiographically using the modified Eaton classification. Multivariable regression controlling for age, sex, and whether dominant or non-dominant hand was studied determined which variables were most strongly correlated to CMC OA. We used separate linear regression models to correlate progression of CMC OA with the percent change of force with functional testing and percent change in patient-reported scores. Statistical significance was set at P<0.05. All analyses were performed in SAS statistical software v9.4 (SAS Institute, Cary NC).

Results
After adjusting for age, sex, and dominance was used for data collection, the linear regression model demonstrated that lateral key pinch and lateral grasp at baseline were significant predictors for thumb CMC OA (P=0.0311 and P=0.0115, respectively). Functional variables were
more strongly correlated with OA progression, correlating with 18.8% of OA progression at 18 months, compared to 4.2% for patient reported variables. This relationship was also present at 3-year follow-up, where functional variables correlated with 21.9% of progression, compared with 5.7% for patient reported variables. Of the individual tests, lateral grasp and lateral key pinch most correlated with OA progression, with 7.1% and 5.8% of the 18-month progression in OA respectively. Three-year OA progression presented equally between male and female subjects (p=0.8712); between dominant and non-dominant wrists (p=0.1595); and between obese and non-obese subjects (p=0.7757).

**Summary Points**

- Functional tests correlate more precisely with the progression of radiographic carpometacarpal osteoarthritis than patient-reported outcomes at 1.5 and 3 year follow-up.
- Lateral key pinch and lateral grasp were highly correlated to OA progression.

**Bibliography**

Poster 006: Outcomes Related to Mechanism of Zone I and II Finger Amputations Treated by Revision Amputation

Category: Hand

Treatment; Prognosis/Outcomes
Level 4 Evidence

Andrew P. Harris, MD
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Hypothesis
Revision amputation is the mainstay of treatment for non-replantable digit amputations. Though variable mechanisms of injury portend different results for replantation, no study has looked at the effect of mechanism on the risk of secondary revision amputation. Identifying risk factors for unplanned secondary revision based on mechanism of injury would allow for improved patient education and counseling and increased focus on prevention of secondary revision.

Methods
After IRB approval, our Level I trauma center’s emergency department database was retrospectively examined for patients presenting with flexor tendon zone 1 and 2 traumatic digit amputations from January 2010 to December 2015. Medical records were reviewed for the mechanism of the injury and parsed into one of eight categories (Table 1). Complications requiring unplanned secondary revision within 1 year after initial revision amputation were analyzed. Conditional Cox Proportional Hazard regression with sandwich estimation, where digits were nested within patients, was used to model risk of unplanned secondary revision within 1 year of index procedure relative to mechanism of injury.

Results
537 patients with 677 amputations were initially treated with primary revision amputation. Crush was the most common mechanism (37.3%). Primary revision amputation was performed in the emergency department more commonly than in the operating room (481 vs. 56 patients). Seventy four patients required unplanned secondary revision amputation within 1 year of index procedure. Relative to crush (Figure 1), amputations caused by bites had 4.8-fold increased risk to require a secondary revision (p=0.0038) and those caused by lacerations had 2.6-fold increased risk (p=0.0108). However, amputations caused by avulsion, lawnmower, saw, and
snow blowers were not observed to be at higher risk for secondary revision (all p>.05). Exposed bone secondary to soft tissue necrosis and nail deformity were the most common complications requiring secondary revision.

Summary Points
• Digit amputations caused by bite and sharp laceration mechanisms have an increased risk of unplanned secondary revision relative crush mechanisms
• Revision amputations most commonly require unplanned secondary revision due to nail deformities and soft tissue necrosis causing exposed bone
• Prevention of unplanned secondary revision should be focused on managing nailbed and germinal matrix injuries as well as adequately shortening bone and rearranging tissue to allow for appropriate coverage

Bibliography
Hypothesis
Our aim was to study the incidence of and trends associated with secondary surgery following replantation/revascularization or revision amputation in patients with a traumatic upper extremity injury. We hypothesized that there were no factors associated with secondary surgery after initial treatment of these injuries. In addition we hypothesized that travel distance to our facility has no influence on undergoing secondary surgery.

Methods
A multi-institutional retrospective medical record review was performed from January 2006 to December 2014 to analyze patients undergoing secondary surgery after initial treatment for traumatic upper extremity injury. We collected patient demographics, traumatic injury details, and secondary surgery related information. We calculated the incidence of secondary surgery and we performed a multivariable regression analysis to determine factors associated with secondary surgery. Additionally we performed an ordinal logistic regression to test the association of living at a further distance (> 50 miles) and having 0, 1 or multiple secondary surgeries.

Results
A total of 1,254 patients were included in this study. We found that the total incidence of secondary surgery following treatment for digital amputation was 25%: 51% following replantation/revascularization and 22% following revision amputation. Among patients who had revision amputation as initial treatment, there was a trend toward less secondary surgery over time. The mean number of secondary surgeries per patient in the replantation/revascularization group was 1.2 and 0.45 for the revision amputation group. Patients living more than 50 miles from the hospital had a higher likelihood of undergoing one or more secondary surgeries compared to those living closer.
Summary Points
• 25% of patients sustaining an upper extremity injury in the hand or digits underwent a secondary surgery following initial revascularization or revision amputation in our study
• Patients undergoing initial revascularization or replantation were more than twice as likely to undergo secondary surgery compared to those undergoing revision amputation
• Avulsion mechanism and multi-digit injuries were associated with higher odds of having secondary surgery

Bibliography
Hypothesis
Conservatively treated patients with an indication for surgery (group 2) might have an increased development of osteoarthritis in the DIP-joint, without a significant difference in functional outcome between the groups.

Methods
Patients at the Reinier de Graaf Groep diagnosed with a mallet finger fracture between 2001 and 2006 were included. The initial treatment and X-rays were reassessed and 3 groups were defined. Group 1 consisted of patients who were treated conservatively and would be treated conservatively according to current guidelines. Group 2 consisted of patients who would be operated under the current guidelines but were treated conservatively. Group 3 consisted of patients who would be operated under the current guidelines and were operated.
All patients completed questionnaires, the QuickDASH, the PRWE, the MHOQ and the SF-12. X-rays were made of the fractured finger and the same non-fractured digit of the other hand as control. During physical examination pain, range of motion and pinch grip strength was evaluated. The degree of OA in the DIP-joints were assessed using the standardised hand radiographs from the Osteoarthritis Research Society International. Osteophytes and joint space narrowing in the DIP-joints were graded 0-3 points each, with total scores for the degree of OA ranging from 0 to 6.

To investigate the presence of osteoarthritis 10-15 year after fracture, a multivariable regression analysis was used. As confounders age, dominant hand treatment and anatomical position were included in the analysis. A multivariable regression analysis was done to study differences in function.

Results
Until November 2016, 42 patients were included. Group 1, 2 and 3 consisted of respectively 21, 16 and 5 patients. The median degree of osteoarthritis during diagnosis was 1, 1 and 0, respectively. During follow-up, the median difference in degree of osteoarthritis between the fractured finger and the control finger was 0 in group 1, 1 in group 2 and 0 in group 3.
The mean ROM in the affected finger in group 1 was 59.7° compared to 62.6° in group 2 and 58.6° in group 3. The mean ROM in the unaffected finger in 78.7°, 86.3° and 93.2°, respectively. No differences in function measured using questionnaires were found.

Summary Points

- No significant difference in functional outcome was found between the groups. However conservatively treated patients with an indication for surgery (group 2) might have an increased development of osteoarthritis in the DIP-joint. A study including a larger group of patients is needed to verify these results.

Bibliography

Poster 009: Thirty-day Complications after Thumb Carpometacarpal Joint Arthroplasty: an ACS-NSQIP study

*Category: Hand*

Treatment; Prognosis/Outcomes  
Level 4 Evidence

Kalpit N. Shah, MD  
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**Hypothesis**  
The first carpometacarpal (CMC) joint is one of the most common sites of degenerative osteoarthritis in the hand, with arthroplasty being a common procedure to provide pain relief and improve function. CMC arthroplasty is generally considered a safe procedure with low complications. Given its low complication rate, very little is known about risk factors that may predispose a patient for acute postoperative complications. We hypothesize that the 30-day post-operative complication rate after CMC arthroplasty is similar regardless of patient comorbidities.

**Methods**  
All instances of thumb CMC joint arthroplasty from 2005 to 2015 in the prospectively collected American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database were identified. Both bivariate hypothesis tests and multiple logistic regressions were performed to determine patient demographics, surgical data and medical comorbidities that were significant predictors for complications which included wound related complications, cardiopulmonary complications, neurological complications, renal complications, return to the operating room (OR) and readmission.

**Results**  
A total of 3344 patients were identified in the database who underwent a thumb CMC joint arthroplasty. Of them, 45 patients (1.3%) experienced a complication including wound issues (0.66%), return to the OR (0.15%) and readmission (0.27%) amongst others (Table 1). When performing bivariate analysis, age over 65, American Society of Anesthesiologist (ASA) Class, diabetes and renal dialysis were all significant risk factors (p<0.05, ASA Class, diabetes and renal dialysis were significant risk factors for complication with bivariate analysis  
- Diabetes requiring insulin, ASA Class 4 and renal dialysis continued to be strong risk factors with a multiple logistic regression analysis.
Hypothesis
Frequently surgeons are confronted with a long spiral fracture of the metacarpal which they may choose to fix with lagged screws alone. Our hypothesis was that fractures fixed with three 1.5 mm screws would be more stable during bending and torsional loading than fractures fixed with two 2.0 mm screws.

Methods
The second and third metacarpal was harvested from twelve matched pairs of fresh frozen cadaveric hands and spiral fractures created. One specimen from each matched pair was fixed with two 2.0 mm cortical lag screws, while the other was fixed with three 1.5 mm cortical lag screws. Nine pairs underwent combined cyclic cantilever bending and axial compressive loading followed by loading to failure. Nine additional pairs were subjected to cyclic external rotation while under a constant axial compressive load and subsequently externally rotated to failure under a constant axial compressive load. Paired t-tests were used to compare cyclic creep as well as stiffness, displacement, rotation, and peak load levels during load to failure tests.

Results
The average failure torque for all specimens was 7.2±1.7 Nm. In cyclic torsional testing, the ‘2 screws’ group exhibited significantly less rotational creep than the ‘3 screws’ group. No other significant differences were found between the test groups during torsional or bending tests.

Summary Points
• Both constructs are biomechanically similar except that the ‘2 screws’ construct displayed significantly less loosening during torsional cyclic loading
• It may be preferable to use two 2.0 mm cortical lagged screws to fix long spiral metacarpal fractures as the cost of an additional screw in the three 1.5 mm screws construct did not result in an obvious biomechanical advantage.
Poster 011: Arthroscopic versus open distal hemitrapeziectomy in osteoarthritis of the CMC thumb joint; Preliminary results of a randomized controlled trial

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 1 Evidence

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Hypothesis
For osteoarthritis of the CMC joint of the thumb, trapeziectomy is described as the treatment with the least complications and therefore the most favored treatment.1 Distal hemitrapeziectomy may prevent complications seen with total trapeziectomy. In the past years, there is increasing experience in arthroscopic techniques.

The objective of this study is to compare arthroscopic hemitrapeziectomy with open hemitrapeziectomy without tendon interposition in a multicenter randomized controlled clinical trial. We hypothesize that patients after arthroscopic hemitrapeziectomy have earlier return to work, less pain and better function than after open hemitrapeziectomy.

Methods
Since 2014 we are performing a multicenter randomized controlled trial in the Netherlands. After informed consent, patients are randomized to either open or arthroscopic distal hemitrapeziectomy. Patients are asked to fill in the PRWHE and perform hand measurements in preoperative setting and at 3, 6, 12 and 24 months postoperative. Control X-rays were obtained in the postoperative period.

We used an independent sample T-test for continuous variables and chi square test for categorical variables.

Results
We compared the two groups (open and arthroscopic) at the different time points. The average operation time for the open technique was 26 minutes and 39 minutes for the arthroscopic technique.

The PRWHE (n=61) showed preoperative a total of 55 (pain 36, function 25) in the open group and 48 (pain 32, function 22) in the arthroscopic group. At 6 months the PRWHE was (n=45) 18
(pain 10 function 8) of the open group and 22 (pain 13, function 9) of the arthroscopic group (not significance). At 12 months (n=36) the open group scored 15 (pain 9, function 6) and the arthroscopic group scored 17 (pain 11, function 6), no significant difference. At 6 months satisfaction was 3.5 and 3.2 for the arthroscopic and open group respectively on a 5-point scale (0=worse, 5=excellent) for both groups. Of the patients in the arthroscopic group 88% would undergo the operation again and 74% of the open group.

Summary Points
- The preliminary results of our RCT arthroscopic versus open distal hemitrapeziectomy, show a slight patient preference for the open hemitrapeziectomy in the PRWHE but satisfaction was higher in the arthroscopic group
- At this moment we have a total of 61 patients in the study, 36 patients with a follow up of more than 1 year.
- At the time of the congress, we will present the results of at least 50 patients with a minimum of one-year follow up.

Bibliography
Hypothesis
The trapeziometacarpal (TMC) joint is a common site of osteoarthritis. Many patients develop symptoms of pain, reduced pinch force and instability, which effects their quality of life. Trapeziectomy with ligament reconstruction and tendon interposition (LRTI) is the most common procedure but in the recent years different types of joint replacements with a prosthetic implant has been introduced.
NuGrip® (figure 1) is a single component joint replacement made of pyrocarbon, a material with elastic and density properties similar to cortical bone. The aim of this study was to evaluate the medium-term outcome for all patients who have received the implant at the Department of Hand Surgery in SUS university hospital, Malmo, Sweden. The focus was on pain relief, stability, need of reoperation and patient satisfaction.

Methods
48/50 implants in 44/45 patients (mean age 58) was followed up after 5.5 years (range 21-67 months). 10 implants were removed due to pain or dislocation, 31/35 patients (35 implants) with remaining implants were clinically examined testing range of motion and grip strength. All patients but one (not reachable) filled in the DASH questionnaires and visual analogue scale (VAS) concerning pain, strength, physical mobility and satisfaction rate.

Results
89% of the patients were significantly pain relieved. 29/38 joints rated VAS pain scale =1 (1-10), equals to pain free. Range of motion and grip strength were statistically indifferent to contralateral hand postoperatively. 55% of the patients feel they have regained strength and the overall satisfaction on a VAS scale was 8.3. The revision rate was 20%.

Summary Points
• The results indicates that the NuGrip® implant is an option for treatment of TMC osteoarthritis.
• However some implants needed to be revised, mainly in the early cases
• Further research to compare with trapeziectomy is needed and further on a randomized study
Bibliography
Images
Poster 014: A Reliable and Standardized Post-Operative Staging System for First Carpometacarpal Arthritis

Category: Hand

Evaluation/Diagnosis; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
Currently, there is no standardized system for measurement of proximal migration after removal of the trapezium when treating first carpometacarpal arthritis. We hypothesize that the presented novel post-operative staging system has a high degree of intra- and inter-rater reliability, and can be used to standardize the measurement of proximal migration after surgical treatment for this disease process.

Methods
The novel staging system is based upon the position of thumb metacarpal base flare relative the index metacarpal base on an AP X-Ray of the hand. The metacarpal base flare of the thumb was chosen due to its proximity to the center of rotation, thereby lessening the untoward effects of thumb positioning on measurements. A description of the staging system is found in Figure 1. X-rays of 57 patients who had undergone trapeziectomy and suture button suspension were obtained. Using the novel staging system, the non-blinded senior author categorized each image into its respective stage. The images were then assigned to two different PowerPoint slide shows (the order of images was shuffled between the two). Four blinded reviewers (two residents and two hand fellows) were given a description of the staging system, and the reviewers categorized each image into its respective stage. To evaluate inter- and intra-rater reliability, two-way inter-class correlation (ICC) values were calculated using “R” software and the “irr” package.

Results
The inter-rater reliability between the 4 raters was excellent (ICC = .911, 95% CI = (.851, .947). The intra-rater reliability was excellent for all 4 reviewers (ICC range: (.856, .901)). On subgroup analysis, inter-rater agreement for fellows was slightly higher than agreement for residents (fellow ICC: .866, 95% CI: (.748, .926), resident ICC: .741, 95% CI: (.423, .869)).
Summary Points

• Without a standardized method for measurement of proximal migration after trapeziectomy, surgeons are unable to make objective comparisons between the various techniques to treat first carpometacarpal arthritis.

• The most often used method is to measure the distance between the distal pole of the scaphoid and the base of the first metacarpal – this measurement is fraught with confounding variables (Figure 2)

• We present a novel post-operative staging system that demonstrates a high degree of inter and intra observer reliability, and believe that this system offers a standardized method to measure proximal migration of the metacarpal.

Bibliography


Poster 015: Suture-Button Stabilization Following Ring Finger Ray Amputation: A Comparative Biomechanical Study

Category: Hand

Treatment; Surgical Technique
N/A - not a clinical study

Grant Received from: The Raymond M. Curtis Research Foundation, Curtis National Hand Center

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Hypothesis
Ring finger ray amputation utilizing traditional techniques requires immobilization for several weeks to allow soft tissue healing. We hypothesized that utilizing a suture-button construct following ring finger ray amputation would allow early range of motion, reliably close the intermetacarpal gap, and not produce scissoring of the adjacent digits.

Methods
We performed ray amputation of the ring finger of 14 cadaver specimens by performing an osteotomy of the base of the ring finger metacarpal and then excising the remainder of the digit. We first performed a soft tissue repair of the transverse metacarpal ligaments and then cycled the fingers in simulated active flexion and extension on a custom computer-controlled device to recreate 6 weeks of range of motion. We then placed a suture-button device across the long and small finger metacarpals and tested the specimens again, thereby using each hand as an internal control for comparison via paired t-test.

Results
The distance between the ring and small finger metacarpals was reduced following suture-button placement compared to the initial control (p<.05); this spacing was maintained following complete cycling of the fingers. The angle between the metacarpals was divergent following soft tissue repair, and then became slightly convergent after insertion of the suture-button construct (p<.05). None of the hands developed clinically relevant scissoring of the digits before or after application of the suture-button construct.
Summary Points
• A suture-button construct provides stable fixation to withstand early range of motion following ring finger ray amputation.
• It also significantly closes the gap and angle between the adjacent metacarpals without causing undue scissoring.
Poster 016: Risk of Reoperation after Primary Revision Digit Amputation Performed in the Emergency Department versus Delayed Treatment in the Operating Room

Category: Hand

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
Patients treated with primary revision digit amputation in the Operating Room (OR) have a decreased risk of secondary revision amputation compared to those treated in the Emergency Department (ED) due to the availability of anesthesia staff, surgical instruments, and controlled sterile environment.

Methods
After IRB approval, our institution’s ED database was reviewed for patients presenting with flexor tendon zone 1 and 2 traumatic digit amputations over a 6-year period, from January 2010 to December 2015. Patients were reviewed for demographics, comorbidities, site of treatment (ED versus OR), and complications requiring secondary revision. Conditional Cox Proportional Hazard regression with sandwich estimation, where digits were nested within patients, was used to model risk of unplanned secondary revision within 1 year of index procedure relative to insurance status, presentation (ED vs. OR), and work-related injury. Significance was established at the .05 level and all interval estimates were calculated for 95% confidence.

Results
537 patients with 677 digit amputations were initially treated with primary revision amputation: 481 patients with 586 amputations were initially revised in the ED, while 56 patients with 91 amputations were initially revised in the OR. 74 patients with 83 amputations (78 zone 1, 5 zone 2) required unplanned secondary revision amputations within 1 year of index procedure; of these, 68 patients were initially treated in the ED and 6 patients in the OR. No increased risk of unplanned secondary revision amputation was observed for patients treated in the ED compared with the OR, (HR 0.723, CI 0.145-1.148, p=0.4811). Those who had a work-related injury had a
1.9-fold increased risk of revision relative to those whose injury was not work-related, (HR 1.904, CI 1.06-3.422, p=0.0312). Those with insurance had a 1.6-fold increased risk of revision relative to those without insurance, this approached significance, (HR 1.553, CI 0.903-2.672, p=0.1119).

Summary Points
- Performing a revision digit amputation in the ED, rather than the OR, is not a predictor of increased risk for unplanned secondary revision.
- Patients with work-related injuries, or who have insurance, have an increased risk of unplanned secondary revision amputation.
- As health care costs continue to rise, efficient utilization of resources is increasingly important. These results support avoiding unnecessary use of operating room time and staff for primary revision of traumatic digit amputations.

Bibliography

Images
Poster 017: A prospective, randomized trial evaluating the effect of incision type on scar quality and outcomes following surgical treatment of trigger finger

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 2 Evidence

Nikolas H. Kazmers, MD, MSE
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Douglas T. Hutchinson, MD

Hypothesis
Trigger finger release is a common surgical procedure, yet it remains unclear whether incision type affects scar quality or outcome. We hypothesize that transverse and longitudinal incision types both yield similar scar quality and functional improvement following trigger finger surgical release.

Methods
In this prospective randomized controlled trial, each digit undergoing A1 pulley release(s) at an academic medical center and affiliated Veterans Affairs Hospital were randomized to receive transverse or longitudinal incisions. Pediatric patients and those undergoing revision surgery or trigger thumb release were excluded. The Patient Scar Assessment Scale (PSAS), Observer Scar Assessment Scale (OSAS), and DASH were collected at 6 and 52 weeks postoperatively, and compared using the student t-test. Complications were recorded and compared using the Fisher exact test. Per a priori power analysis, 37 incisions per group were required to discern a 4 point difference in the PSAS or OSAS scores with 80% power, assuming mean scores of 10 and 16 with standard deviations of 5 and 8, respectively.

Results
A total of 132 patients were randomized, with 78.8% available for follow-up at a mean of 7.9 weeks, and 60% at a mean of 54.0 weeks postoperatively. At both time-points, there were no differences in PSAS or OSAS scores between transverse and longitudinal incisions (Table 1). Among patients receiving both incision types for multiple simultaneous trigger releases, there were no differences in PSAS or OSAS scores at either time-point between incision types (Table 2). The DASH improved from a mean of 34.3 preoperatively to 19.3 at 7.9 weeks (p < 0.001), and to
9.8 at most recent follow-up (p < 0.001). No differences in DASH improvement were observed between 0 and 7.9 weeks (p = 0.85), or between 0 and 54.0 weeks (p = 0.14), when comparing incision types. Complication rates were similarly low between groups (p = 0.20 - superficial infection resolving on oral antibiotics in 1 longitudinal patient, superficial dehiscence resolving with local wound care in 1 transverse and 2 longitudinal patients, and residual clicking resolving 6 weeks postoperatively in 1 longitudinal patient), and were not affected by diabetes (p = 0.17).

Summary Points
- Based upon this prospective randomized study, transverse and longitudinal trigger release incisions heal with equally satisfactory scar quality
- Reliable improvement in patient-reported disability occurs regardless of incision type used
- Complications were infrequent for both incision types
- The strength of our conclusions may be affected by patient attrition

Bibliography
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Images
Hypothesis
Polydigit amputation is a more severe injury than single digit amputation. It requires a longer operation time for replantation with a longer warm ischemia time and often a secondary or reconstruction surgery. Therefore, our hypothesis is that the clinical results of replantation for polydigit amputation are not as good as expected. The purpose of this study was to report clinical results of replantation and reconstruction surgery for polydigit amputation.

Methods
A retrospective study of 61 fingers of 21 patients with polydigit amputation who had more than one digit in Tamai’s zone III or IV was performed. In total, 19 patients were men and 2 were women, with a mean follow-up period of 12 months. The number of amputation fingers, zone of injury, survival rate, and clinical results of replantation and reconstruction surgery at the final follow-up were reviewed and analyzed.

Results
The mean number of amputated fingers was 2.9 (2–5) per patient. Crush injuries were the main mechanism of injury in 15 patients. Five were clean-cut and one was an avulsion. Regarding the injured area of the fingers, 24 fingers were injured in zone IV, 21 in zone III, 10 in zone I, and 3 in zone III. The survival rate of replantation was 87% (44 of 52 digits). The mean final %TAM of injured digits was 58%, and the mean %TAM of zone IV was significantly lower than those of other zones (mean, 28%; p < 0.05, Fig. 1). The grip strength at the final follow-up in three finger amputation was lower than that in two finger amputation (45% vs. 71%; p < 0.05). Aging was negatively correlated with the sensory recovery (r = -0.36; p < 0.05). The second toe transfer for finger reconstruction in five patients, and the %TAM and grip strength at the final follow-up were
significantly higher in patients with the PIP joint than in those without the PIP joint (%TAM, 72% vs. 28%, p < 0.05; grip strength, 70% vs. 21% of the normal side; p < 0.05; Fig. 2).

**Summary Points**
- The success rate of polydigit replantation was similar to single finger replantation.
- Clinical outcomes were poorer, particularly in zone IV injuries and in more involved fingers.
- In the second toe transfer for finger reconstruction, better clinical results were achieved in patients with the PIP joint than in those without the PIP joint.

**Bibliography**

Images
Poster 019: The Efficacy of image-guided injections compared to non-guided injections of the thumb carpometacarpal joint

*Category: Hand*

Treatment;Prognosis/Outcomes
Level 4 Evidence

Paul A. Shultz, MD
Haroutioun Boyadjian
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Megan Conti Mica, MD

**Hypothesis**
Up to 42% of non-image guided injections of the carpometacarpal (CMC) joint are placed out of the joint. However, the clinical benefit of precise intra-articular injection has been poorly defined. This study sought to quantify and compare the time to subsequent injection and time to surgery following image-guided (ultrasound or fluoroscopy) corticosteroid injection versus non-guided injection for treatment of CMC arthritis. Our hypothesis was that anatomically precise image-guided injection would result in a longer duration of time between injections and ultimately to surgery, as compared to non-guided corticosteroid injection.

**Methods**
This retrospective study used Truven Health Marketscan® Research Databases to identify patients from 2003 to 2014 with common ICD-9 codes for osteoarthritis of the CMC joint, who also had respective CPT codes for injection with or without image guidance and CPT codes for surgical intervention of the CMC. Length of time from injection until subsequent injection(s) and/or surgery was extrapolated for identified patients. Analysis included binomial logistic regression, ANOVA and Chi-Square. All analyses used SAS 9.3 and SPSS.

**Results**
We identified 62,333 patients (68% female, 32% male), average age 59.7 (SD 11.6), with common ICD-9 diagnostic codes for CMC arthritis with respective injection CPT codes. The average number of injections was 1.9 (SD 1.8). The average number of days between first and second injection for patients treated with non-guided injection was 237.3 (SD 175.6) versus 183.1 (SD 181.5) for US-guided injections (p=1) and 177.2 (SD 162.1) for fluoroscopically guided injections (p=1). Among all patients, 8,106 (13%) went on to operative treatment. The average number of days to surgery following initial non-guided injection was 317.7 days (SD 203.4) versus 331.5 (SD 204.9) in the US-guided group (p=0.0035) and 324.8 (SD 205.8) in the fluoroscopically
guided group (p=0.24). Among all patients treated operatively, the average number of injections preceding surgery was 1.8 (SD 1.3).

Summary Points
• Image-guided CMC corticosteroid injections do not result in a significant increase in time between subsequent corticosteroid injections as compared to non-image guided injections.
• US-guided CMC corticosteroid injections result in a statistically significant increase of 14 days to surgery as compared to non-image guided injection.
• The benefit of 14 additional days of relief prior to surgery may not be clinically meaningful.
• Further research is needed to clarify the value of image-guided versus non-guided CMC corticosteroid injection in an increasingly economically conscientious healthcare environment.

Bibliography

Images
Hypothesis
Phalangeal neck fractures are most often dorsally displaced and angulated. Surgical treatment is often necessary to restore the retrocondylar recess. The purpose of this study was to determine if radiographic landmarks can serve as a reference tool for assessing phalangeal neck fracture alignment based on age and sex.

Methods
1,061 lateral finger radiographs that were interpreted as ‘normal’ by pediatric radiologists in children aged 1 to 18 years were retrospectively reviewed. The proximal and middle phalanges of each digit had a line drawn along the volar cortex (termed the volar phalangeal line [VPL]) and a second perpendicular line was drawn at the level of the phalangeal condyle. A ratio of the anterior to posterior aspects of the phalangeal condyle was determined at the intersection of these lines. Gender of the patients was noted to determine if sex influenced the temporal course of ossification. A linear regression model was utilized to determine the average annual coefficient of growth for the phalangeal condyles.

Results
The average coefficient of growth for the proximal and middle phalangeal condyles is summarized in Table 1. As children increase in age, the VPL will intersect the phalangeal condyle more dorsally due to the eccentric ossification. The 8-9 year old interval had the largest change in size. In most children >9 years of age, the VPL will intersect the middle 1/3 of the condyle. No significant difference exists between the ratios of the proximal and middle phalanges. Gender did not significantly affect the linear regression model.

Summary Points
• The phalangeal condyles ossify in an eccentric manner with a rapid growth phase between 8 and 9 years of age. The VPL will intersect the phalangeal condyle more dorsally with increasing
age. There is no difference in the time course of development between the proximal and middle phalanges and gender does not influence growth patterns.
• The volar phalangeal line (VPL) and knowledge of where it should intersect the phalangeal condyle can be used as a reference guide for evaluating the reduction of proximal and middle phalangeal neck fractures in children.
Poster 021: Preoperative Patient Reported Outcome Measures in the Prediction of Outcome in Arthroplasty of the Basal Joint of the Thumb

Category: Hand

Level 2 Evidence

Rasmus W. Jørgensen
Jens-Christian Vedel, MD
Anders Odgaard, MD
Claus H. Jensen, MD

Hypothesis
Indication for thumb carpometacarpal joint (CMC-1) arthroplasty is clinical and radiographic osteoarthritis of the joint resistant to conservative treatment. The purpose of this study was to evaluate Patient Reported Outcome Measures as a predictor of outcome. The Quick-DASH questionnaire was used pre- and postoperatively to assess its ability to predict outcome of surgery.

Methods
157 consecutive patients prospectively answered Quick-DASH questionnaire preoperatively and at 6 months following interposition arthroplasty of the basal joint of the thumb. Student T-test was used comparing pre- and postoperative values and preoperative values with respect to patient satisfaction. The questionnaire’s ability to predict outcome was assessed using multiple regression analysis. P<0.05 was considered statistically significant.

Results
The follow-up was 6 months for all 157 patients. 128 were women. The mean age at follow-up was 62.8 years (SD 9.18, range 41-84 years).
The mean preoperative Quick-DASH was 46.41 (SD 15.64). The mean postoperative Quick-DASH was 22.89 (SD 19.40). Showing an average improvement of 23.52 (SD 24.93), P < 0.0001. The mean preoperative pain-score (1-5, 5 being worst) was 3.62 (SD 0.74). The mean postoperative pain-score was 2.11 (SD 0.96). Showing an average improvement of 1.51 (SD 1.15), P < 0.0001.
At follow-up, 122 patients of 157 were satisfied. The mean preoperative Quick-DASH values for patients who were satisfied or unsatisfied at 6 months follow up did not differ, P = 0.22.
However, the mean improvement in Quick-DASH values for patients who were satisfied or unsatisfied with the treatment at 6 months follow up was 28.89 (SD21.71) and 4.81 (SD 26.67), respectively, P = 0.00012.
The multiple regression analysis showed a correlation between the preoperative Quick-DASH and the improvement in Quick-DASH, P < 0.0001. I.e. a higher preoperative score resulted in
greater improvement. Age and gender did not correlate with the postoperative values $P = 0.127$ and 0.377, respectively. A preoperative Quick-DASH score of less than 30 resulted in improvement at follow-up in only 54% of patients.

**Summary Points**

- CMC-1 arthroplasty is an effective treatment of thumb CMC osteoarthritis.
- There is a strong correlation between the preoperative Quick DASH and the improvement in Quick-DASH at 6 months follow-up.
- Quick-DASH score may therefore assist in the decision making in the operative treatment of osteoarthritis of the basal joint of the thumb.
- We suggest a preoperative Quick-DASH score of less than 30 as a contraindication of surgery.

**Bibliography**


Images
Poster 022: Clinical Outcomes of Surgical Treatment for Chronic Fracture-dislocation of the Proximal Interphalangeal Joint

Category: Hand

Treatment
Level 4 Evidence

Kazuki Sato, MD, PhD
Takuji Iwamoto, MD, PhD
Taku Suzuki, MD, PhD
Satoshi Oki
Naoto Inaba
Tsuyoshi Amemiya

Hypothesis
Fracture-dislocations of the proximal interphalangeal (PIP) joint are complex, and management is challenging once they become chronic. The purpose of this study is to retrospectively clarify the clinical outcomes of surgical treatment for chronic PIP joint fracture-dislocation.

Methods
Forty-one PIP joints (11 index, 5 middle, 14 ring, and 11 little fingers) in 41 patients with chronic fracture-dislocation after trauma were treated surgically between 1998 and 2015. There were 34 males and 7 females, ranging in age from 14 to 72 (average, 33). The interval between injury and surgery ranged from 6 weeks to 19 months (average, 5.6 months), and the types of fracture-dislocation were dorsal in 38, volar in 2, and comminuted in 1. Surgical procedures included corrective osteotomy with/without bone graft in 27, arthroplasty using costal osteochondral graft in 13, and artificial prosthetic replacement in 1, and the duration of postoperative follow-up was 6 to 72 months (average, 18 months). Clinical symptoms, including relief of pain, the range of PIP joint motion before and after surgery were evaluated in these patients. Two-sided paired t-test was utilized to compare pre- and postoperative range of motion. P value of less than 0.05 was considered statistically significant. We also analyzed several factors, including surgical procedure, sex, age, fingers, the interval between injury and surgery, and preoperative range of motion that might influence postoperative range of motion.

Results
Arthroplasty using costal osteochondral graft and artificial prosthetic replacement tended to be applied to the cases with severely damaged articular cartilage and to the cases with longer intervals between injury and surgery.
The average arc of motion of the PIP joint significantly increased to 73.0 degrees postoperatively from 19.2 degrees preoperatively in the corrective osteotomy group, 65.8 degrees postoperatively from 5.9 degrees preoperatively in the costal osteochondral graft group. Preoperative arc of motion of the artificial prosthetic case was 25 degrees, improving to 70 degrees postoperatively. Multiple regression analysis showed that the affected finger (the little finger being worst) and the interval between injury and surgery influenced postoperative range of motion.

Summary Points
• All surgical procedures, including corrective osteotomy, arthroplasty using costal osteochondral graft, and artificial prosthetic replacement, demonstrated successful reconstruction and improved clinical outcome in the treatment of chronic PIP joint fracture-dislocation.
• Arthroplasty using costal osteochondral graft and artificial prosthetic replacement may be suitable treatment options for cases with severely damaged articular cartilage.

Bibliography
Images
**Poster 023: Rethinking Pyogenic Flexor Tenosynovitis: Biofilm formation on Tendons and Considering New Treatment Strategies**

*Category: Hand*

Treatment; Surgical Technique; Basic Science
N/A - not a clinical study

Constantinos Ketonis, MD, PhD
Asif Ilyas, MD

**Hypothesis**
Pyogenic flexor tenosynovitis (PFT) of the hand remains a challenging problem that often requires surgical irrigation and parenteral or oral antibiotics. We hypothesize that due to the tendons limited blood supply and the closed-space nature of the sheath, PFT shares many similarities to peri-prosthetic joint infections (PJI), and as such, facilitated by bacterial attachment and biofilm formation on tendons, renders standard treatments less effective. Furthermore, previous studies have demonstrated that local administration of corticosteroids in conjunction with antibiotics can improve treatment outcomes in patients with septic arthritis and in animal models of PFT. We hypothesize that the local administration of corticosteroids and antibiotics, either together or separately, can act directly on the adherent bacteria resulting in decreased colonization and biofilm formation.

**Methods**
Fresh human cadaveric hand tendons were harvested and divided into 0.5cm segments. Samples were sterilized and inoculated with 1x10⁴ cfu/ml Green Fluorescent Staphylococcus Aureus (GFP-SA) for 48hrs, 37°C. After saline washing to rid planktonic bacteria, samples were treated for 24 hours with: 1) Saline irrigation 2) antibiotics (Vancomycin), 3) corticosteroids, 4) Antibiotics/corticosteroid combined. Samples were visualized using Confocal Laser Scanning Microscopy (CLSM) and Scanning Electron Microscopy (SEM), plated and counted. Three samples were plated from each condition and counts were expressed as means ± SE.

**Results**
Following bacterial challenge, CLSM revealed heterogeneous green fluorescence representing bacterial attachment with dense areas of signal, typical of biofilm formation. SEM at >3000X magnifications, demonstrated bacterial colonization in grape-like clusters, typical of Staphylococcus aureus, that at higher magnifications, reveal dense colonies covered by a thick slimy veil characteristic of biofilm (Figure 1). Next we examined the efficacy of various treatments in decreasing bacterial load by direct colony counting. Irrigation with saline alone yielded a 18.5% decrease in bacteria burden as compared to 42.6% with steroids, 54.4% with
antibiotics, and 77.3% with antibiotics/steroids combined (Figure 2). These findings were further demonstrated with confocal and electron microscopy.

Summary Points
• Staphylococcus aureus can readily form biofilm on human flexor tendons analogous to PJI, which may render current PTF with local irrigation less effective contributing to its typical sequale.
• The addition of both local antibiotics and corticosteroids resulted in considerable decrease in biofilm formation and bacterial burden on flexor tendons
• We suggest re-thinking the current treatment of PFT and recommend considering a strategy more analogous to PJI management with the adjunctive use of local antibiotics in combination with corticosteroids to decrease the bacterial burden and biofilm formation on flexor tendons.
Poster 024: Surgeon Preference, Influence, and Treatment of Thumb Carpometacarpal (CMC) Arthritis

Category: Hand

Evaluation/Diagnosis; Treatment
N/A - not a clinical study

Steven Niedermeier, MD
Hisham M. Awan, MD

Hypothesis
The purpose of this study was to evaluate current surgical practice patterns, the factors that influence these patterns, and overall trends in the treatment of thumb carpometacarpal (CMC) osteoarthritis.

Methods
An online survey containing 14 questions was sent to all active members of the American Society for Surgery of the Hand (ASSH). Information on demographics and treatments was collected. Results were anonymously uploaded to an online spreadsheet.

Results
823 respondents were recorded. Trapeziectomy with ligament reconstruction and tendon interposition (LRTI) using whole flexor carpal radialis (FCR) was the most popular technique at 37.44%. 26.38% of surgeons with less than five years of experience utilize trapeziectomy with suture suspension. 55.76% choose a particular procedure because of “Personal Clinical Experience” over “Current Evidence” and “Training.” 24.17% of surgeons that have been practicing for longer than five years have changed procedures in the last five years. In the United States, 97.2% of hand surgeons prescribe either oxycodone or hydrocodone post-operatively compared to just 23.75% of international hand surgeons.

Summary Points
• The results show that trapeziectomy with LRTI remains the most popular treatment of choice.
• The use of trapeziectomy with suture suspension is on the rise, particularly in younger surgeons.
• International hand surgeons rely more on current evidence, utilize less postoperative therapy and opioid medications, and change procedures more often than USA hand surgeons.
Bibliography

Images
Poster 025: Composite graft outcomes in Digital Tip Amputation and Analysis of Affected Factors

Category: Hand

Treatment; Prognosis/Outcomes
Level 4 Evidence

Ja Hea Gu, MD, PhD

Hypothesis
In fingertip amputations, multiple treatment options have been described. When an amputated tip is too distal for microvascular replantation or vessels are severely injured, a composite graft can be a treatment option. We report the outcomes and factors affecting graft outcomes in digital tip amputations to determine the efficacy of this treatment modality and present evidence for its use.

Methods
In a retrospective study, we analyzed 7 years of surgical data for 168 digital amputations in 163 patients. Patients with at least 12 months of follow-up were included and other combined injuries of the same hand were excluded. Age, level (tip, tip to mid-nail, mid-nail to nail fold, nail fold to distal phalanx) and pattern of injury (transverse, volar oblique, dorsal oblique), bony injury (presence of fractures), injury type (crush or guillotine), smoking and outcomes were reviewed. Outcomes were determined after follow-up examination by the authors and were divided into 4 groups: complete survival (grade 4), partial survival and healed by secondary intention within 6 weeks (grade 3), partial flap survival and healed with surgical management or resulting complications (grade 2), and total flap.

Results
Of the 168 amputated digits, 33.93% showed complete survival. Partial survival (groups 3 and 2) occurred in 35.12% and 26.8%, respectively. Only 4.17% resulted in total necrosis. Total necrosis was treated with stump revision, reverse island flap coverage, and V-Y advancement flap coverage. Of 45 grade 2 patients, 17 were treated with skin grafting, reverse island flap coverage, V-Y advancement flap coverage or stump revision. Others healed with only surgical debridement or secondary intention after a few months. Seven patients developed a nail deformity and 5 had sensory difficulty. Age, injury type, injury level, and bony involvement were statistically correlated with outcomes (p<0.05). Logistic regression analysis showed that age, injury type, injury level, smoking and bony involvement were associated with complete graft survival. Young and non smoking patients with a distal injury and no bony involvement had uncomplicated graft healing.
Summary Points

• Survival rates were increased in young, non-smoking patients with a clean cut, lack of bony involvement, and a more distal injury.
• Old age and history of smoking, amputation more proximal than mid-nail, and stump involving a fracture led to a low graft survival rate and healing with complications.
• Survival rates may improve if certain criteria are met to qualify for a composite tissue graft, which could be an alternative treatment option for selected patients.

Bibliography
**Poster 026: Complications and Co-morbidities of Common Hand Surgery Procedures**  
*Category: Hand*

Treatment; Patient Education  
Level 3 Evidence

**Ian R. Smithson, MD**  
**Michael Wigton, MD**  
**Ethan R. Wiesler, MD**

**Hypothesis**  
Tobacco use, diabetes, and obesity increase the risk of complications associated with operative treatment of carpal tunnel syndrome (CTS), trigger finger (TF), and DeQuervain’s (DQ).

**Methods**  
A retrospective chart review based on CPT® code was performed for a single surgeon at a level-one trauma center to identify patients who underwent elective surgery for the treatment of CTS, TF, or DQ from January 2010 to December 2015. Status with regards to diabetes, obesity, and tobacco abuse was recorded. Operative reports were reviewed to identify any concomitant surgical procedures, patient comorbidities, and/or preoperative history that disqualified the procedure as elective. All perioperative complications were recorded. Statistical analysis was performed.

**Results**  
647 patients initially identified by EMR search under CPT codes 25000 (DQ), 26055(TF), and 64721(CTR); 469 adult patients with complete charts met the inclusion criteria. 649 total procedures were performed: 27 De Quervain’s releases, 179 hands underwent one or multiple trigger releases, and 443 carpal tunnel releases. 150 (32%) of our patients were identified as “healthy” (i.e. non-smoking, non-diabetic, and non-obese) and 319 (68%) as “sick”. 108 patients were diabetic, 95 smokers, 250 obese (53%). 66 patients were identified as having developed complications: ranging from finger stiffness, to wound infection, to CRPS. In healthy patients, 15/151 (10%) had a complication. 19/95 (29%) of smokers developed a complication with a RR 1.68 (p = 0.108) and an odds ratio 2.3 (p = 0.03). In our diabetic patients, 22/108 (20%) had complication; RR 2.05 (p = 0.02) and odds ratio 2.3 (p = 0.02). Complications for obese patients were 38/250 (15%) with a RR 1.53 (p = 0.14) and an odds ratio of 1.63 (p = 0.13). In diabetic patients who smoke and are obese (13/469 patients or 2.8%), 4 had complications (30.8% complication rate, RR 3.1 (p = 0.019)). In diabetic patients who smoke, but are not obese (7/469 patients or 1.5%), 3 patients had complications (42.9% complication rate, RR 4.3 (p = 0.003)).
Finally, in obese diabetic patients who do not smoke (65/469 patient or 13.9%), 15 patients had complications (23.1% complication rate, RR 2.32 (p = 0.01)).

Summary Points

- Patients with diabetes and who smoke have four-times the risk of developing a complication after simple hand surgery than healthy patients
- Patients with diabetes and who smoke and who are obese have three times the risk of developing a complication as compared to their healthy counterparts.
Poster 027: Challenging Traditional Methods of Intra-operative Learning: Comparing Effectiveness of Video Tutorial with Apprenticeship Model for Zone II Flexor Tendon Repair

Category: Hand

Surgical Technique; Anatomy; Basic Science
Level 2 Evidence

Grant Received from: Orthopaedic Research and Educational Foundation

Adam Shar, MD
Marci Jones, MD
Christina Kane
Katherine Mallett

Hypothesis
1) There is improvement in outcome of cadaveric Zone II flexor tendon repair after technique instructions (either video tutorial or apprenticeship model) compared to no instructions.
2) There is no difference in outcomes of cadaveric Zone II flexor tendon repairs between video tutorial group and apprenticeship model group.

Methods
Orthopedic surgery residents at teaching institution were instructed to repair cadaveric flexor tendon to mimic Zone II flexor tendon repair (using repair method of choice) prior to receiving formal instructions (Pre-tutorial, either Group A or Group B). All participants were then randomized into two groups: video tutorial group (Group A; participants watched video demonstration of Zone II flexor tendon using 4-strand locked cruciate with running epitendinous repair method), and apprenticeship model group (Group B; participants observed same repair method performed by live instructor). Immediately following tutorial, participants performed Zone II flexor tendon repair using aforementioned repair method (Post-tutorial). Tendon dimensions were measured at non-repair sites and repair sites using digital caliper and tendon cross-sectional areas were determined. All tendons were evaluated on MTS machine for 2-mm gap strength, ultimate load strength, tendon elongation between 2mm gap strength and ultimate load strength, and increase in cross-sectional area at repair site (compared to non-repair site) to assess bulk of repair. Data analysis was performed to evaluate repair strength and bulk of repair.
Results
Twenty-two residents participated in study (Group A: n=10; Group B: n=12). Mean cross-sectional area of tendon at non-repair site measured 12.19mm2 in Group A compared to 15.35mm2 in Group B (p=0.002). Overall, post-tutorial (Groups A and B combined) tendons had stronger 2-mm gap strength (36.0N vs 22.9N, p = 0.002) than pre-tutorial tendons. Cross-sectional area at repair site (compared to non-repair site) increased by 111.9% in pre-tutorial group and by 101.7% in post-tutorial group (p =0.54). The 2-mm gap strength improved by 11.6N after tutorial in Group A and improved by 14.4N in Group B. Ultimate load strength did not improve after tutorial in group A (30.3N pre vs 30.0N post) but improved by 12.0N in Group B (41.3N pre vs 53.3N post).

Summary Points
• Compared to no tutorial, both video tutorial and apprenticeship model groups demonstrated improved 2mm gap strength of cadaveric zone II flexor tendon repair.
• Ultimate gap strength improved following tutorial in apprenticeship model group, but remained the same in video tutorial group.
Hypothesis
It remains unclear how many patients undergo secondary surgery after initial arthroscopy for trapeziometacarpal (TMC) arthrosis. We studied the null hypothesis: There are no factors related to secondary TMC arthroplasty. We also examined secondary questions of 1) what percentage of patients underwent secondary TMC arthroplasty and 2) how much time elapsed from initial arthroscopy to arthroplasty.

Methods
In this retrospective study, we included all adult patients who were treated with arthroscopy of the TMC joint at two Level I hospitals and affiliates. Explanatory factors were assessed for their independent association with secondary TMC arthroplasty using bivariate and multivariable logistic regression analyses.

Results
Fourteen of 84 (17%) thumbs underwent secondary TMC arthroplasty, an average of 11 months after the initial arthroscopy. The indication for revision surgery was persistent pain. Synovectomy alone and smoking were independently associated with secondary TMC arthroplasty when compared to arthroscopic (partial) trapeziectomy with additional tendon interposition or allograft.

Summary Points
• This study demonstrated that one in six thumbs underwent secondary TMC arthroplasty, an average of 11 months after the initial arthroscopy
• Isolated debridement is associated with re-operation which suggests that arthroscopy alone is a less preferred strategy than arthroscopy coupled with another procedure may be more durable
• Smoking is associated with inferior outcomes regardless of surgical technique
Bibliography
Images
Hypothesis

Arthroscopic complete trapeziectomy is an alternative treatment option for patients with symptomatic basilar joint arthritis of the thumb. In patients with Eaton stages II through IV carpometacarpal (CMC) osteoarthritis, complete trapeziectomy using an arthroscopic technique offers an effective, minimally invasive solution with a minimal risk of complications requiring revision surgery.

Methods

A retrospective review of patients treated with arthroscopic complete trapeziectomy with suture button suspensionplasty (ACTBS) by one senior hand surgeon from January 1, 2012 - August 30, 2016 was performed. Inclusion criteria included patients > 18 years of age, an established diagnosis of thumb CMC osteoarthritis (Eaton stages II-IV), a failed trial of conservative management, surgical treatment with ACTBS, and a minimum time of follow-up of > 10 weeks. Patients were excluded if they had a prior surgery aimed at stabilizing the thumb CMC joint, underwent partial trapeziectomy or had incomplete preoperative radiographic data. Paired t-testing, chi-square analysis and independent t-tests were used to evaluate the data.

Results

191 cases of arthroscopic complete trapeziectomy were performed in 179 patients. There were 57 males and 122 females with a mean age of 64.4 ± 8.9 years. Surgery was performed on the dominant hand in 93 cases (49%). 14.1% of the cases were classified as Eaton stage II, 22.0% Eaton stage III and 63.9% Eaton stage IV CMC osteoarthritis. 180 cases involved arthroscopic complete trapeziectomy and 11 involved arthroscopic complete trapeziectomy with hemitrapezoidectomy. Mean follow-up duration was 9.4 ± 10.2 months. Key pinch strength decreased from 9.9 pounds preoperatively to 8.8 pounds postoperatively (P = 0.019). In 81% (154/191) of the cases, patients were able to regain full opposition postoperatively. Revision
surgery was performed in 24 of the 191 cases (~12.6%). Of those patients requiring revision surgery, suture button removal was the most common secondary surgery performed (19/24). Additional secondary surgeries included arthroscopic hemitrapezoidectomy ($n = 3$) and revision arthroscopic trapeziectomy ($n = 2$). Female ($P = 0.029$) sex was associated with higher revision rates, while younger age ($P = 0.053$) and Eaton stage of osteoarthritis ($P = 0.54$) were not predictive of the need for revision surgery.

**Summary Points**
- Revision surgery is required in approximately 12% of cases and removal of the suture button is the most common secondary procedure.
- Key pinch strength decreases by ~1 pound (10%) postoperatively following arthroscopic complete trapeziectomy with suture button suspensionplasty.
- Eaton stage of osteoarthritis is not predictive of the need for revision surgery.

**Bibliography**

Images
Poster 030: Establishing an Efficient Care Paradigm for Trigger Finger  
Category: Hand

Treatment; Prognosis/Outcomes  
Level 2 Evidence

Sam Abrams  
Rashad Usmani  
Greg Merrell, MD

Hypothesis
To determine when a patient has failed steroid injection for trigger finger and might thus consider surgery, the injection would achieve maximal response by four weeks.

Methods
Inclusion criteria were: 1) symptoms new to the affected digit, 2) daily locking/catching (Quinell grade 2 or 3)12, 3) corticosteroid injection chosen by patient/surgeon as the initial treatment. Exclusion criteria were: 1) diabetes, 2) prior injection to the affected digit, 3) a fixed/locked trigger digit (Quinell grade 4), 4) age less than 18 years, 5) those unable to keep up weekly communication through email or phone.

Patients completed an initial Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire at the beginning of the study and an exit questionnaire at the end. Following injection patients were contacted at or around 3 days after injection, then at or around 1 week, and then weekly for 12 weeks until their symptoms either resolved or they failed treatment. To determine symptom resolution we asked the patients to answer 2 yes or no questions at each contact point: 1) Have you had any triggering in the affected digit in the last 3 days?, 2) Have your symptoms resolved to your satisfaction? Once the answers were no and yes respectively, we considered the patient’s symptoms resolved, they were provided an exit DASH questionnaire, and no longer followed.

Recurrence of symptoms after a period of 3 months (12 weeks) has been defined by a previous study as a recurrence following trigger finger injection1. Because our study was analyzing the effect following just one injection and not looking at recurrence, we choose 12 weeks as the study endpoint. Failure of the injection within that period was defined as the need for a second injection or surgical intervention. If patients failed treatment prior to the 12 week study period they were also provided an exit DASH questionnaire, and no longer followed. Those that at 12 weeks did not have symptom resolution, were then considered to have failed.
Results
The latest that any study participant experienced resolution of symptoms was 60 days. At 38 days the rate of resolution of the population slowed significantly, represented by an inflection point of the regression line.

Summary Points
- 4 weeks is not long enough to consider resolution of triggering after steroid injection. Clinicians should wait at least 6 weeks to consider surgical release after injection.
- Some resolution was achieved as late as 60 days.

Bibliography
Poster 031: Prosthetic Arthroplasty of Non-Border Digits for Treatment of Osteoarthritis and Posttraumatic Arthritis: A Systematic Review

Category: Hand

Treatment; Prognosis/Outcomes
Level 4 Evidence

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Jacques Hacquebord, MD

Hypothesis
Despite the common teaching that non-border digits are more appropriate for arthroplasty of the proximal interphalangeal (PIP) joint than border digits, we hypothesize that prosthetic arthroplasty of non-border digits is associated with a clinically important complication profile that may not be significantly different than previously reported complication rates for border digits.

Methods
A computerized keyword search of EMBASE, Medline, and Cochrane databases from 1976 through 2016 was conducted for “proximal interphalangeal” and “arthrodesis or fusion or arthroplasty” and “hand or finger or finger joint”. Included studies were restricted to those including 10 or more patients who underwent PIP joint prosthetic arthroplasty or arthrodesis for osteoarthritis (OA) or post-traumatic arthritis (PTA). Papers were then reviewed to include studies that provided data specifically on the outcomes of the long and ring non-border digits.

Results
Computerized search generated 378 original articles. Of these, 11 studies reporting outcomes of arthroplasty on 226 non-border digits (120 middle and 106 ring) were included in the review. Silicone arthroplasty was the most common with a total of 138 fingers included. 6 studies report on silicone prostheses; 3 on pyrolytic carbon; 2 Cobalt-Chrome; 1 biomeric; and 1 ceramic. There were no articles reporting outcomes for arthrodesis of the PIP joint in the setting of OA or PTA.

Reports on angular deformity after silicone replacement included incidences of up to 22%. One study reported that 7% of patients demonstrated instability requiring revision surgery. Another demonstrated mean static and dynamic coronal deformities of 3° and 9° for the ring finger and 5° and 11° for the long finger. A study of both silicone and pyrocarbon implants reported coronal deformity of greater than 10 degrees in 40% of long and 14% of ring finger
arthroplasties. Another study of pyrocarbon implants in index, long, ring, and small fingers found that the only variable associated with revision surgery was implantation in a ring finger. One study reporting Cobalt Chrome arthroplasty resulted in 6% and 20% 5-year incidences of failure for ring and long fingers, respectively, while the other report on Cobalt Chrome prostheses described 22% and 23% revision rates for ring and long fingers.

**Summary Points**
- Existing literature on outcomes after non-border digit arthroplasty is limited; however, data suggests that complications such as revision surgery and coronal instability remain in non-border digits
- Further research is necessary to compare arthroplasty in non-border and border digits to determine if complications in border digits is in fact significantly higher.

**Bibliography**

Images
Poster 032: Osteochondral Joint Reconstruction: Is a Vascular Pedicle Needed?

Category: Hand

Basic Science
N/A - not a clinical study

Grant Received from: 2016 Paracelsus Medical University Research Grant (E-12/16/080-BOR)

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Hypothesis
Subchondral perfusion of osteochondral grafts has been shown to be important in preventing long term cartilage degeneration. In carpal reconstruction subchondral perfusion from the graft bed is limited. The purpose of this study was to compare the histologic characteristics of cartilage in osteochondral grafts supported by synovial imbibition alone to cartilage of vascularized osteochondral flaps provided support of synovial and vascular pedicle perfusion.

Methods
Two adjacent osteochondral segments were harvested on the medial femoral trochlea in domestic 6-8 month old pigs. Each segment measured approximately 12mmx15mmx17mm. One segment was maintained on the descending geniculate artery vascular pedicle. The adjacent segment was purposefully separated from the pedicle to serve as a nonvascularized graft. A thin layer of methylmethacrylate cement was used to line the harvest site defect to prevent vascular ingrowth to the subsequently replaced specimens. The pigs were maintained on a high-calorie feed and returned to ambulation and full weight bearing on the surgical legs. The animals were sacrificed after 6 months and the specimens were reharvested, sectioned and examined. The cartilage was graded by two pathologists blinded to the origin of specimens as vascularized flaps or nonvascularized grafts.

Results
All specimens were assigned scores utilizing the International Cartilage Repair Society grading system. The scoring for chondrocyte viability, cartilage surface morphology and cell and matrix appearance were significantly higher in the vascularized osteochondral group compared with the graft group.
Summary Points

- When deprived of subchondral perfusion from underlying bone, osteochondral vascularized flaps in an intrasynovial environment demonstrate superior cartilage quality and survival when compared to nonvascularized grafts.
- In locations where perfusion from surrounding bone may be limited (i.e., proximal scaphoid or proximal lunate reconstruction) articular reconstruction using vascularized osteochondral flaps will yield superior cartilage organization and architecture than nonvascularized osteochondral grafts. The clinical and functional relevance of this finding requires further study.

Bibliography
Poster 033: Disparities in Digit Revision Amputation and Digit Replantation following Pediatric Traumatic Amputations: Analysis of 3,090 patients

Category: Hand

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Level 4 Evidence

Neill Li, MD
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Hypothesis
Indications for replantation following pediatric traumatic digit amputations are more liberal than adults, given the benefit of providing return of function and psychosocial health in an overall healthy patient population with high healing potential. Despite these benefits, age, insurance status, and digit amputated play a significant role in deciding upon replantation versus revision amputation.

Methods
The Kid’s Inpatient Database (KID) from the Healthcare Cost and Utilization Project (HCUP) for 2000, 2003, 2006, 2009, and 2012 were queried for traumatic amputations of the thumb or finger (ICD-9: 885.0, 885.1, 886.0, 886.1). Subjects were then divided between those who underwent replantation (ICD-9-CM: 84.21, 84.22) with those requiring amputation (ICD-9-CM: 84.01, 84.02). Patient age, sex, insurance status, and digit(s) affected were recorded. National estimates of incidence were calculated using discharge weighting. Fisher’s exact tests and multivariable regressions were utilized with p values < 0.05 determined to be significant a priori.

Results
Between 2000-2012, 3,090 patients suffered traumatic digit amputations. In this group, 1950 (63.1%) patients underwent revision amputation. Of these patients, 1,477 (75.7%) were male, mean age of 12.4 years, and 839 (43%) had private insurance. Among these patients, there were 2023 digits amputated with 1,681 (83.1%) fingers and 342 (16.9%) thumbs. Patients undergoing replantation numbered 1,140 (36.9%), of which 828 (72.6%) were male, mean age of 10.4 years, and 577 (50.6%) had private insurance. Of digits replanted, 884 (75.9%) were fingers and 281 (24.1%) were thumbs. Fisher’s exact test revealed insurance status, digit amputated, age, and sex varied significantly in patients undergoing replantation. However, treatment patterns over
this time period did not change. With multivariable regression analyses, young patients had an increased likelihood for replantation (OR = 0.955 for each additional year, 95% CI: 0.935-0.975, p<0.0001), thumb injuries were more likely to undergo replantation than finger injuries, (OR = 1.831, 95% CI: 1.382-2.426, p<0.0001), females underwent replantation more than males (OR = 1.375, 95% CI: 1.053-1.795, p<0.05), and private insurance patients were more likely to receive replantation (OR = 1.266, 95% CI: 1.024 – 1.564, p<0.05).

Summary Points
• The period between 2000 to 2012 had no change in treatment patterns following pediatric traumatic digit amputations.
• Patients who were younger, female, had thumb injuries, and had private insurance were significantly more likely to undergo replantation.
• These findings support trials of replantation are being done in those who may benefit the most: young patients with greater healing potential and thumb injuries that provide maximum return of function.

Bibliography
Poster 034: The “Fish Hook” Technique on Bony Mallet Finger

*Category: Hand*

Treatment; Surgical Technique  
Level 4 Evidence

Hongje Kang  
Sang Su Han  
Byung Min Yoo

**Hypothesis**

This study describes a new technique called the “fish hook” technique for the treatment of bony mallet finger. This technique catches the dorsal fragment with a bent K-wire shaped like a fish hook. Transarticular fixation is performed with another K-wire. This technique does not directly penetrate the bone fragment to prevent fragment comminution.

**Methods**

This study included 26 patients with mallet finger fractures who underwent surgery using the fish hook technique between 2010 and 2014. The fractures were classified according to the method of Wehbe and Schneider. The fracture fragment was fixed with a fish hook technique in all patients. The K-wire was removed after 6 weeks, when bone union was achieved. Clinical parameters, including range of motion and extensor lag, were assessed at the distal interphalangeal joint according to Crawford’s criteria.

**Results**

The mean follow-up period was 12.8 months. Mean extensor lag was 3°, and mean range of flexion of the distal interphalangeal joint was 76°. All patients achieved bone union after 6 weeks. According to Crawford’s criteria, there were 20 excellent results, 5 good results, and 1 fair result. No complications, including skin necrosis, pin loosening, and nail deformity, occurred.

**Summary Points**

- The “fish hook” technique is an effective treatment option for bony mallet finger with regard to both clinical and radiological results.

**Bibliography**

Poster 035: Comparison of Retrograde Intramedullary Screw vs Plating in the Treatment of Metacarpal Neck and Shaft Fractures

*Category: Hand*

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

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**COI**
Consulting Fees: AxoGen
Contracted Research: AxoGen

**Hypothesis**
Retrograde intramedullary metacarpal screw fixation is a newer technique, but has been shown to impart stable fixation that allows early range of motion [1-3]. The purpose of the study is to compare plating vs intramedullary screw fixation for unstable metacarpal fractures.

**Methods**
A retrospective review of all metacarpal neck and transverse or short oblique shaft fractures treated surgically by four hand surgeons from 2010 to 2016 was completed. Fractures treated by plate-screw fixation (PSF) and headless intramedullary screws (HIS) were compared. Exclusion criteria included severe comminution or length unstable fractures. Early active motion without casting was allowed in each group. Patients were followed for an average of 3 months. Postoperative radiographic parameters at healing were compared using t-tests.

**Results**
Forty-three fractures were treated with PSF, and 35 fractures were treated with HIS. Patient characteristics were similar in both groups. Anterior-posterior (AP) angulation averaged 2.2 degrees in the PSF group and 3.4 degrees in the HIS group (p-value 0.145). Lateral angulation averaged 1.2 degrees in the PSF group and 2.4 degrees in the HIS group (p-value 0.483). Shortening averaged 0.0 mm in the PSF group and 0.7 mm in the HIS group (p-value 0.001). No fractures had failure of fixation.
Summary Points

• Intramedullary screw has the potential benefits over plating with less soft tissue dissection, indirect fracture reduction and without hardware prominence.
• As compared to plating, there were no differences in fracture healing.
• Retrograde intramedullary screw imparts stable fixation to allow early active motion.

Bibliography

Hypothesis
When conservative treatment fails to alleviate the symptoms of carpometacarpal (CMC) arthritis in younger patients, CMC fusion is the recommended surgical modality, given concerns about long-term results of CMC arthroplasty in this patient cohort. We hypothesized that patients under 50 would have favorable clinical and radiographic outcomes following CMC arthroplasty in terms of patient satisfaction, strength, and functional outcomes.

Methods
Patients under age 50 at time of primary CMC arthroplasty for thumb CMC arthritis with minimum five-year follow-up were eligible for inclusion in this study. All patients meeting the inclusion criteria were contacted for long-term follow-up. Following informed consent, the study visit included questionnaires (Disabilities of the Arm, Shoulder, and Hand (DASH) score and visual analog scores) and physical exam. Patients that had been seen within one year, including radiographs, who did not wish to return for the long-term visit were asked to complete the questionnaires over the phone.

Results
Of the 2,624 thumb CMC arthroplasty patients at our institution since 2005, 260 patients were under age 50 (Mean age: 46 years; Range: 25-49 years) – only three of which required revision
arthroplasty. Of these, 36 patients under age 50 (mean age: 47 years; range: 42-49 years) were available for long-term follow-up, the majority of which were female (34/36; 94%). Mean DASH disability/symptom score was 13.7 (standard deviation (sd): 20.2), while mean DASH work and sports/arts scores were 3.4 (sd: 8.1) and 16.7 (sd: 40.8), respectively. Overall, patient-reported pain was low (mean: 0.5/10, sd: 1.4) and satisfaction was high (mean: 9.8/10, sd: 0.4). Range of motion for MCP flexion (p=0.095), MCP extension (p=0.645), IP flexion (p=0.674), IP extension (p=0.341), and passive MP extension (0.576) were not significantly different from the non-operative side. However, tip pinch (8.5 vs. 9.4; p=0.016) and key pinch (7.2 vs. 8.5; p=0.019) on the operative side were slightly lower than the non-operative side, while there was no significant difference in grip strength between sides (p=0.5608).

Summary Points
- Younger patients undergoing thumb CMC arthroplasty reported minimal pain, high patient satisfaction, and satisfactory DASH scores at long-term follow-up.
- There was not a significant difference in range of motion (flexion/extension) between operative and non-operative thumbs at long-term follow-up.
- Tip and key pinch strength was slightly lower on the operative side, with no significant difference in grip strength between sides.
- In this retrospective case-series, thumb CMC arthroplasty in patients under 50 had satisfactory results.
Hypothesis
We propose: 1) microstructural characteristics of the trapezium exist unique to advanced thumb carpometacarpal (CMC) osteoarthritis (OA); and 2) the histomorphometric properties of the trapezium differ significantly between geographic regions of the trapezium.

Methods
Research subjects were identified in a tertiary care facility with symptomatic basilar thumb CMC osteoarthritis who chose surgical management. Sixty-one consecutive trapezia were harvested from patients with advanced OA who underwent CMC joint reconstruction. The senior surgeon removed the complete trapezium via a modified Wagner incision, using a 3.5-mm tap to aid extraction. Trapezial specimens were categorized according to three previously described shapes: retained saddle, dish, and cirque [Van Nortwick, 2013]. Microscopic imaging of the trapezia were imaged using a MicroCT scanner at a resolution of 38-μm isometric voxels and oriented using isosurface rendering software (MicroView, Parallax Innovations) (Figure 1). Bony landmarks were used to define 3mm x 3mm x2mm volumes of interest in the trabecular bone within four different quadrants of the trapezium on the first metacarpal articulating surface: volar-radial, volar-ulnar, dorsal-radial and dorsal-ulnar. Auto-thresholding using Otsu’s method defined histomorphometry calculations, including bone volume fraction (bone volume divided by total volume), connectivity density, and trabecular thickness. Means and 95% confidence intervals were calculated for each of the quadrants, and the four groups were then assessed with an analysis of variance (ANOVA) to determine if their histomorphometric characteristics were significantly different.
Results
There were significant differences between geographic quadrants of the trapezium with respect to all three histomorphometric characteristics (Table 1). Variation in bone volume fraction was driven by relatively high values in the volar-ulnar quadrant (.36), with relatively lower values in the volar-dorsal (.30). Trabecular thickness mirrored this distribution of values, while connectivity density was driven by high dorsal-radial values relative to lower dorsal-ulnar values.

Summary Points
• Contact forces on the articulating surface of the trapezium and first metacarpal result in microstructural changes in trabecular bone structure.
• Significant differences exist in geographic quadrants of the trapezium with respect to bone volume fraction, connectivity density, and trabecular thickness.
• Bone volume and trabecular density are highest in the volar-ulnar quadrant, supporting evidence of high compressive forces at this corner of the joint.
• Connectivity density is highest in the dorsal-radial corner, which may contribute to eccentric load transmission across the joint.

Bibliography
Poster 039: A Systematic Review and Meta-analysis of Arthroscopy for Carpometacarpal Osteoarthritis

Category: Hand

Treatment; Prognosis/Outcomes
Level 2 Evidence

Suzanne Caroline Wilkens, MD
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Hypothesis
Arthroscopic management is a relatively new technique and has gained popularity as a potential treatment option for mild thumb carpometacarpal (CMC) osteoarthritis (OA). We performed a systematic review of arthroscopy for the treatment of thumb CMC OA and a meta-analysis of Visual Analog pain Scores (VAS), Disability of Arm, Shoulder and Hand (DASH) scores, grip strength, and pinch strength before and after arthroscopy for the treatment for thumb CMC OA.

Methods
We performed a systematic search in 3 electronic databases until May 2016 for studies describing arthroscopy for treatment of thumb CMC OA. Study characteristics were extracted and meta-analyses of VAS, DASH scores, grip strength, and pinch strength before and after arthroscopy were performed for the 10 included nonrandomized cohort studies including 294 patients. The pooled Hedge’s g was calculated for each outcome and then classified as either a trivial small, medium, or large effect. We also performed a subgroup analysis comparing the various surgical procedures used among the included articles. One group of matched controls was compared to the arthroscopic techniques in a secondary subgroup analysis. The number needed to treat was thereafter approximated using the Furukawa and Kraemer method.

Results
About 64-100% of patients were satisfied with arthroscopy and all patients were able to return to work. The overall combined complication rate was low (4%). Most studies did not report the rate of secondary surgery. This meta-analysis found a large effect on VAS and DASH scores and a small effect on grip strength. There was no effect on pinch strength. The NNT was 1.5 for improvement of the VAS, 1.2 for DASH and 5.8 for grip strength.
Summary Points
• Current evidence suggests that arthroscopy for CMC OA may improve pain scores and patient validated outcomes
• It is unclear whether these outcomes are durable

Bibliography
Images
Poster 040: Superior Healing in Small Joint Fusion in the Hand Using the Acutrak 2 Headless Compression Screw as Compared to Kirschner Wires

Category: Hand

Treatment;Surgical Technique;Prognosis/Outcomes
Level 3 Evidence

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Hypothesis
The purpose of this study was to assess healing and complication rate after arthrodesis of the distal interphalangeal joint or the thumb interphalangeal joint using the Acutrak 2 headless compression screw or Kirschner wires.

Methods
We retrospectively analyzed 147 consecutive primary fusions performed with the Acutrak 2 headless compression screw (n=107) or Kirschner wires (n=40) in 139 patients. Healing was assessed clinically and radiographically at 6 to 8 weeks postoperatively. Minimum follow-up was 12 months. Chi-square values were calculated for binary data and the Student t-test was used for numerical data. P<0.05 was considered statistically significant.

Results
In 95 of 107 cases, healing occurred at 6 to 8 weeks postoperatively following arthrodesis using the Acutrak 2 headless compression screw. Seven cases healed after 8 weeks. Secondary surgery with screw removal was required in 11 cases. In five cases, the screw was removed due to prominence of the screw, in two cases due to infection, and in four cases because of nonunion. In the latter four cases, fusion was subsequently obtained following Kirschner wire arthrodesis. In one case where fusion did not occur, the patient declined any further surgery.
In 29 of 39 cases, fusion had occurred at 6 to 8 weeks postoperatively following arthrodesis using Kirschner wires showing a lower fusion rate at this stage as compared to the Acutrak 2 headless compression screw group (Chi-square = 9.5, p<0.01). Another eight joints in the K-wire group fused at some point after 8 weeks of follow-up yielding a total fusion rate of 93% which was no different than a total fusion rate of 96% in the Acutrak 2 headless compression screw group (Chi-square = 0.7, p = 0.4). One infection occurred following Kirschner wire arthrodesis.
Summary Points
Distal interphalangeal joint and thumb interphalangeal joint arthrodesis can be achieved with either the Acutrak 2 headless compression screw or Kirschner wires with both showing equivalent total fusion rates. A shorter time to fusion using the Acutrak 2 headless compression screw as compared to Kirschner wires should be considered when choosing between the two methods.

Bibliography
Images
The use of modified Kutler method for the treatment of amputation of the fingertip

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Hideyuki Mizushima

Hypothesis
Replantation cannot be performed in all cases of fingertip amputation, and in such cases, a pedicle flap is sometimes used to cover the skin and soft tissue defect. Kutler described a technique of bilateral V-Y advancement flap for reconstructing fingertip amputation in 1947. In this study, we show an newly developed bilateral V-Y advancement flap (modified Kutler method) and evaluated the outcomes of this local flap.

Methods
Materials: We reviewed 21 cases (men, 21; women, 1; average age, 47 years) of amputation of the fingertip from July 2009 to February 2016. The injury sites were as follows: thumb (1), index finger (6), middle finger (7), ring finger (4), and little finger (3). Nineteen cases were injured in crush, and 2 were in clean cut. The average follow-up period was 188 weeks. Sensory disturbance and pain were examined at the final follow-up.

Methods: Inverted triangular flaps, the apex of those were placed on distal interphalangeal joint, were designed in radial and ulnar side of amputated finger. The volar incision was slightly undermined but left attached to subcutaneous tissue, and the dorsal incision was made to periosteum in both flaps. Both dorsal incisions were connected anterior to distal phalanx and volar subcutaneous tissue which include two flaps was separated from distal phalanx. Because of this maneuver, mobility of both flaps was greater than original Kutler method.

Results
All flaps survived. numbness, hypersensitivity, or hypesthesia remained in 8, 5 and 10 cases respectively. And pain due to an attack remained in 1 case. Coldness remained in 5 cases. Affected finger were useful in 18 patients and not useful in 3 patients. Of three cases, one was not useful because of pain, one was of hypersensitivity, and remained one was of hypesthesia.

Summary Points
Our modification allowed much greater mobility of the bilateral V-Y advancement flap than original Kutler method. But in this study, the incidence of numbness, hypersensitivity, or
hypesthesia after operation were higher than expected. Otherwise, this flap is very useful method for fingertip injury because affected fingers were useful in most of patients.

Bibliography

Images
Hypothesis
A limited number of reports was found for arthroscopic surgeries and diagnostic tools for thumb metacarpophalangeal joint (MCPJ), regardless of usefulness for reduction of displaced ulnar collateral ligament (UCL) and synovectomy in patients with rheumatoid arthritis [1-4]. The purposes of this study were 1) to report normal arthroscopic anatomy of uninjured ligaments and other articular structures, 2) to describe arthroscopic findings of injured UCL and radial collateral ligaments (RCL).

Methods
The study group consisted of 26 patients (6 women and 20 men) with 18 UCL and 8 RCL injuries. Surgery proceeded under vertical traction. Arthroscopic anatomy was evaluated from video during surgery of normal articular tissues, including the normal collateral ligament of the unaffected side. In addition, we examined injured UCLs and RCLs regarding degree, tear site, and reduction of displaced ligaments. The degree of injury was defined as follows: incomplete, complete and displaced. The site of ligament injuries were classified into distal, proximal, or midsubstance.

Results
Normal ligaments had 2 bundles to obliquely run across the joint, and had synovial plica-like meniscus at the rim of phalangeal joint surface in all patients. Radial sesamoid was clearly visible in all patients, whereas ulnar sesamoid and palmar plate were difficult to observe. Injured UCL and RCL had complete tear in 16 and 8 cases, respectively. All but 1 had distal injury in UCLs, whereas injured site of the RCL was not uniform with 3 midsubstance, 3 proximal, and 2 distal injuries. The distribution of the injured site was statistically significant between RCLs and UCLs. Furthermore, degree of UCL injury was incomplete, complete, and displaced in 2, 9, and 7 patients, respectively (Figure 1). Of 7 displaced UCLs, 5 were successfully treated under arthroscopy. Following the reduction, ligaments were stabilized at synovial plica. RCLs were
completely ruptured without displaced ligaments in all 8 patients. Six injured RCL fell into the joints at proximal to synovial plica (Figure2).

Summary Points
The arthroscopic findings showed that both UCL and RCL had synovial plica-like meniscus. Almost UCLs were stabilized at synovial plica even in complete injury and after reduction of displacement. In contrast, RCL were injured at proximal to synovial plica-like meniscus in 6 of 8 patients, and needed to be repaired in open technique due to difficulty of preservation to reduced position under arthroscopy. We believe that the synovial plica-like meniscus could play an important role for stabilization of injured UCL and RCL in the thumb MCPJ.

Bibliography
1: Chen YC. Arthroscopy of the wrist and finger joints. Orthop Clin North Am, 1979
3: Rozmaryn LM and Wei N. Metacarpophalangeal arthroscopy. Arthroscopy, 1999

Images
Poster 043: Shared Decision Making in Ulnar Sided CMC Dislocations

Category: Hand

Treatment
Level 4 Evidence

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Hypothesis
A shared decision making process can be an effective method to decide on operative vs. nonoperative management of ulnar-sided carpometacarpal (CMC) dislocations and fracture-dislocations.

Methods
We reviewed all patients with 5th or 4th and 5th CMC dislocations or fracture-dislocations presenting within 2 weeks to our ED. Patients’ injuries were reduced by an orthopedic resident in the ED upon presentation. At their first clinic visit, radiographs are taken and if either joint is subluxated or dislocated they are encouraged to have surgery to reduce and pin the joint(s). If the reduction is maintained, then a balanced discussion of options is presented to the patient. It is explained that the standard is to perform CRPP, that this is a low risk procedure, but that there is no guarantee of a better outcome, and that outcome is related to the final position at union. Questions are answered and the patient decides upon their treatment. We retrospectively reviewed the records and x-rays of operatively and nonoperatively treated patients and compared the two with respect to the reduction at union.

Results
Forty-three patients (42M:1F) with an average age of 27 years were treated for 5th or 4th and 5th CMC dislocations or fracture-dislocations. There were 33 injuries to the 4th and 5th and 10 isolated injuries to the 5th CMC joint(s). Eight were purely ligamentous and 35 had some bony injury and were considered fracture-dislocations. Seventeen patients were treated operatively, of whom 12 (71%) had subluxation of the joint upon presentation to clinic. The other 5 patients opted for surgery despite an accurate joint reduction. Twenty-six patients opted for nonoperative management, 24 had accurate reductions of the dislocations (4 had some minor incongruence of a small fracture fragment) and 2 had minor subluxation but refused surgery. There was no difference in any demographic factor in those who chose surgery vs. nonoperative care. At final followup after healing (141 days nonop; 85 days op), 16/17 treated operatively and 24/26 treated nonoperatively had reduced joints (p=1). One operative case subluxated slightly.
during followup and the two nonanatomic joints treated nonoperatively healed in the position that they were in.

**Summary Points**
- A shared decision making approach resulted in similar radiographic outcomes for operative and nonoperative treatment of 4th and 5th CMC injuries.
- 20% of patients whose reduction was maintained at the time of their first clinic visit chose surgery and 80% chose continued non-operative treatment.
Poster 044: pedicled digital artery perforator adipose flap for treatment of chronic digital osteomyelitis

Category: Hand

Treatment; Surgical Technique
Level 4 Evidence

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Hiroaki Nakamura, MD, PhD

Hypothesis
We have reported a surgical technique of pedicled vascularized tissue transfer for treating chronic digital osteomyelitis. This technique has the possibility of cold intolerance because the vascular pedicle utilizes the digital artery. In this report, we demonstrate a modified technique without scarifying the digital artery to prevent cold intolerance.

Methods
Adipose tissue nourished by the perforator vessels of digital artery was obtained at the level of the proximal phalanx. During this procedure, the digital artery was preserved. The vascularized adipose tissue was inserted into the dead space after bone debridement. Seven patients were treated with this procedure from 2014 to 2017. Three patients had chronic osteomyelitis in the index finger, 2 in the middle finger, and 2 in the ring finger. Foci of chronic osteomyelitis were located at the distal phalanx in 2 patients, at the distal phalanx to the middle phalanx via the distal interphalangeal joint in 4, and at the middle phalanx to the proximal phalanx via the proximal interphalangeal joint in 1. Mean duration of follow-up was 17 months. We assessed the efficacy of the technique by clinical symptoms and imaging. Aside from clinical series, we examined the localization of the digital artery perforators in both fingers of 5 healthy individuals with Doppler ultrasonography.

Results
The pedicled perforator adipose flap was successfully transferred from the digital tip to the proximal phalanx. The postoperative courses were uneventful; no additional treatments were required. Postoperative physical data and follow-up images showed no evidence of chronic osteomyelitis. No functional loss was caused by procuring vascularized adipose tissue from the
digits. No patients developed cold intolerance. Color doppler ultrasonography showed 3.5 perforator vessels on average in the proximal phalanx.

Summary Points
• Pedicled vascularized adipose tissue transfer based on perforator vessels of the digital artery was a reliable and reproducible with evidence of the short-term results.
• This technique is utilized for chronic osteomyelitis from the tip to the base of digits without microsurgical anastomoses.
• Color Doppler ultrasonography indicated the presence of a few perforator vessels in the proximal phalanx.
• In addition, cold intolerance can be avoided.

Bibliography

Images
Hypothesis
In this study, we describe and report on the outcomes of a novel technique using suture suspension arthroplasty (SSA) in the treatment of thumb basilar joint arthritis. Additional attention was also given to recession of the first metacarpal and assessment of the distance of the collapse between the 1st metacarpal and the scaphoid.

Methods
The surgical technique involves trapeziectomy under fluoroscopic assistance, followed by passing a suture through the abductor pollicis longus and flexor carpi radialis in order to create a suture suspension sling construct to maintain joint space and soft tissue tension. A retrospective chart review was performed on 60 patients in a 6 year period with a mean follow up of 14 months. X-ray analysis of 1st metacarpal subsidence was accomplished by measuring the loss of trapezial height ratio as described by Kadiyala et al (1996).

Results
Clinical outcomes for 60 patients treated with suture suspension arthroplasty (average follow-up of 14 months) were satisfactory, with an average initial follow-up DASH score of 45.94, 8-12 week score of 55.41, 6 month score of 29.93, 1 year score of 25.15, and final follow-up score of 25.74. The average pre-op trapezial space ratio was 0.337 with an average decrease of 0.116 after surgery. Grip strength, lateral pinch and precision pinch at 3 month follow up was 24.8 lbs, 6.0 lbs and 4.9 lbs, and 30.7 lbs, 7.1 lbs and 5.3 lbs at 6 month follow up, respectively.

Summary Points
• Trapeziectomy and suture suspension arthroplasty is an effective treatment option for thumb basilar joint arthritis when compared to other arthroplasty techniques.
• SSA allows for shorter immobilization, avoids sacrificing a tendon or using anchors, and can be performed in an efficient manner.
• Minimal subsidence of the 1st metacarpal was experienced using the SSA technique.
Bibliography
Poster 047: High Pressure Water Injection Injuries to the Hand: Perhaps Not a Benign Injury

Category: Hand

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Level 4 Evidence

R. Glenn Gaston, MD
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Shane Cook, MD
John Bracey, MD
Mark Tait, MD

COI
Royalty: Biomet
Consulting Fee: Biomet, BME
Speaker’s Bureau: Auxilium, BME, Smith & Nephew
Other: American Society for Surgery of the Hand: Board or committee member; Journal of Hand Surgery - American: Editorial or governing board

Hypothesis
High pressure water injections of the hand are uncommon injuries and only a few case reports have been described in the literature. It is unclear from these case reports whether water injection injuries should be treated nonoperatively with close observation or with surgical debridement. We hypothesize that the outcomes of high pressure water injections treated with initial observation versus initial surgical treatment will be similar.

Methods
We retrospectively identified a cohort of patients with high pressure injection injuries to the hand over a 16 year period using ICD-9 and CPT codes. Charts were subsequently reviewed to identify only those with water injection injury. Data collected included demographics, location of injection, hand dominance, type of initial treatment (operative versus nonoperative), need for additional surgery, and complications. We attempted to reach all patients by phone and email to assess long-term motion loss, sensation loss, pain, and need for additional surgeries.

Results
Nineteen patients with high pressure water injections to the hand were identified. Average patient age was 44 years and 79% were male. The non-dominant hand was involved in 84% of cases and nearly half involved the index finger. Nine patients were initially treated
nonoperatively while 10 patients underwent surgical treatment. Three of 9 nonoperative patients eventually required surgery at an average of 14 days post-injury, including debridement of a septic flexor tenosynovitis, fingertip amputation for tip necrosis, and a third patient with severe infection requiring amputation at the metacarpophalangeal joint. Two of the 10 patients initially treated operatively required additional surgery, including a trigger finger release with excision of scar tissue and a second patient requiring two repeat debridements for pseudomonas infection. Nine of 19 patients were reached by phone/email for long-term followup. One of 3 nonoperative patients had permanent loss of sensation, loss of motion and pain. Four of 6 operative patients had permanent loss of sensation, 3 had loss of motor and 1 had permanent pain.

Summary Points
• Our data represents the largest reported cohort of both operatively and nonoperatively treated high pressure water injection injuries.
• These injuries are not inherently benign and can be associated with high complication rates, whether treated operatively or conservatively. They warrant immediate medical attention, a low threshold for hospital observation with IV antibiotics, and operative debridement at the discretion of the treating surgeon.
• Our 33% complication rate for nonoperatively treated injuries, which included two amputations, highlights the potential pitfalls of conservative management.
Poster 048: Comparing Flat Panel and Micro Computed Tomography in the Measurement of Trapezium Microstructural Characteristics

Category: Hand

Evaluation/Diagnosis; Anatomy
N/A - not a clinical study

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Hypothesis
The histomorphometric measurements of the trapezium are significantly different between lower-resolution flat panel and high-resolution micro computed tomography (CT).

Methods
Research subjects were identified in a tertiary care facility with symptomatic thumb carpometacarpal (CMC) osteoarthritis (OA) and preoperative radiographs staged as modified Eaton stage III or IV (Ladd, 2015). A total of nine trapeziums were harvested from nine different subjects with advanced thumb CMC arthritis that underwent elective CMC joint reconstruction. The senior surgeon removed the complete trapezium via a modified Wagner incision, using a 3.5-mm tap to aid extraction.
We imaged the subject’s hand with flat panel CT at a resolution of 308 microns followed by micro CT at a resolution of 38 microns. We utilized isosurface rendering software with the MicroView CT analysis software (Version 2.5.0, Parallax Innovations) to orient relative surface landmarks to divide the bone into 3 columns – radial, middle and ulnar. Within each column, we selected a 7mm x 5mm x 2.5mm volume of interest that was uniform in location between the flat panel and uCT images. Bone volume fraction (BV/TV), trabecular number (Tb.N.), and trabecular spacing (Tb.N) were collected for each volume of interest. Matching columns from the nine specimens (N=27) were compared with Student’s t-tests and Bland-Altman plots to analyze the agreement between the two imaging modalities.

Results
There were significant differences in all trabecular parameters—thickness, number, and spacing—between the flat panel and micro CT using paired t-tests (Table 1). Trabecular thickness and spacing were significantly increased on the flat panel (.58mm and .80mm, respectively)
relative to micro CT (.28mm and .66mm). Trabecular number was greater on the higher-resolution micro CT (1.08) than flat panel (0.81). However, the values of BV/TV did not significantly differ between the scans, which also held for each of the columns (Figure 1). Means of the differences in measurements compared to the differences of the means in the Bland-Altman plots revealed data constrained within 95% confidence intervals.

**Summary Points**
- Flat panel in vivo imaging enables comparison to high resolution ex vivo micro CT imaging.
- Bone volume fraction (BV/TV) did not vary significantly between lower-resolution flat panel and the higher resolution micro CT. Future studies may assess if this is a useful proxy for anatomic characteristics of the trapezium in thumb CMC OA (Lee 2013).
- Trabecular thickness, number, and spacing were significantly different for the two modalities, indicating that flat panel scans may not appropriately estimate these characteristics in-vivo.

**Bibliography**
Poster 049: Epidemiology of flexor tendon injuries and repairs in an adult population

Category: Hand

Evaluation/Diagnosis; Surgical Technique
N/A - not a clinical study

Min Kai Chang

Hypothesis
Flexor tendon injuries are common and cause significant morbidities and socio-economic implications, but there have been limited studies on the epidemiology. The purpose of this study is to describe the epidemiology of flexor tendon injuries and repairs in an adult population, which can be used to identify the population at risk, provide information for the estimation of economic burden, and ultimately plan resources and policies for the management and prevention of flexor tendon injuries.

Methods
This study is a retrospective review of patients with flexor tendon injuries treated in a local hospital in Singapore from January 2011 to December 2014. Subjects were identified from hospital electronic medical records and patient case notes using names and abbreviations of the digital flexor tendons. All patients with flexor digitorum profundus, flexor digitorum superficialis, and flexor pollicis longus tendon repairs from zones I to V, with or without concomitant fractures, nerve, or vessel injuries, were included. The data was grouped into patient demographics, injury details, and surgical details. Statistical analyses were performed using the one-sample z test. All tests were two sided and p<.05 was considered statistically significant.

Results
A total of 214 patients, 308 digits, and 446 flexor tendon repairs were identified. Male (79.0%) in the 20-29 age range (37.9%) were the most vulnerable to flexor tendon injuries. Using the International Standard Classification of Occupations, it was found that cleaners/laborers/related workers (24.3%) were more prone than other occupations (p-value < .0001). Most injuries were caused by glass lacerations (35.5%) and work-related (48.1%). Non-dominant hand (56.2%) was injured more often than dominant hand (p-value = .030). Zone 2 injuries contributed 35.7% of all injuries (p-value <.0001). Nerve and vessel injuries accounted up to 69.8% and 58.1% of all digits with flexor tendon repairs, and they usually occur together, requiring microsurgical repair. Most procedures lasted 1 to 2 hours (35.0%). General anesthesia was most commonly used (74.3%). Out of all the tendons injured, 68.6% were repaired using core sutures. In our institution, most core repairs were done with Lim-Tsai technique (83.7%).
Summary
• To the best of our knowledge, this is the largest epidemiological study on flexor tendon injuries in an adult population
• The study encompasses patient demographics, injury characteristics, and surgical details of an adult population with flexor tendon injuries and repairs
• This data can be used to aid prevention and plan resources for the management of flexor tendon injuries

Bibliography

Images
Poster 050: A systematic review of digital survival rate after replantation during the last 10 years in Japan

Category: Hand

Prognosis/Outcomes
Level 4 Evidence

Koji Moriya, MD
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Naoto Tsubokawa, MD
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Yutaka Maki, MD

Hypothesis
In Japan, digital replantation is preferred to revision amputation; the reverse is true in the USA. A large US replantation series experienced a 57% survival rate. Our purpose was to systematically review the English and Japanese literature on digital replantation, to clarify the survival rate over the last 10 years in Japan.

Methods
We systematically searched PubMed (an English-language database) and Ichushi-Web (a Japanese-language database) from January 2007 to December 2016 and scanned the reference lists of retrieved articles for relevant studies. The initial searches included the keywords “traumatic amputation”, “replantation”, “finger”, and “Japan”. The inclusion criteria were (1) presentation of primary data, (2) discussion of five or more replantations, and (3) presentation of survival rates. Additional data extracted included demographic information, and the nature and level of amputation.

Results
We identified 99 unique records. Of these, 53 were excluded after screening of titles and/or abstracts, on the basis that they lacked relevance (usually because they did not deal with digital replantation). The reference lists of the remaining 46 records were screened, which led to the identification of one further record, yielding a final total of 47 eligible full-text articles. Of these, 28 were excluded because they were review articles (18), studied only survival or circulatory insufficiency (7), or contained very few results (3). Thus, 19 articles were finally included. These dealt with 923 digital replantations in 699 patients. The index finger was the digit most commonly replanted, followed by the long finger. Most replantations were performed following Tamai zone I or zone II amputations. The most common injury triggering surgery was crushing, followed by avulsion. The overall digit survival rate was 82.4%. Survival did not differ by the
injury levels of the Tamai classification. In terms of the mechanism of injury, the survival rate after avulsion-type amputations was significantly poorer than that after clean-cut or crush-type amputations.

**Summary Points**

The success rate of digital replantation over the last 10 years in Japan (82.4%) was higher than that in the US. We believe that this may be because US hand surgeons currently have few opportunities to perform digital replantations; the necessary surgical skills are, thus, better preserved in Japan. However, in Japan, avulsed-type amputation was a significant negative predictor of replantation success.

**Bibliography**


Images
Hypothesis
Factors such as comorbidities, fracture characteristics, and surgical treatment methods are not associated with reoperation of the proximal interphalangeal (PIP) joint. There is no association between postoperative dorsal subluxation and arthritis in volar base fractures.

Methods
In this retrospective study, demographic, injury, treatment, and revision surgery related characteristics were gathered of 161 surgically treated PIP joint involved fractures between 2002 and 2015. In 47 volar bas fractures, the articular involvement was measured and postoperative subluxation was assessed on radiograph.

Results
25 of 161 fingers underwent revision surgery. After performing a bivariate selection for a multivariable logistic regression, open fracture was independently associated with revision surgery (P= 0.027; OR=6.3; 95% CI of 1.2-32). The most common indication for reoperation was joint stiffness (35%).
Seven of 47 fingers had postoperative dorsal subluxation. Bivariate analysis showed a significant association between postoperative subluxation and comminution (P=0.04) and a borderline significant association with percent articular involvement (41% versus 55%; t-test: P=0.086) and postoperative arthritis (20% versus 57%; Fisher’s exact test: P=0.060).

Summary Points
• The revision rate of PIP joint involved fractures was 16% with open fractures having the highest odds of needing revision surgery.
• Postoperative dorsal subluxation was present in 15% of the fingers and was more prevalent in PIP joint fractures with a large fragment, comminuted fractures, and was associated with postoperative arthritis.
• Recognizing these factors might help planning the treatment of these injuries.

Bibliography
Images
Poster 052: A Prospective Evaluation of Complications After Pinning in the Hand

Category: Hand

Treatment
Level 2 Evidence

Kevin Lutsky, MD
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COI
Consulting Fee: DePuy Synthes

Hypothesis
Kirschner wires (K-wires) are commonly used during hand surgical procedures. The current understanding of complications rates of K-wire use are based almost entirely on retrospective studies. The purpose of our study was to prospectively evaluate the frequency of K-wire related complications during hand surgical procedures.

Methods
All patients who had K-wires placed as part of their surgical procedure by one of 12 attending hand surgeons over a 6-month period were included. Patients were enrolled prospectively. Complications were recorded by the attending surgeon at follow-up visits and reported to the principal investigator. Demographics and patient comorbidities including diabetes mellitus and smoking history were recorded.

Results
There were 152 patients enrolled during the study period. There were 59 women and 73 men. The mean age was 42 years (range: 11-82). There were a total of 24 complications in 19 patients. This included 11 infections. There were 13 other complications including pin migration or pins falling out.

Summary Points
We identified a high rate of complications in this prospective study, substantially higher than values reported in the literature which are largely based on retrospective studies. The most
common of these is pin site infection. While K-wires are often needed during hand surgery, surgeons should be aware that adverse events are frequent.
Poster 053: Correlation of Mucous Cysts with Radiographic Degeneration

Category: Hand

Evaluation/Diagnosis
Level 4 Evidence

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Hypothesis
Mucous cysts (MC) are common ganglions that form around the distal interphalangeal (DIP) joints of fingers and the interphalangeal (IP) joint of the thumb. It has been hypothesized that there is a correlation between the degree of DIP and thumb IP joint radiographic degeneration and the presence of clinically diagnosed MC.

Methods
Seventy six consecutive patients were reviewed retrospectively with a diagnosis of MC over a 24 month span. All had radiographic evaluation of the affected digits or hand. The DIP joints were graded (0-normal, 1-spurring, 2-loss of joint space, 3-erosive changes of joint surface). 40 radiographs with conditions unrelated to the DIP joint or thumb IP joints were randomly selected as controls. Other clinically relevant data such as prior surgery/trauma to the affected hand, age, hand dominance, gender and affected finger were also included in the analysis. Unpaired t-test and Analysis of Variance model was used to compare the groups, the digits, and the demographic parameters.

Results
Patients with MC are more likely to have a statistically significant higher chance of radiographic degeneration (1.18) compared to controls (0.30, p<0.0001). The middle finger was most commonly affected at 35.2% (95%CI: 25.5-45.9%) and the ring finger was the least affected at 3.3% (95%CI: 0.0-9.3%). When comparing to an expected even distribution of 20% for each finger, the middle and ring fingers were the only digits with a statistically significant difference from the expected value (p<0.01). Males (28.6% of patients) with a MC were represented less than females (95% CI: 19.6-39.0%, p<0.01). There was no correlation between age or sex and the affected finger.
Summary Points
• Patients with MC’s were more likely to have a greater degree of radiographic degeneration than age and gender matched controls.
• The middle finger is affected more frequently and the ring finger less.
• Women were more likely than men to present for an evaluation of a MC.

Bibliography

Images
Poster 055: Efficacy of "Knuckle splint" for Fractures around the Metacarpophalangeal Joint

Category: Hand

Treatment; Prognosis/Outcomes; Patient Education
Level 4 Evidence

Daiki Yamamoto, MD
Kaoru Tada, MD
Tadahiro Nakajima
Hiroyuki Tsuchiya, MD

Hypothesis
We developed the “Knuckle splint” which fixes the metacarpophalangeal (MP) joint at 90 degrees of flexion and allows free mobility of the wrist, proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints. This functional splint is effective for treatment of fractures around the MP joint.

Methods
In this retrospective case series study, we evaluated 20 patients with fractures around the MP joint who were treated either with a “Knuckle splint” for conservative treatment, or post-operatively. The sample consisted of 14 men and 6 women between 38 and 82 years of age (average 57.1). Fractures included 11 fractures of the metacarpal diaphysis, 7 fractures of the distal metacarpal bone (neck fracture), and two fractures of the basal part of the proximal phalanx. We evaluated the duration of splinting, the stability of the fracture site, joint contracture after splinting, and adverse events with the “Knuckle splint”.

Results
The duration of splinting ranged from 2 to 6 weeks (average 4.3 weeks). There were no patients in which transposition of the fracture progressed, and all cases achieved bony union. There was one extension contracture of the MP joint. This patient could not apply the splint with enough MP joint flexion because of hard swelling. In two cases, skin disorders occurred on the dorsal aspect of the hand, but they healed with wound dressing.

Summary Points
• Fractures around the MP joint are treated not only by hand surgeons but also by all orthopaedists. On treatment of these fractures, fixation for bone union and mobilization to prevent joint contracture or tendon adhesion should be done concurrently.
• The “Knuckle splint” makes it very easy to achieve the ideal position of 90 degrees of flexion of the MP joint and early mobilization of the PIP and DIP joints. Every physician and patient can put on the splint regardless of their ability.
• The “Knuckle splint” is an effective splint for conservative treatment and post-operative splinting of fractures around the MP joint.

Bibliography
Images
Poster 056: Modified Bouquet technique for metacarpal fractures

Category: Hand

Surgical Technique
Level 4 Evidence

Yong-Woo Kim
Jae-Hoon Choi
Seok-Whan Song, MD, PhD

Hypothesis
The purpose(hypothesis) of this study was to report the clinical outcome of “modified Bouquet technique”, as a simple and effective internal fixation with Kirschner- wire for the metacarpal neck fractures.

Methods
Sixty-seven patients with metacarpal neck fracture treated by modified Bouquet technique were retrospectively reviewed. The operation time and removal time were evaluated. For radiologic evaluation, posterior angulation of fracture and metacarpal shortening were measured pre and postoperatively. For clinical evaluation, range of motion of metacarpophalangeal joint, Green and O’Brien score were evaluated.

Results
Preoperative neck shaft angle of metacarpal bone was 46.0° and length of metacarpal bone was 51.2 mm, and postoperative neck shaft angle was 24.4° (p=0.003) and length of metacarpal length was 52.8 mm (p=0.031) in average. The mean range of motion was 86.6° and Green and O’Brien score was 96.1 points at last visit. We had one complicated case with type II complex regional pain syndrome of affected hand with hypertrophic scar formation.

Summary Points
• Modified Bouquet technique for metacarpal neck fracture is a good method using just two K-wires, plier and mallet without electric devices in short operation time.
• The technique can correct angulation of fracture site, rotation of finger and metacarpal shortening by controlling inserted K-wires with high bone union rate with less joint stiffness.

Bibliography
Images
Poster 057: Simultaneous volar fracture-dislocation of distal interphalangeal joint and dorsal fracture-dislocation of proximal interphalangeal joint in a single digit (Double fracture-dislocations in a single digit)

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Jeonghwan Kim, MD

Hypothesis
Up to date, simultaneous volar fracture-dislocation of DIP joint and dorsal fracture-dislocation of PIP joint in a single digit was not reported. We report two cases of double fracture-dislocations of simultaneous volar fracture-dislocation of DIP joint and dorsal fracture-dislocation of PIP joint in a single digit.

Methods
From Jan 2015 to Aug 2016, we treated two patients who showed simultaneous volar fracture-dislocation of DIP joint and dorsal fracture-dislocation of PIP joint in a single digit. All patients were male, and their ring fingers were injured. Mean age was 38 years, and all patients got injury during playing baseball. Mean follow-up period was 6 months.

Results
All patients had dorsal base fracture on their distal phalanx with mean 35% involvement of joint surface. And they had volar base fracture of their middle phalanx with mean 40% involvement of joint surface. We treated all volar fracture-dislocations of DIPJ by closed reduction and pinning with extension block technique. Pins were removed at 6 weeks after surgery. And the fracture-dislocations of PIP joint were treated by open reduction and screw fixation of middle phalanx. And three weeks after injury, active range of motion exercise of PIP joint was stared. At 6 weeks after surgery, all fractures were united without any complications. At the final follow-up, the mean extension and flexion of DIP was 0 degree and 50 degrees, respectively. And the mean extension and flexion of PIP was 0 degree and 85 degrees, respectively. And there was no instability at the final follow-up.
Summary Points

• Double fracture-dislocations of simultaneous volar fracture-dislocation of DIP joint and dorsal fracture-dislocation of PIP joint in a single digit were very rare injury by high energy on the finger tip, such as basketball or baseball injury.
• These injuries were very rare, but these injuries could be successfully treated by careful surgical techniques.
Poster 058: Osteosynthesis of mallet finger using plate and screws: evaluation of 25 patients

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes

Level 4 Evidence

Fabio Simoto, MD

Hypothesis
To evaluate the results from surgical treatment of patients with mallet finger injury using a hook plate and screw.

Methods
Twenty-five patients (19 males and six females) between the ages of 20 and 35 years were analyzed between May 2008 and December 2012.

Results
The results from 10 patients (40%) were excellent and from 15 (60%), good. Twenty-one patients (84%) reported no pain, 18 months after the operation. There was no limitation to range of motion in 14 cases (56%), limitation of extension in seven (28%) and limitation of flexion in four (16%).

Summary Points
• Surgical treatment by means of open reduction and internal fixation using a hook plate and screw proved to be an excellent option for treating mallet finger fractures and was considered to be a safe and effective method.

Bibliography
Poster 059: Dupuytren Disease – Risk Factors Associations

Category: Hand

Evaluation/Diagnosis; Basic Science
Level 4 Evidence

Vera Resende
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Hypothesis
Dupuytren Disease (DD) is the most common heritable disorder affecting connective tissues. It is benign but chronic progressive and results in fibrotic changes on the palmar and digital fascia and adjacent soft tissues. Dupuytren contracture is the end of Dupuytren disease. DD has been associated with hypercholesterolemia, diabetes, tobacco, alcohol abuse, epilepsy, antiepileptic medication, regional trauma, chronic heavy manual labor, and a lower body mass index. The literature is far from clear on this topic and lack of association has also been reported for each of these factors. The objective of this work is to clarify some of this associations by identifying and correlate the risk factors with DD.

Methods
This is a retrospective and observational study that analyze the data from the patients operated between 2010 and 2015 with DD or Carpal Tunnel Syndrome (CTS).
The risk factors evaluated were: sex, age, CTS, Trigger Finger, De Quervain Disease, Synovial Cysts, Diabetes, Arterial Hypertension, Obesity, Anxiety, Depression, Thyroid Diseases, Degenerative Osteoarticular Diseases, Benign Prostatic Hyperplasia, Asthma, Dyslipidemia, Anemia, Auricular Fibrillation, Smoking, Rhinitis and American Society of Anesthesiologists (ASA) Score.
To compare the means of one variable (age) for the two groups of patients we use the Independent-samples t test. The association of the risk factors with DD was performed with the Chi-Square Test. The data were processed in statistical software version 20.0 of SPSS. It was considered a probability of type 1 error of 0.05 in all inferential analyzes.

Results
The incidence of DD in the 3481 patients studied were 12.2%, 88.4% CTS, so 0.6% had both diseases.
Mean age of 61.18 years in DD and 53.05 years in CTS. Comparing the two groups of patients with the Independent t test show that there was a statistical difference in age (t(3479)=12.880; p=0.000). 87.1% were male in DD meanwhile in CTS 82.5% were female. The inferential analyzes shows that DD is associated with sex (p=0.000), CTS (p=0.000), Trigger Finger (p=0.004), Diabetes (p=0.000), Obesity (p=0.01), Anxiety (p=0.002), Depression (p=0.000), Degenerative Osteoarticular Diseases (p=0.003), Benign Prostatic Hyperplasia (p=0.000), Dyslipidemia (p=0.000), Auricular Fibrillation (p=0.002) and ASA Score (p=0.000), showing no correlation with all other risk factors studied.

Summary Points
• This study identifies many risk factors associated with DD. The identification of this risk factors is of great value in the prediction of risk of DD, but, more investigation is necessary to explain the mechanism underlying these risk factors and to understand the correlations between them.

Bibliography
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3: Dupuytren's disease risk factors. Geoghegan JM, Forbes J, Clark DI, Smith C, Hubbard R - J Hand Surg Br - October 1, 2004; 29 (5); 423-6

Images
Poster 060: A Novel Technique for Correcting Extensor Lag in Vascularized Toe PIP Joint Transfers

Category: Hand

Surgical Technique
Level 5 Evidence

Yu-Te Lin, MD

Hypothesis
The use of the vascularized second-toe proximal interphalangeal joint (PIPJ) for vascularized joint transfers (VJTs) allows for restoration of powerful pinch/grasp and range of movement of a PIPJ in the hand. However, because of the lack of central slip formation in the majority of toes, the reconstructed PIPJ often results in extension lag. Extension lag associated with poor central slip formation in the lesser toes can be corrected using central slip reconstruction methods such as the Stack method. However, such methods are often cumbersome and involve extensive dissection and soft tissue manipulation. We present a novel, reproducible, simple yet effective technique in recreating the insertion point of the extensor tendon in the reconstructed finger, hence correcting the issue of extensor lag in vascularized toe joint transfers. The crux of this technique empowers the surgeon with the ability to correct inherent extensor lag of toes in VTJs. This will hence nullify “toe PIPJ angles” as a preselection criteria in determining patients suitable for VJT, thus enabling more patients to benefit from VJTs.

Bibliography
Hypothesis
We hypothesized arthroscopic resection arthroplasty (ARA), which is a minimally invasive procedure that involves performing hematoma and distraction arthroplasty (HAD) 1,2) under arthroscopic guidance, for thumb carpometacarpal (TM) joint arthritis is superior to conventional methods, ligament reconstruction and tendon interposition arthroplasty (LRTI). We compared rates of early postoperative recovery between ARA and LRTI.

Methods
We compared 24 patients who underwent ARA with postoperative follow-up of at least 1 year and 14 patients who had previously undergone LRTI. The mean subject age at the time of surgery was 66 years in the ARA group and 62 years in the LRTI group, with no statistically significant difference between the two groups. For the ARA procedure, in patients at Eaton stage 3, 4 mm of the articular surface of the trapezium was arthroscopically resected through dorsal portals, at Eaton stage 4, the procedure was performed as per the aforementioned method, with additional arthroscopic distal scaphoid excision. LRTI was performed using the entire FCR tendon following total trapeziectomy via Wagner approach. From 3 months to 1 year postoperatively, the grind test, pinch power, quick DASH score, and trapezial height in X-ray were chronologically evaluated every 3 months.

Results
According to the Eaton classification, stage 3 and 4 disease was observed in 20 and four patients, respectively, in the ARA group and 10 and two patients in the LRTI group. In the grind test, pain disappeared within 1 year of surgery in all patients in the ARA group, whereas it persisted in two patients in the LRTI group. Figure 1 shows postoperative transition of pulp and key pinch power in both groups. Quick DASH scores changed from 38 to 26, 19, 19, and 11, respectively, in the ARA group and 44 to 28, 19, 16, and 11 in the LRTI group, with a significant improvement compared with the preoperative scores observed at 9 months postoperatively in the LRTI group.
and 6 months postoperatively in the ARA group, indicating earlier recovery in the ARA group. Figure 2 shows postoperative transition of trapezidal height in X-ray.

Summary Points
• In both objective and subjective evaluations, the ARA group, as expected, demonstrated superior outcomes.
• Pain relief in the ARA is attributable to the fact that arthroscopic surgery is minimally invasive and involves mechanisms related to interpositioning with fibrocartilage formation from hematoma.
• Pinch power improvement in the ARA is attributable to decreased metacarpal subsidence compared to that with LRTI.

Bibliography
Images
Poster 062: Factors associated with radiographic trapeziometacarpal arthrosis in patients not seeking care

Category: Hand

Evaluation/Diagnosis
Level 4 Evidence

Suzanne Caroline Wilkens, MD
Matthew Tarabochia, MD
David C. Ring, MD, PhD
Neal C. Chen, MD

Hypothesis
In this study we aimed to determine factors associated with radiographic severity of trapeziometacarpal (TMC) arthrosis, thumb pain, thumb-specific disability, pinch strength, and grip strength in patients not seeking care for TMC arthrosis. Our primary null hypothesis was that there are no factors independently associated with radiographic severity of TMC arthrosis according to the first 3 stages of the Eaton classification among patients not seeking care for TMC arthrosis.

Methods
We enrolled 59 adult patients not seeking care for TMC arthrosis. We graded patient’s radiographic TMC arthrosis and asked all patients to complete a set of questionnaires: demographic survey, pain scale, TMC arthrosis related pain and disability questionnaire (TASD), and a depression questionnaire. Metacarpophalangeal hyperextension, pinch and grip strength were measured and the grind test and shoulder test were performed. Multivariable logistic regression analysis and multivariable linear regression analysis were used to determine possible independently associated factors, controlling for potential confounders.

Results
Older age was the only factor associated with more advanced radiographic pathophysiology of TMC arthrosis. One in 5 patients not seeking care for TMC arthrosis experienced thumb pain; no factors were independently associated with having pain or limitations related to TMC arthrosis. Youth and male sex were associated with stronger pinch and grip strength.

Summary Points
• Collective evidence can reassure patients with TMC arthrosis that the radiographic findings are frequently incidental and do not correlate with symptoms
• This supports that patients can remain active in spite of discomfort of the thumb without meaningfully accelerating of the pathophysiology.

Bibliography
Images
Hypothesis
This study prospectively evaluates the time required for grip strength to return to preoperative levels following trigger finger release.

Methods
Forty-six patients with unilateral, single digit trigger finger were prospectively enrolled from March 2014 to May 2015. Patients were indicated for surgical release of the affected digit after failing nonoperative treatment, which included at least one corticosteroid injection. Grip strength using a JAMAR Handgrip Dynamometer was measured preoperatively as well as at the 2 week, 6 week, 20 week, and 1 year follow up visits. DASH surveys were administered both preoperatively and postoperatively at follow up visits. Postoperative results were reported as a percentage of the preoperative grip strength of the contralateral extremity.

Results
Forty-two cases were included in the follow up analysis: 24 women and 18 men, with an average age of 60 years (range 33-84). The average preoperative grip strength of the affected hand was 62% of the uninvolved side and the average preoperative DASH score was 51 (range 3-83). Following surgical release, the average grip strength of the affected hand decreased by 20.54% compared with preoperative measurements. Grip strength returned to preoperative status at approximately 4-6 weeks. Patients’ affected hand grip strength improved by 34.64% (9.63 ± 8.07 lbs) at 20 weeks and 83.95% (30.60 ± 16.30 lbs) at 1 year follow up compared with preoperative measurements. Grip strength improvement reached a plateau at 9-10 months post surgical release based on a polynomial regression analysis. There was a 38% reduction in reported DASH scores compared with preoperative values. No statistical significance was noted between DASH score and preoperative grip strength.

Summary Points
• This is the first study to evaluate the return of grip strength following trigger finger release.
• Surgical release of the A1 pulley results in an initial decrease in grip strength during the immediate postoperative period, which aptly correlates with early post-surgical healing.
• Based on this study, patients may be counseled to expect a return of grip strength to preoperative levels by 4-6 weeks with an estimated improvement of 84% over the course of 1 year follow up.

Bibliography

Images
Poster 064: Dynamic suspension-sling arthroplasty with extensor carpi radialis longus tendon for the treatment of thumb carpometacarpal arthropathy

*Category:* Hand

**Treatment;Surgical Technique**

**Level 2 Evidence**

Takehiko Takagi, MD, PhD
Sho Yanagisawa
Miyuki Yokoyama
Yuka Kobayashi
Masahiko Watanabe

**Hypothesis**

There still remain some complications such as proximal migration, dorsal subluxation of the first metacarpal base, and hyperextension of the first carpometacarpal (CMC) joint, even though various techniques involving ligament reconstruction for thumb CMC arthropathy are reported. However, flexor carpi radialis (FCR) tendon is sometimes too thin to keep the suspension on the first metacarpophalangeal (MCP) joint. We used one-half of the extensor carpi radialis longus (ECRL) tendon instead of FCR tendon, and compared it with conventional reconstruction using FCR tendon.

**Methods**

The procedures have been performed on 11 thumb CMC arthropathies. One-half of the ECRL tendon was passed and then wrapped around the intact FCR tendon several times for 5 cases (ECRL group). One-half of the FCR tendon was passed for 6 cases (FCR group). We compared between both procedures with the thumb to index finger metacarpal angle (M1M2) and the first MCP angle (P1M1) using radiographs. Grip strength, pinch strength, and DASH score were also evaluated until one year after surgery.

**Results**

M1M2 and P1M1 one year after surgery had significant improvements compared to those before surgery in ECRL group while they had no significant difference in FCR group, although they achieved a peak at the 3 month after surgery in both groups. There were improvements on other parameters from 3 months to 1 year after surgery in both groups.

**Summary Points**
• Postoperative progression of hyperextension of the first CMC joint was significantly reduced on ECRL group. ECRL tendon is thicker than FCR tendon.

• In addition, the insertion of ECRL tendon is at the dorsal side of the second metacarpal and the tendon can go from dorsal side to volar side to stabilize the first metacarpal.

• The thumb CMC arthroplasty using one-half of ECRL tendon is one of the useful reconstructions.

**Bibliography**


Images
Poster 065: Long-term PROMs for CMC thumb joint arthrodesis

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Cecile C.M.C.A. van Laarhoven, MD
Verena Schrier
Mark van Heijl
Arnold H. Schuurman, MD, PhD

Hypothesis
The results after CMC arthrodesis of the thumb for osteoarthritis vary widely in literature. Long-term results of patient related outcome measurements (PROMs) are lacking. The goal of this study was to evaluate long-term results of PROM’s after thumb CMC arthrodesis for osteoarthritis. We hypothesize that long-term results of PROMs show good function and pain reduction, with good patient satisfaction.

Methods
We performed an analysis on all thumb CMC arthrodeses performed between 1996 and 2015. Three PROMs questionnaires, for evaluation of function, pain and satisfaction, were sent to all patients. All electronic patient charts were reviewed retrospectively. Baseline characteristics and outcome measurements were presented for all patients individually. We used median scores with interquartile range to present outcome for the total group of patients. Correlations between DASH / PRWHE and satisfaction were calculated using Spearman’s Rank Correlation test for non-parametric data.

Results
A total of 63 arthrodeses of the first CMC joint was performed. Of these 63 arthrodeses, 51 arthrodeses were done for purely osteoarthritis. Thirty arthrodeses were available for long-term follow up. These were 30 arthrodeses in 25 patients (11 men and 14 women), with a mean age at the time of surgery of 54.7 year (range 41-71). The mean follow up was 10 years (range 1-19 year). The average postoperative DASH score was 25.4 (range 0-60) with an average PRWHE of 31.7 (range 0-59.5), subdivided in PRWHE function (14.3, range 0-43) and PRWHE pain (16.6, range 0-38). The average satisfaction after operation and satisfaction about outcome of operation was 8.4 and 8.0 respectively (on a scale of 0 to 10, with 0 worse and 10 excellent). Of this group 77.4% would advice the operation to family and friends and 67.7% would undergo the operation again. There was a statistical significant correlation between the PRWHE total score...
and satisfaction (p=0.001) and PRWHE pain score and satisfaction (P < 0.0001). Pseudoarthrosis was found in 6.7% of the cases.

Summary Points
- Our study presents the long-term results of PROMs after arthrodesis for osteoarthritis of the CMC thumb joint.
- The results show a high satisfaction on the long term
- We saw a significant correlation between pain and patient satisfaction
- Future studies for treatment of osteoarthritis of the carpometacarpal thumb joint should aim at to long-term prospective results of different PROM’s.

Bibliography
Poster 066: The epidemiology of Dupuytren’s disease in South Korea: a nationwide population-based study

Category: Hand

Evaluation/ Diagnosis
Level 4 Evidence

Wan-Sun Choi, MD
Kwang-Hyun Lee, MD
Joo-Hak Kim
Chang-Hun Lee
Sung-Jae Kim
Hee-Soo Kim

Hypothesis
There was little study about the nationwide population-based epidemiology of Dupuytren’s disease (DD). We investigated the prevalence rate and the incidence rate of the Dupuytren’s disease in South Korea using the big data provided by Korean Health Insurance Review and Assessment Service (HIRA). This study is the second nationwide epidemiologic study of DD after Taiwan’s study.

Methods
The patients extracted from the big data between 2007 and 2014 by diagnostic code searching (International Classification of Disease 10th revision code M720) were included in the study. We calculated the prevalence and incidence rates of DD based on the total population of south Korea provided by Korean Statistical Information Service. Diseases associated with DD and the trend of surgery for DD were also analyzed.

Results
Total 16630 patients were diagnosed with DD in this period. The mean annual prevalence rate was 32.2 per 100,000 (41.8 per 100,000 for men, 22.5 per 100,000 for women). The mean annual incidence rate was 1.09 per 100,000 (1.80 per 100,000 for men, 0.38 per 100,000 for women). The common diseases associated with DD were hypertension (30.5%), diabetes mellitus (26.7%), hyperlipidemia (20.4%), ischemic heart disease (7.9%), cerebrovascular disease (4.6%). The mean annual proportion of the patients who had surgery for DD was 5.24% of all DD patients.
Summary Points

• The prevalence and incidence rates of DD of south Korea were as small as 1/1000-1/100 of the western countries’ data
• They were slightly larger than Taiwan’s

Bibliography

Poster 067: Different Trigger Finger Injection Solutions May Affect Outcomes

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

John M. Roberts, MD
Brittany J. Behar, MD
Morgan Brgoch, MD
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Kenneth F. Taylor, MD

Hypothesis
Different trigger finger injection techniques and composition do not affect patient outcomes.

Methods
We performed a retrospective chart review of patients who received trigger finger injections by three Plastic Surgery and three Orthopedic hand surgeons from January 2013 through December 2015. A power analysis was completed and 35 randomly selected trigger finger injection patients were collected for each surgeon for a total of 210 patients. Patient information including demographics, comorbidities and details of their treatment were collected. Prospectively, the six treating hand surgeons were surveyed about their trigger finger injection techniques. Data were anonymized and evaluated with SPSS software (version 24.0; IBM, Armonk, NY) including crosstabulations, Pearson correlation of primary and secondary outcome evaluation, Fisher’s exact test, one-way analysis of variance, and t-test. where appropriate. Matched groups were evaluated with two-sample t-tests and chi-squared analyses. A post-hoc analysis was completed to differentiate significant findings noted on analysis of variance.

Results
There was no significant difference in the demographics or comorbidities amongst all groups. Survey results for the six surgeon’s injection preferences demonstrated close similarities between groups with an exception being the type of steroid used in the injection solution. Kenalog, dexamethasone and solumedrol were each used by two treating surgeons respectively. The average degree of severity based on the Green classification was 2.1±0.06 with no difference between groups (p=0.122). Additional injections were performed on average 25±3% of the time with a significantly higher rate in surgeons using kenalog (39±5.8%, p=0.03). Open release was eventually performed in 32.4±3.3% of patients, although the rate of operative intervention differed significantly based on the drug utilized in the injection (Kenalog 17.4±4.6%,
Dexamethasone 22.9±5.1%, Solumedrol 57.4±6.0%; p=.000). The mean length of time from first injection to surgery among all drug cohorts was 8.9±1.2 months, although this was also statistically correlated with the drug utilized (Kenalog 21.8±3.1, Dexamethasone 10.7±2.3, Solumedrol 4.3±0.6; p=0.000).

Summary Points
- This study represents a large, random cohort of patients who underwent trigger finger injection treatment by six hand surgeons. Equal numbers of patients received kenalog, dexamethasone or solumedrol, and there was no difference between the groups in regards to demographics or the severity of the trigger finger.
- Patients receiving a kenalog had higher rates of additional injections.
- Patients receiving solumedrol had a shorter interval of time between their first injection and surgery and required operative trigger finger release significantly more frequently than the other groups.
Poster 068: Are Patients Satisfied after Needle Aponeurotomy?

Category: Hand

Treatment; Prognosis/Outcomes
Level 4 Evidence

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Spencer Kitchin
Martin I. Boyer, MD, FRCS(C)
Charles A. Goldfarb, MD

Hypothesis
1. Satisfaction in Dupuytrens contracture patients will be greater after treatment with needle aponeurotomy (NA) in the palm alone compared with palmodigital treatment.
2. There will be no significant difference in satisfaction between patients assessed at less than or greater than 2 years after NA.

Methods
We identified 326 patients treated with NA under local anesthesia over 5 years. Demographic details were obtained from medical records and patients’ feedback on satisfaction, recurrence, and complications were solicited using phone survey. Continuous variables were evaluated using t-tests and categorical variables were compared using X2 analysis with a p=0.05 for significance.

Results
Procedure Data: 451 procedures were performed on 326 patients. 375 procedures were ulnar only (small/ring/long), 16 procedures were radial only (thumb/index), and 41 procedures were both. 139 procedures were performed in the palm only, 80 were digital only, and 213 were palmodigital.
Survey Data: 131 patients completed the survey at an average of 30 months after treatment. 94 patients (71%) were very satisfied or satisfied, 93 patients (73%) would have the procedure again, 97 patients (74%) reported complete or near complete initial correction, and 41 (31%) patients reported contracture recurrence.
Cohort analyses were performed on time from procedure and disease location. Group 1 was assessed less than 2 years from NA and Group 2 at 2-5 years from NA. The groups were similar in age (p=0.40) and gender (P=0.19). Patients less than 2 years from surgery were more likely to be satisfied with procedure (p<0.01), more likely to have the procedure again (p<0.01), reported less complications (p =0.02), reported less recurrence of contracture (p <0.01), without any significant difference between the amount of correction at initial procedure (p=0.76).
For disease location, Group 1 had NA in the palm only and Group 2 patients had NA in the fingers. The groups were similar in age ($p=0.20$), gender ($p=0.18$), and time since NA ($p=0.34$). Patients with NA of the palm only were more likely to be satisfied with the procedure ($p=0.01$), more likely to have the procedure again ($p=0.04$), with no significant difference in complications ($p=0.12$), recurrence of contracture ($p=0.06$), correction at initial procedure ($p=0.33$).

**Summary Points**
- 75% of patients can expect partial or complete correction of deformity with NA.
- 71% of patients are satisfied following NA.
- Patients were more likely to be satisfied within 2 years of NA.
- Patients were more likely to be satisfied with NA of the palm only.
Poster 069: Evaluation of Functional Outcome after Collagenase (Xiapex) Injection for Dupuytren’s Disease

Category: Hand

Treatment; Prognosis/Outcomes
Level 4 Evidence

Kai Nie
Judith Wood
Randeep Mohil

Hypothesis
The functional outcome after collagenase clostridium histolyticum (Xiapex) injection for Dupuytren’s disease is not well established as previous studies mostly focused on clinical evaluation of the range of movement in the affected digit. This study hypothesized that Xiapex injection would improve the functional score for patients correlating to similar improvement in digital range of movement.

Methods
The prospective cohort of patients with single joint involvement of Dupuytren’s disease attended clinic for Xiapex injection and manipulation 24 hours later. Clinical assessment of metacarpophalangeal joint (MCPJ) and proximal interphalangeal joint (PIPJ) movements were undertaken by dedicated hand therapist pre- and post-manipulation and at 1 week. The functional outcome was evaluated by the 45-point Unite Rhumatologique des Affections de la Main (URAM) score which has been validated for Dupuytren’s disease and data was collected using self-reported questionnaires at 6 months and at 12 months after injection. Statistical analysis was by Student t test and multivariant analysis of variance.

Results
69 patients were recruited between Mar 2013 and Dec 2015. 75.4% (52 out of 69) were men. 89.7% (61 out of 68) had the disease in the ring or little finger. 73.9% (51 out of 69) involved the MCPJ. 26.1% (18 out of 69) involved the PIPJ. 58.0% (40 out of 69) returned the questionnaire at 12 months. The mean increase in joint extension was 36.6° after Xiapex injection and manipulation. This correlated to the mean improvements in URAM scores of 12.4 and 12.2 at 6 months and 12 months respectively. Indeed 47.5% (19 out of 40) of the patients who returned the questionnaire at 12 months reported an URAM score of 0 which suggested no functional limitation in activities of daily living whatsoever. 21.7% (15 out of 69) of our cohort had a skin tear but none required suturing.
Summary Points

• Collagenase (Xiapex) injection is a safe and effective treatment for single joint Dupuytren’s disease.
• Significant improvement in URAM score after injection which reflected functional performance in activities of daily living.
• Further analysis may reveal links between functional outcome with severity of deformity, degree of correction, or duration of disease and may help better define the patient group that will most benefit from collagenase injection.
Poster 070: Short-term outcome after metacarpophalangeal arthroplasty with semi-constrained cemented prosthesis in rheumatoid arthritis

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes

Level 4 Evidence

Daisuke Kawamura, MD
Norimasa Iwasaki, MD, PhD
Yuichiro Matsui, MD, PhD

Hypothesis
Despite efforts to develop an ideal prosthesis for arthroplasty of the metacarpophalangeal (MCP) joint for patients with rheumatoid arthritis, silicone implants are still the primary prostheses used. Silicone implants restore the MCP joint extension but cannot obtain a physiological arc of motion. The FINE Total Finger Arthroplasty System (Nakashima Medical) was developed to reproduce MCP joint movements close to the physiological motion with its anatomical design (Figure 1). We hypothesized that MCP arthroplasty using this system could obtain satisfactory clinical results, especially in arcs of motion, in rheumatoid arthritis.

Methods
The FINE Total Finger Arthroplasty System was used in 43 MCP joints of 10 patients. Thirteen prostheses were inserted for the index finger and 10 each for the other fingers. The patients’ age at operation ranged from 38 to 78 years (mean, 61 years), and the follow-up period varied from 18 to 73 months (mean, 40 months). For the recent 18 fingers, tenodesis of the extensor digitorum communis (EDC) tendon to the base of the proximal phalanx was additionally performed. We evaluated Disability of the Arm, shoulder and Hand (DASH), grip strength, active range of motion, and ulnar deviation angles at the MCP joints before surgery and at the final examinations. The ranges of motion were compared between the two groups with or without tenodesis of the EDC tendon. Statistical analysis was performed using the paired t-test (p < 0.05).

Results
The DASH score improved from 58.8 to 53.7 without a statistical significance. The mean grip strength and ulnar deviation angle improved significantly from 3.9 kg and 33.9° pre-operatively to 7.7 kg and 2.1°, respectively. At follow-up, active extension increased (p < 0.01), active flexion decreased (p < 0.05), and arc of motion slightly increased (p = 0.293). The cases with EDC tenodesis demonstrated an improved total arc of motion from 20.3° pre-operatively to 38.3° (p
< 0.01), while those without tenodesis had arcs of motion only shifting to a more extended position (Table 1). No case showed radiological signs of loosening at follow-up.

**Summary Points**

- The FINE Total Finger Arthroplasty System obtained satisfactory clinical improvements after MCP arthroplasty.
- The total arc of motion improved significantly with the additional tenodesis of the EDC tendon to the proximal phalanx.
- The FINE Total Finger Arthroplasty System could be a good alternative prosthesis for MCP arthroplasty in rheumatoid arthritis.
Poster 071: A precise and safe method for Collagenase Clostridium Histolyticum injection for Dupuytren contracture with the needle length adjusted by silicone tube interposition

Category: Hand

Treatment
Level 4 Evidence

Takako Kanatani, MD
Issei Nagura, MD
Yoshifumi Harada, MD

Hypothesis
Our injection method for Collagenase Clostridium Histolyticum (CCH) using a silicone tube after determining the optimal depth by ultrasonography provides not only precise injection into the cords but also avoids the possible complications of skin laceration and flexor tendon rupture(1).

Methods
This study enrolled five male patients (7 fingers) with Dupuytren contracture with a mean age of 73 years (range; 59-87 years). We marked the collagenase injection point on the skin above the cord before injection and measured the distance from the skin to the middle of the cord as “injection depth” by high resolution ultrasonography with long axis images (SNiBLE; Konica Minolta, Tokyo, Japan). Then, we injected CCH adjusting the exposed needle length to the planned injection depth by placing a precut, measured and sterilized silicone tube (Phycon tube SH, No. 1; Fuji Systems, Tokyo, Japan) over the needle of a VA syringes; one inch fixed needle (Nipro, Osaka, Japan), where the pocked needle provides the planned injection depth. Silicone tubes were prepared to length by the engineers at BEAR Medic corporation’s factory (Ibaraki, Japan) using a calibrated scale.

Results
The average injection depth was 2.2 ±0.14 mm (range; 1.6-2.9 mm), which was comparable to the technical manual for the collagenase injection which states “the needle insertion should not be more than 2 to 3mm in depth”(2). Local edema and swelling presented from Day 1 after injection in all cases but dissipated in a week. There was no incidence of skin laceration or tendon rupture. All cases showed favorable improvement of fixed flexion contractures (FFC); the MP joint (averaged 66 to 7.5 degrees) and the PIP joint (averaged 31 to 15 degrees) at Day 14. Further, the FFC of the PIP joint decreased to averaged 4 degrees at Day 30.
Summary Points
Injection of CCH to an adequate depth into the cords is very important not only to obtain the maximum effect of collagenase but also to avoid possible complications. However, currently, the “more than 2 to 3 mm in depth” needs to be estimated by physicians visually. Our procedure utilizing a silicone tube after evaluation of the adequate depth by ultrasonography results in precise and reliable injection and a demonstrated favorable outcome. This method is safe, simple and inexpensive.

Bibliography

Images
Poster 072: Arthrodesis of the metacarpophalangeal and interphalangeal joints of the hand by two-dimensional intraosseous wiring

*Category: Hand*

**Treatment; Surgical Technique; Prognosis/Outcomes**

Level 4 Evidence

Tomoaki Suzuki, MD  
Daisuke Kawamura, MD  
Yuichiro Matsui, MD, PhD  
Norimasa Iwasaki, MD, PhD

**Hypothesis**

Two-dimensional intraosseous wiring (two-DIOW) is a modified intraosseous wiring method for the fixation of phalangeal fractures to provide enough stability for an early active motion of the adjacent joints. We hypothesized that this two-DIOW method would be applicable in the arthrodesis of the metacarpophalangeal (MP) or interphalangeal (IP) joints of the hand.

**Methods**

This study included 45 digits of 30 patients (25 women and 5 men) who had undergone arthrodesis of the MP and IP joints via two-DIOW (Figure 1). Rheumatoid arthritis was observed in 24 digits, osteoarthritis in 18 digits, posttraumatic arthritis in 2 digits, and flexor tendon rupture in 1 digit. Three thumbs, 5 index fingers, 7 long fingers, 12 ring fingers, and 20 small fingers were affected. Two thumb MP joints, 18 thumb IP joints, 9 proximal interphalangeal joints, and 18 distal interphalangeal joints (DIP) joints were fused. We evaluated bone union and time to union radiologically and investigated the presence of any surgical complications.

**Results**

Forty-three of the 45 digits were fused (96%) at an average of 109 days (range, 45–323 days). Three digits presented with erosive osteoarthritis of the DIP joints and took >6 months to be finally fused. Mild nail deformity was observed in 2 digits; both involved the DIP joints with erosive osteoarthritis. Wire removal was required in 3 digits due to irritation by the intraosseous wire knot. In 2 osteoarthritis cases, bony spurs of the adjacent digits caused an irritation. In the other rheumatoid arthritis case, the skin over the intraosseous wire atrophied owing to a long-term steroid use.

**Summary Points**

- The two-DIOW method showed a 96% union rate in the arthrodesis of the MP and IP joints.
• The DIP joints with erosive osteoarthritis were considered a relative contraindication to the two-DIOW method because of higher complication rates.
• Two-DIOW could be an alternative procedure of arthrodesis for MP and IP joint problems in the hand.
Poster 074: Fluoroscopic Evaluation Can Predict Post-Surgical Metacarpophalangeal Hyperextension Deformity Development after Thumb Carpometacarpal Arthroplasty

Category: Hand

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Level 4 Evidence

Yusuke Hagiwara
Mitsuhiko Nanno, MD, PhD
Ryu Yoshida, MD
Shiro Takai, MD, PhD

Hypothesis
Introduction: Many patients with thumb carpometacarpal (CMC) arthritis have some hyperextension deformity of metacarpophalangeal (MCP) joint. Some patients significantly worsen the deformity after CMC arthroplasty while others remain stable.

Hypothesis: We hypothesized that dynamic fluoroscopic evaluation before surgery can predict post-operative metacarpophalangeal (MCP) hyperextension deformity development after CMC arthroplasty.

Methods
8 patients (1 male, 7 females) with thumb CMC arthritis underwent ligament reconstruction with tendon interposition arthroplasty [1]. Mean age was 69.6 years (range: 61 to 78). 5 patients had Eaton stage III and 3 patients had stage IV CMC osteoarthritis [2]. Fluoroscopic movies of thumb active extension were recorded at before surgery and then at 6 months and 1 year after surgery. The angle between thumb proximal phalanx shaft and thumb metacarpal shaft was measured just before the CMC joint started to extend (“Ext_ini”). The angle was also measured at maximal thumb extension (“Ext_max”). We chose positive angles to indicate degrees of hyperextension.

Results
The mean Ext_max angle was 20.8 degrees (range: 8 to 36). Average increase in Ext_max after surgery at 6 months was 1.8 degrees (range: -11 to 23). Coefficient of determination (R2) between pre-operative Ext_ini and increase in Ext_max was 0.75 (Figure 1). There was a weaker correlation between pre-operative Ext_ini and post-operative Ext_max (R2=0.53). There was no correlation between pre-operative Ext_max and post-operative Ext_max (R2=0.006, Figure 2).
Summary Points

- Pre-operative measurement of thumb MCP hyperextension does not reliably predict post-operative hyperextension.
- Dynamic fluoroscopic evaluation of thumb extension allows measurement of pre-operative Ext_ini (the angle between proximal phalanx and metacarpal just before the CMC starts to extend during active thumb extension).
- Pre-operative Ext_ini is a good predictor of post-operative MCP hyperextension development.
- References

Bibliography

1: Burton RI, Pellegrini VD. Surgical management of basal joint arthritis of the thumb. Part II: Ligament reconstruction with tendon interposition arthroplasty. J Hand Surg Am 1986; 11(3): 324–32

Images
Poster 075: over 2 years follow-up outcomes of surface cementless replacement arthroplasty for proximal interphalangeal joints by volar approach for osteoarthritis

Category: Hand

Treatment; Surgical Technique
Level 4 Evidence

Yasushi Morisawa, MD
Shinichiro Takayama

Hypothesis
There are many reports of arthroplasty for rhumatoid arthritis. But for Osteoarthritis (OA), the number of reports are few. The aim of this report is to review clinical, subjective results of surface cementless replacement arthroplasty for proximal interphalangeal (PIP) joints using a volar approach for osteoarthritis.

Methods
Subjects comprised 16 joints: index finger, n=2; middle finger, n=6; ring finger, n=7; little finger, n=1). Average age at time of surgery was 66 years (range, 55–75 years). Average follow-up period was 44 months. In all cases, operative procedures were used a volar approach. The implant was a self-locking finger joint system(Nakashima medical, Japan) which is surface cementless replacement type. We investigated joint range of motion (ROM) at preoperative evaluation and final follow-up, state of pain, Mayo Clinic score evaluation.

Results
ROM was -11 degree extension to 53 degree flexion preoperatively, compared to -19 degree extension to 70 degree flexion at final follow-up. Pain disappeared in all cases. Mayo Clinic score evaluation was “Good” in 10 patients, “Fair” in 1, and “Poor” in 5.

Summary Points
• Pain and limited ROM represent the main complaints for OA of the finger PIP joints. Pain can be improved by arthrodesis, but as a result, ROM is lost.
• Artificial finger joint replacement improves both pain and ROM. Pain improved in all the present cases, but the degree of improvement in ROM varied between cases.
• As in OA, treatment of the dorsal side was not required, unlike rheumatoid arthritis. The volar approach was more effective in OA.
• Using cementless implants, the insertion depth of the implant can be adjusted while checking the ROM during surgery.
Bibliography


Images
Hypothesis
There has been controversy regarding hand dysfunction following of index finger amputation. The aim of this study was to evaluate the functional outcome of these injuries. Our hypothesis was that without pain, there will be no use of the index finger in hand function with no decrease in hand function.

Methods
We evaluated all patients with index finger amputations as the major injury to the hand injured between 2000 and 2008. Strength, sensation, range of motion and pain levels were evaluated, as well as standard tools of measurement of hand function and dexterity. Two matched control groups were examined; 1. patients who were at least one year after having suffered a phalangeal fracture of the index finger; 2. volunteers with no previous significant injury to the hand.

Results
We evaluated 8 patients with an index finger amputation and found a significant decrease in Purdue Pegboard Test, palmar pinch and grip strength, 2 point discrimination and DASH scores in comparison with the control group (p<0.05). We found no difference between the groups in key pinch and hand dexterity as tested by the Jebsen Hand Function Test (p<0.05). VAS score was 3.5 (0-9).

Summary Points
• In contrast to our hypothesis, the index finger stump is used for hand function.
• Index finger amputation results in significant dysfunction of the hand including decrease in dexterity and strength, sensation and subjective perception of function
Poster 077: The Utility of Acellular Allograft Pulley Subunits for Digital Pulley System Reconstruction

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes

Level 4 Evidence

Brent R. DeGeorge, Jr., MD, PhD
David B. Drake, MD

Hypothesis
Current methodology for pulley reconstruction involves non-anatomic tendon graft techniques, and restoration of the digital pulley mechanism is paramount to achieving optimal tendon gliding without bowstringing. We theorized that acellular pulley allografts could provide an anatomic pulley reconstruction for patients with acquired A2 or A4 pulley incompetence and bowstringing.

Methods
Under institutional approval, A1-A5 allograft pulleys are procured. The allograft pulleys undergo tissue processing to generate sterile, acellular pulley allografts. The A2 and A4 pulley subunits of the allograft constructs are then isolated, and utilized for anatomic pulley reconstruction. Indications for acellular allograft pulley reconstruction are patients greater than 18 years with bowstringing on clinical examination and intra-operative evidence of acquired A2 or A4 pulley incompetence from trauma, infection, or iatrogenic etiologies. The pulleys are appropriately sized and secured to recipient bone using Mitek suture anchors or bone tunnels.

Results
Four A2 and one A4 pulley reconstructions were performed on four patients. Average total length of follow-up was 15.1 ± 3.0 months. Total active motion significantly improved from pre-to post-operatively from 107.5 ± 16.6 to 213.8 ± 15.0 degrees, p < 0.05. Average DASH scores were significantly improved from a pre-operative mean of 32.3 ± 8.3 to a post-operative mean of 5.2 ± 1.7, p < 0.05. No instances of surgical site infection, tendon adhesions, re-operation, or removal of allograft were reported.

Summary Points
- Reconstruction of pulley deficits using the A2 or A4 acellular pulley allografts allows for anatomic replacement of “like with like” without additional donor site morbidity or technically demanding tendon weave constructs.
- Allograft pulley reconstruction results in amelioration of bowstringing, significantly improved range of motion, and significantly improved DASH scores.
Poster 078: Obtaining a Reliable Scaphotrapeziotrapezoid Radiograph: Pronation, Ulnar Deviation, and Thumb Abduction Technique

Category: Hand

Evaluation/Diagnosis; Surgical Technique; Residents/Fellow/Educator Resources
Level 5 Evidence

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Hypothesis
Multiple radiographic views have been described to evaluate the trapeziometacarpal joint, however to obtain a reliable view of the scaphotrapeziotrapezoid (STT) joint is challenging. The purpose of our study was to define the reliability of our positioning method for imaging the STT joint for evaluation of STT arthrosis and to optimize STT joint injection.

Methods
Following institutional IRB approval, four healthy volunteers and four cadavers with documented STT arthritis were assessed. The following protocol was performed for obtaining a PA radiograph of the STT joint: the hand is placed in neutral pronosupination on the flat detector plate, the hand is pronated 40 degrees, the wrist is maximally ulnar deviated, the forearm is maintained parallel to the detector plate and elevated until only the small finger is touching the detector, the thumb is maximally radial deviated with the thumb nail parallel to the detector plate.

Results
A total of 8 asymptomatic wrists and 4 cadaveric wrists with known STT arthritis were visualized. The concordance of visualization of the STT joint was 100%. The mean angle of the wrist and forearm to achieve an optimal PA of the STT joint was 35-45 degrees of pronation, 40-55 degrees of ulnar deviation, and 40-50 degrees of thumb radial deviation.

Summary Points
- Optimal imaging of the STT joint is required for the care of patients with thumb basilar joint arthritis.
- The technique of serial positioning with 45 degrees of pronation, ulnar deviation, and thumb abduction reliably generates a PA of radiograph of the STT for staging and intra-articular injection.
Hypothesis
Trigger finger is commonly perceived as a single diagnosis and classified based on symptomatology. This paper is the first to describe trigger finger as two distinct entities based on pathophysiology: thickening of the A1 pulley versus tenosynovitis tethering the FDS and FDP tendons. The authors describe a unique physical exam finding that may distinguish between types of trigger finger, gauge the efficacy of nonoperative management, and guide the surgical approach.

Methods
Fifty-seven patients with unilateral, single digit trigger finger were identified and prospectively enrolled from September 2015 to January 2017. The “FDS test” was performed on the triggering digit to assess for independence between the FDS and FDP tendons. Patients underwent ultrasound evaluation of the affected and contralateral unaffected digits to determine the thickness of the A1 pulley and corresponding flexor tendons. Surgery was offered if patients had persistent triggering following at least one corticosteroid injection. Preoperative FDS test results guided the surgical approach: FDS negative patients underwent a longitudinal incision centered over the A1 pulley while FDS positive patients underwent an oblique incision to allow for a more extensive flexor tenosynovectomy, if necessary. Patients were evaluated intraoperatively for evidence of thickening of the A1 pulley (“DRY”) versus adhesions between the FDS and FDP tendons (“WET”). Findings were correlated with preoperative FDS test examinations.

Results
Thirty patients were FDS positive and 27 patients were FDS negative. Sixteen patients were diabetic, 11 of which were FDS positive (p >0.05).
The average A1 pulley thickness of the affected and contralateral unaffected digits were 0.174cm and 0.115cm, respectively. The average thickness of the affected and contralateral unaffected digit flexor tendon was 0.384cm and 0.352cm, respectively.

Eighteen patients underwent operative treatment: 11 patients were considered DRY and 7 were considered WET. The sensitivity and specificity of the FDS test in predicting WET versus DRY was 71.4% and 72.7%, respectively. The PPV and NPV of the FDS test was 62.5% and 80%, respectively.

WET patients had thicker flexor tendon ultrasound recordings compared with DRY patients (0.40cm vs. 0.36cm). No statistically significant difference was noted for A1 pulley thickness.

Summary Points
• Trigger finger is an umbrella diagnosis comprised of two distinct entities: DRY and WET.
• DRY types present with thickening of the A1 pulley; WET types present with synovitis and intratendinous adhesions between the FDS and FDP tendons.
• The FDS test is a useful clinical exam that may predict intraoperative findings and guide the surgical approach.

Bibliography

Images
Poster 081: A Retrospective Study Analysing Surgically Treated Digital Mucous Cysts with Comparison of Practice Between Orthopaedic and Plastic Surgeons

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
To evaluate practice and recurrence rates of surgically treated DMC in a single-centre where DMC excision is performed by both plastic and orthopaedic surgeons; comparing practice to the suggested operative-triad outlined by Shin and Jupiter(1).

Methods
A retrospective review of all patients with surgically treated DMC, under the care of plastics or orthopaedic surgery, from April 2012-April 2016 was performed. Data was collected from an online database of operative records, outpatient follow-up letters and histology reports. The areas that were analysed were patient demographics, grade of surgeon, documentation of osteophyte debridement and synovectomy, methods of closure, follow-up period, recurrence and complications.

Results
A total of 136 cases were included; 66.2% were female patients with an average age of 58.9 (range 16-90). 73 (53.7%) were treated by plastic surgeons and 63 (46.3%) by orthopaedic surgeons. There was a total 14 (10.3%) documented recurrences; the average recurrence rates for plastic surgery were 13.7%, compared to the orthopaedic surgery recurrence rate of 6.4%. All three of the suggested triad were documented as performed in 4(2.9%) cases – with a 100% cure rate.

Debridement of osteophytes was documented in 39 (28.7%) cases, 31 (79.5%) of which were under the care of the plastic surgeons. Synovectomy was documented in 13 (9.6%) cases, 9 (69.2%) of which were under the care of the plastic surgeons. 114(83.8%) cases underwent direct closure and 16(11.8%) had local flaps. Plastic surgeons sent more samples for histology at 84.9% when compared to orthopaedic surgeons, 36.5%. The follow up period ranged from 1 week to 12 months but on average plastic surgeons followed their patients up for longer, with a
mean follow-up period of 8.6 weeks, while orthopaedic surgery had a mean follow-up of 3.6 weeks. The complication rate for plastic surgeons was 23.3% while orthopaedic surgeons had a complication rate of 19%.

**Summary Points**

- The study has shown discrepancies in practice and outcomes between plastic and orthopaedic surgeons which cannot be commented on due to the difference in follow-up periods
- The use of a universal proforma for both plastic and orthopaedic hand surgeons will promote consistency and provide better outcomes.
- The triad of skin excision, osteophyte debridement and synovectomy as described by Shin and Jupiter (1) will provide the best results with no recurrences.

**Bibliography**


Images

Category: Hand

Treatment; Anatomy; Basic Science
N/A - not a clinical study

Grant Received from: 2016 Paracelsus Medical University research grant (E-12/16/080-BOR)

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Hypothesis
A1 pulley stretching, a clinically beneficial treatment for snapping fingers, requires resisted PIP and MIP joint flexion achieved by grasping a block in order to generate an active flexion force and a counter-acting flexion tendon force, leading to a possible increase in the cross-sectional areas (CSA) of the A1 pulley lumen region, and possibly improving snapping finger symptoms. The purpose of the present study was to investigate the resultant forces during stretching that increase the CSA of the A1 pulley, using fresh frozen cadavers.

Methods
Eighteen fingers from three fresh frozen cadavers were used in this study. To replicate the A1 pulley stretching, flexor digitorum profundus (FDP) was tracted with MP and PIP in flexion. Traction forces to FDP tendon were increased in steps from 4.9 N to 49 N, and at each step, the CSA of the lumen region at A1 pulley was measured by ultrasound.

Results
CSAs of A1 pulleys increased with the step-wise increase in FDP traction. When the FDPs were tracted proximally using 49 N force, CSA of A1 pulley showed an average 28% increase compared to that of the unloaded FDPs.

Summary Points
- Resisted finger flexion by A1 pulley stretching was replicated using fresh frozen cadavers.
• CSA changes of the lumen region at the A1 pulley due to resultant active flexion force and counteracting flexion tendon force were quantitatively evaluated by holding the fingers and the ultrasound probe in the same position.
• A1 pulley stretching causes CSA of the luminal region of A1 pulley to increase.
• This increase may potentially reduce the friction between flexor tendon and A1 pulley and may help in the resolution of snapping fingers.
Poster 083: Partial Trapeziectomy with LRTI for Isolated Thumb Carpo-Metacarpal Osteoarthritis - A New Technique

Category: Hand

Treatment;Surgical Technique;Prognosis/Outcomes

N/A - not a clinical study

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Hypothesis

Trapeziectomy with or without ligament reconstruction and tendon interposition (LRTI) is by far the most common excision arthroplasty procedure done routinely by hand surgeons around the world to treat thumb basal joint osteoarthritis. It is effective in relieving pain and restoring reasonable function to the thumb. The tendency for the 1st metacarpal to subside into the trapezial gap has often been attributed for the potential for ongoing pain and persistent grip weakness. Another problem particularly in patients with severe adduction contractures and Z-deformities from the outset is the added 1st metacarpal base instability created by removing the entire Trapezium. There are a sub group of patients however who would benefit from less radical surgery to maintain as much original anatomy as possible. The hypothesis for the described technique is that a partial trapeziectomy provides patients with improved and faster attained grip strength after surgery while also preventing any altered posture and instability of the thumb. The procedure removes the isolated effected arthritic joint and associated osteophytes but does not remove the trapezium in totality.

Methods

Over twelve months this technique has been refined allowing better bone cuts for the remaining joint. The technique has been refined by a single surgeon and is now standardised.

Results

A standard trapeziectomy incision is performed. The 1st CMC joint capsule is opened longitudinally and the joint surfaces are inspected. At this stage all surgical options are still available. The distal ½ of the Trapezium is exposed detaching the capsule and articular surface excised using an oscillating small saw removing only a thin 2mm disc - turning the saddle shaped surface into a flat cancellous surface parallel to the 1st Metacarpal. An oblique chamfer cut at the dorso-radial corner of the Trapezium with the 1st Metacarpal extended and abducted to
prevent impingement and maximise the movement. FCR tendon is then harvested and used as an LRTI.

**Summary Points**
The advantages of this technique over a total trapezietomy are:
- More conservative with no unnecessary damage to a normal or non-symptomatic STT joint
- Smaller gap with more effective tendon interposition and hence less metacarpal subsidence
- Potential for better mechanics and closer function to a normal thumb (strength and movement)
- No need for immobilisation beyond 2 weeks and quicker functional recovery.
- There are more revision options in cases of persistent pain and even conversion to a CMCJ fusion is still possible.

**Bibliography**
Poster 084: Quality, Accuracy and Readability of Online Queries for Dupuytren’s Contracture: Are They Reliable Resources for Patient Education?

Category: Hand

Patient Education; Residents/Fellow/Educator Resources
N/A - not a clinical study

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Hypothesis
To critically evaluate readily available Internet resources for Dupuytren’s contracture and evaluate their quality, accuracy, and readability.

Methods
Using three standard Internet search engines, we performed a comprehensive evaluation of the first 50 websites that discussed Dupuytren’s. The website’s affiliation was identified, and the quality and accuracy of online information were independently evaluated by three reviewers using predetermined scoring criteria based upon current evidence-based recommendations (Table 1). The readability of the available resources was evaluated using the Flesch-Kincaid (FK) grade score. One-way analysis of variance tests and Kruskal-Wallis tests with post hoc pairwise comparisons utilizing Tukey’s tests and Dunn’s tests were used to determine any differences in quality, accuracy, and readability. Independent sample t tests and Mann-Whitney U tests were used to determine any differences in quality, accuracy, and readability based on authorship, presence of commercial bias, and FK grade level. Inter-rater reliability for quality and accuracy ratings was evaluated using the intraclass correlation coefficient. Significance was considered for a p-value of less than 0.05.

Results
A total of 53 unique websites were identified and evaluated (Figure 1). The average quality and accuracy of the websites was 14.0 ± 3.5 (out of maximum 25) and 11.4 ± 1.0 (out of maximum 12), respectively. The average FK grade level was 10.9 ± 1.5, which is several grades higher than the recommended 8th grade level for general patient education material. Eighty-three percent (44/53) of websites were authored by physicians, and 19% (10/53) contained commercial bias.
Mean quality and accuracy ratings were significantly greater in websites authored by physicians (14.5 ± 3.0 vs. 11.7 ± 4.3, p=0.03 and 11.5 ± 0.90 vs. 10.7 ± 1.3, p=0.02, respectively). In addition, mean quality ratings were significantly greater in websites without commercial bias (14.7 ± 3.2 vs. 11.2 ± 2.9, p<0.01). Although 77% (41/53) of online resources discussed palmar fasciectomy and collagenase injections, only 30% (16/53) and 21% (11/53) mentioned the risks or complications of these treatment options, respectively.

Summary Points
• The quality of online patient resources for Dupuytren’s contracture is poor, and the information overestimates the reading ability of the general population.
• The majority of these websites discuss treatment options without reporting their risks, which may fail to provide appropriate patient understanding and treatment expectations.
• In the absence of quality control on the Internet, physicians should help guide patients towards high quality, accurate, and readable online patient education material.

Bibliography

Images
Poster 085: Predicting Post-Operative Pain After Carpometacarpal Arthroplasty – A Comparison of Techniques

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes

Level 4 Evidence

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Hypothesis
Numerous procedures exist for correction of thumb osteoarthritis at the carpometacarpal (CMC) joint, and post-operative pain is a common complication that prolongs recovery. This retrospective cohort study compared factors that predict post-operative pain for patients undergoing CMC arthroplasty.

Methods
CMC arthroplasty surgeries at a single institution were collected between 2011 and 2015. The outcome of interest was complaint of continued pain at 8 weeks post-operatively. Patients demographics and procedure characteristics were evaluated with univariate analyses. A multivariate regression model was used to estimate the association between patient factors and post-operative pain.

Results
A total of 79 procedures were identified, with patients having a mean age of 64.8 and mean follow-up time of 7.9 months. Of the procedures, 33 (42%) were TRS (tight rope suspensionplasty), 19 (24%) were APLS (abductor pollicis longus suspensionplasty), and 27 (34%) were HI (hematoma interposition). A total of 30 patients (38%) in the cohort had continued CMC joint pain at 8 weeks or greater. Female sex (OR=5.943, p=0.015, 95% CI: 1.416-29.940) and the presence of a concurrent procedure (OR=3.294, p=0.043, 95% CI: 1.041-10.423) were significantly associated with higher odds of experiencing post-operative pain at 8 weeks or greater. Procedure type (TRS, APLS, and HI), age, complications, and comorbid psychiatric diagnoses were not found to significantly predict pain.

Summary Points
• Prolonged pain is a common complication following surgery for carpometacarpal osteoarthritis
• The presence of a concurrent surgical procedure during CMC arthroplasty significantly increased the odds of experiencing pain at 8 or more weeks post-operatively
• Significant differences were not seen between procedure types of TRS, APLS, and HI for predicting post-operative pain
Poster 086: The 1st Carpometacarpal(CMC) Arthrodesis with Two Headless Screws in the 1st CMC joint arthritis

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
In the 1st carpometacarpal(CMC) joint arthritis, several methods has been introduced to improve arthritic pain. Arthrodesis of the CMC joint of the thumb has been recommended for relatively young patients as one of the technical option that provides pain relief and stability. The purpose of this study was to report the results of the patients with the 1st CMC arthritis who were treated with arthrodesis with two headless screw (Mini-Acutrak®, Acumed, Beaverton, Oregon).

Methods
We treated 21 patients(pts) who had advanced 1st CMC arthritis with joint space narrowing and subluxation. The average age of the patients was 61.0 (range: 53~71, SD: 7.9) years. Arthrodesis was performed with two headless screw (mini-acutrak) after decortication of the remaining CMC joint cartilage. Thumb spica cast was maintained for 6 weeks. We measured preoperative and postoperative clinical outcomes including pre- and postoperative VAS score, grip strength, wrist ranges of motion, and DASH scores 6 months after operation and the presences of complication.

Results
Mean operation time was 28 minutes (range: 23~45, SD: 8.7). 19 patients were achieved bony union without notable complication at postoperative 6 months. However, 2 pts of total 21 pts had nonunion or delayed union, requiring revision surgery. There was significant difference between the preoperative VAS score and the postoperative VAS score, that the preoperative VAS score averaged 6.8±3.2, however the postoperative VAS score averaged 2.2±1.9 in these 35 patients (p value=0.000). All patients were evaluated in clinical outcomes including ROM, DASH score after postoperative 6 months. All patients considered their result as good or excellent outcomes including ROM, and improved functional score.
Summary Points
• Arthrodesis of the 1st CMC achieved satisfactory results with arthrodesis using two screws. Despite of possibility of nonunion, the 1st CMC can be an effective option to improve stability and functional outcomes in the advanced 1st CMC arthritis patients.

Bibliography
Images
Poster 087: Dorsal skin island transplantation to the palmar skin defects reduced recurrence of Dupuytren’s cords.

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
Firebreak grafts\(^1\),\(^2\) using skin island flaps harvested from the dorsum of the hand and transplanted to a palmar skin defect after fasciectomy in patients with Dupuytren’s contracture would prevent reformation of pathological cords.

Methods
We performed dorsal skin island transplantation on patients with Dupuytren’s contracture. The palmar skin defects were created with the involved fingers maintained in the neutral position after correction of the flexion deformity with a fasciectomy. In patients having undergone the above operation for more than two fingers, the finger first operated on was included in this study. Twenty-four fingers with 25 flaps in 24 patients were included (20 men and 4 women; mean age, 60 years; mean follow-up period, 40 months). The skin islands (width, 0.8–1.8 cm, length, 1.2–2.5 cm) were based on dorsal perforators of the palmar digital artery and the dorsal digital arterial network. Using the patients’ medical records, gender, and age; history of smoking, manual work, and diabetes mellitus (DM); mean passive extension angles of the proximal interphalangeal (PIP) and metacarpophalangeal (MP) joints of the operated fingers before surgery and at the final follow-up; and visual analog scale (VAS) score for satisfaction at the final follow-up were investigated retrospectively.

Results
At the final follow-up, four patients exhibited nodular structures and one patient had cord-like structures. The mean extension/flexion angles of the MP and PIP joints were \(-44/88^\circ\) and \(-46/89^\circ\) before surgery and \(-1/88^\circ\) and \(-7/85^\circ\) at the final follow-up, respectively. In both joints, the mean extension angles improved significantly after surgery (\(p<0.0001\) in both joints). At the final follow-up, the mean passive extension loss was significantly smaller in the MP joints (1\(^\circ\)) than in the PIP joints (7\(^\circ\)) (\(p=0.0013\)) (Table 1). Gender, a history of smoking, manual work, or
DM, and preoperative passive PIP and MP joint extension angles did not differ significantly between patients with and without recurrence (Table 2). At the final follow-up, the mean VAS score for satisfaction was 9.1 (0, least satisfied to 10, completely satisfied).

**Summary Points**
The dorsal skin of the hand is hard to be involved by Dupuytren’s disease. In a previous report, fasciectomy followed by transplantation of a ‘firebreak’ of dorsal skin islands had a lower recurrence rate of Dupuytren’s contracture (4%) compared with that for fasciectomy only because the islands might have blocked intradermal or subdermal extension of the pathological fibers.

**Bibliography**

Images
Hypothesis
Metabolic syndrome is a constellation of medical conditions that arise from insulin resistance and abnormal adipose deposition and function. In patients with metabolic syndrome and De Quervain tenosynovitis (DQT) this might affect the outcome of treatment by local corticosteroid injection.

Methods
Sixty-four consecutive patients with DQT and metabolic syndrome treated with corticosteroid injection were age- and sex- matched with 64 control patients without metabolic syndrome. The response to treatment, including VAS (visual analog scale) score for pain, objective findings consistent with DQT (tenderness at first dorsal compartment, Finkelstein test result), and Disability of the Arm, Shoulder, and Hand (DASH) score were assessed at 6, 12, and 24 weeks’ follow-up. Treatment failure was defined as persistence of symptoms with a positive Finkelstein test or surgical intervention.

Results
Prior to treatment, patients with metabolic syndrome had mean initial pain VAS and DASH scores similar to those in the control group. The proportion of treatment failure in the metabolic syndrome group (43%) was significantly higher than that in the control group (20%) at six months’ follow-up. The pain VAS scores in the metabolic syndrome group were higher than the scores in the control group at the 12- and 24-week follow-ups. The DASH scores of the metabolic syndrome group were higher (more severe symptoms) than those of the control group at the 12- and 24-week follow-ups.

Summary Points
• Although considerable improvements in symptom severity and hand function will likely occur in patients with metabolic syndrome, corticosteroid injection for DQT is not as effective in these
patients compared to age- and sex-matched controls in terms of functional outcomes and treatment failure.

**Bibliography**


Images
Poster 089: Usefulness of orthotic therapy with a new functional splint made of thermoplastic knit material for thumb carpometacarpal osteoarthritis

Category: Hand

Treatment; Patient Education
Level 3 Evidence

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Hypothesis
There are multiple types of orthoses for thumb carpometacarpal (CM) osteoarthritis. Material, hardness, and application (target joints) differ depending on the splint [1-3]. For thumb CM osteoarthritis, we developed the Kitasato Thumb Splint (KTS), a functional device made using a thermoplastic knit material that stabilizes the CM joint only at the base, so as not to disturb the motion of other thumb joints. The purpose of this study was to examine the potential of orthotic therapy using the KTS.

Methods
We prospectively tested 24 hands of 21 patients who were diagnosed with thumb CM osteoarthritis from March 2013 to October 2014 (6 hands from 6 males, 18 hands from 15 females; average age ± standard deviation = 64 ± 16 years). According to the Eaton classification for severity, 4 hands were categorized as stage I, 8 hands as stage II, and 12 as stage III. In all cases, bracing therapy with KTS was prescribed without the need for medication. Evaluation items were: 1) joint movement range and pinch strength with and without KTS installation at the start of orthotic therapy; and 2) pain, evaluated with a visual analog scale (VAS); grip strength; pinch strength; hand function, evaluated by Hand 20 [4]; and patient satisfaction (VAS) at the start and after 3 months of orthotic therapy. Comparisons were performed using the paired t-test, and a risk ratio of less than 5% was considered significant.

Results
At the start of orthotic therapy, no change was observed in the range of thumb motion but pinch strength increased significantly following KTS installation. After 3 months, there was no significant difference in grip strength but pain, pinch strength, and hand function were
significantly improved compared to the start of appliance therapy. Patient satisfaction was also high.

Summary Points

- The range of thumb joint motion was not restricted but pinch strength increased immediately upon application of the KTS.
- Three months after starting KTS therapy, pain was relieved, pinch strength increased, hand dysfunction improved, and patient satisfaction was high.
- KTS is a new functional splint for thumb CM osteoarthritis that can be adjusted to the thumb of the individual patient.

Bibliography


Images
Poster 090: Patient outcomes following Phalangeal and Metacarpal fractures treated by External Fixation – A Case Series

Category: Hand

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
External fixation (EF) is a viable treatment option for treatment of Phalangeal and metacarpal fractures

Methods
We retrospectively analysed all patients with Phalangeal and Metacarpal fractures who underwent treatment with EF application from October 2005 to July 2015. The mechanism of injury, type of fracture and associated injuries were recorded. The Hoffman II micro external fixation system by Stryker was used in all cases. Post-operative complications and the duration in EF were recorded. Functional recovery was assessed using Total Active Range of Movement (TAM) of the injured digit and graded Excellent, Good, Fair or Poor [1].

Results
38 Patients with injury to 39 rays and a total of 41 fractures were treated by external fixation. Patient age range was 14 – 78 years old (mean 41.5 years) of which 82% (31) were male. Mechanism of injury was Crush in 34% (13/38), Fall in 26% (10/38), Punch in 26% (7/38), Machinery in 13% (5/38) Hyperextension in 5% (2/38), Explosion in 2% (1/38) and Axe in 2% (1/38). Of the fractures, they were intra-articular in 73% (30/41), comminuted in 100% (41/41), open in 34% (13/41), and associated with significant tendon injury in 24% (10/41). The average time in EF was 5.5 weeks. Functional outcomes by the TAM method, revealed 52% (17/33) of digits achieving excellent or good results. Poorer outcomes were seen in patients who did not complete hand therapy, or had associated tendon, severe soft tissue or multiple injuries. During the fixation period, the complication rate was 19% (8 fractures in 8 patients out of 41 fractures). 1 patient sustained an additional injury in the 1st postoperative week, displacing the fixation. In 2 patients there was loss of fracture position requiring revision. Two pin site infections resolved with oral antibiotics. Three fractures did not achieve bony union of which 2 were part of multiple digit open fractures with severe soft tissue injuries from machinery, and one was a severe open blunt crush injury with severe bone loss requiring autologous bone
grafting. After removal of fixator, 3 patients underwent tenolysis and arthrolysis for joint stiffness.

Summary Points
- External fixation is a viable treatment for unstable phalangeal and metacarpal injuries especially in open or severe soft tissue injuries
- Good results can be achieved but are limited by mode and severity of injury

Bibliography

Images
Poster 093: Trends in Incidence and Treatment Setting of Fingertip Injuries in the United States

Category: Hand

Evaluation/Diagnosis; Treatment; Billing/Coding
Level 4 Evidence

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Hypothesis
To examine trends in incidence of fingertip injuries as well as treatment setting. We hypothesized that while overall incidence of such injuries would remain stable over time, simple surgical procedures would tend to be performed more commonly in the emergency department than in other settings.

Methods
Using the MarketScan Research Databases (Truven Health Analytics), we queried for all occurrences of coded fingertip injuries and related procedures performed between 2003 and 2014 as documented using relevant ICD-9 and CPT codes. Examined injury diagnoses included: open wound of finger (ICD-9 883.0, 883.1), crushing injury of finger (927.3), and open distal phalanx fracture (816.12). Examined procedures included wound repair (CPT 12001, 12002), avulsion of nail plate (11730), evacuation of subungual hematoma (11740), and repair of nail bed (11760); analysis was restricted to only those procedures associated with hand-related diagnoses. The incidence of these injuries was then examined over time as well as with respect to patient age. The treatment setting of the procedures (e.g. emergency department, inpatient hospital) was also tracked. Trends were analyzed with simple linear regression analysis.

Results
The most common diagnosis across all years was uncomplicated open finger wound, with an average incidence of 6366/year/million. Crush injury, complicated open finger wound, and open distal phalangeal fracture codes each accounted for fewer than 1000 cases per year per million. Overall incidence of each particular injury across all ages remained stable over 2003-2014, with exception of complicated finger wounds, which showed a 25% decrease in reported incidence (933 to 706/year/million, p < 0.001). A similar 30% significant decrease in incidence over time was noted for finger wounds in patients under 18 (1457 to 1044/year/million, p<0.001). All
injuries occurred most frequently in persons 41-65 years of age. Fingertip injury repair was performed with increasing incidence in the emergency department than in other settings over time, with approximately 50% such procedures performed in the ED by 2014.

Summary Points
- The overall incidence of common finger injuries in the United States has remained stable over the last decade.
- Fingertip injuries are most common in patients between 41-65 years. This may indicate higher risk from occupational or recreational activities in adults.
- Simple hand wound repair is most commonly performed in the ED than any other treatment setting. This may reflect economic and financial trends with decreased access to elective followup care or a greater role by the emergency physician.
Poster 094: Trends in the Surgical Treatment of Thumb Carpometacarpal Arthritis

Category: Hand

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Hypothesis

Multiple clinical studies have shown clinical outcomes of trapeziectomy with ligament reconstruction and tendon interposition (LRTI) to be equivalent to yet more expensive and risky than trapeziectomy alone. The purpose of this study was to evaluate utilization of these two procedures used to treat trapeziometacarpal osteoarthritis using a US healthcare claims database.

Methods

Claims data were analyzed from MarketScan Research Databases (Truven Health Analytics), which includes patients with private insurance as well as Medicare patients who also have private insurance. Data includes claims of 367,535,445 patients from 2003 through 2014. Data was also stratified by patient age, surgeon type, gender, and surgeon practice region. The specific surgical procedures analyzed were trapeziectomy (CPT code 25447) and trapeziectomy with LRTI (CPT code 25447 and 26480).

Results

Overall, the rate of trapeziectomy alone peaked in 2005 and is declining (154.9 per million patients in 2005 to 112.7/million in 2014 (p=0.038)), while the rate of trapeziectomy with LRTI is increasing (13.0/million in 2003 to 121.0/million in 2014 (p<0.001)). In 2014, the raw number of coded trapeziectomy with LRTI surpassed number of trapeziectomy alone (Figure 1). This trend of increasing trapeziectomy with LRTI is constant for all age groups, with the exception of those younger than 50 years of age. The increasing rate of trapeziectomy with LRTI over trapeziectomy alone was demonstrated in both orthopaedic and plastic hand surgeons; however, orthopaedic hand surgeons have incorporated this procedure more frequently than their plastic surgeon colleagues. Analyzing gender and location show similar growth of trapeziectomy with LRTI coding with decreasing utilization of trapeziectomy alone.
Summary Points

- The rate trapeziectomy alone slowly tapered from its high in 2005 to 2014, whereas the rate of trapeziectomy with LRTI has increased, despite evidence suggesting it is equivalent in outcomes to trapeziectomy alone. Reasons for this are likely multifactorial and may include training, slow adoption of a newer procedure, and financial incentive.
- Patients younger than 50 years of age do not fit into this trend, presumably because they have prosthetic arthroplasties or arthrodeses rather than soft tissue arthroplasties.
- Orthopaedic hand surgeons are performing trapeziectomy with LRTI more often, which may reflect differential specialty numbers, familiarity, or training bias.
- Research is needed to explain this dichotomy and to examine trends of other surgical procedures including arthrodesis and implant arthroplasty. Since it is not worse, but equivalent, trapeziectomy with LRTI arthroplasties may continue to gain popularity for treatment of thumb carpometacarpal arthritis.

Bibliography

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Poster 095: Late-stage Management of second phalanx fracture-dislocation of the thumb using a dynamic external fixator - discussion of a case

Category: Hand

Treatment;Surgical Technique
N/A - not a clinical study

Xavier Gueffier

Hypothesis
Intra-articular second phalangeal fracture of the thumb is a rare injury and, in the absence of displacement, is treated orthopaedically. The main complication is secondary displacement. Late-stage management is particularly problematic. The following reports on a case of delayed management of such injury at the fracture-dislocation stage, using a dynamic external fixator.

Methods
The patient is a 40 year old municipal employee, right-handed. Injury to his left thumb was sustained while playing football. Clinical examination evidenced a comminuted anterior face fracture at the base of the second phalanx. There was no interphalangeal dislocation. Orthopaedic management was initiated using a thermoformed Stack splint. Radiographic examination was performed on days 10 and 31. A dorsal fracture-dislocation of the second phalanx was observed when the patient was seen at one month. Surgical treatment involved closed reduction under image intensification, using a dynamic external fixator. Post-operative rehabilitation therapy began immediately. The external fixator was removed on day 45.

Results
The patient recovered full passive and active mobility. At 6 months, radiographic verification showed favourable development, with fracture consolidation and no evidence of dislocation relapse.

Summary Points
The management of articular fractures is highly complex, particularly when the fracture is comminuted and observed tardily. Faced with complex injury and late-stage management, the non surgical option is often given preference.
An external fixator with transfixing pins is a possibility despite the second phalanx bone stock issue. Closed reduction of the injury was achieved in the case under discussion by the use of a dynamic distraction system. Our patient’s functional recovery outcome leads us to suggest this course of action for displaced interphalangeal articular fractures of the thumb, even when observed at a late stage.

**Bibliography**


Images
Poster 096: Outcomes Related to Injury Characteristics of Zone 1 and 2 Digit Amputations Treated with Revision Amputation

Category: Hand

Treatment;Surgical Technique
Level 4 Evidence

Andrew P. Harris, MD
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Hypothesis
Revision amputation is the most common treatment for non-replantable finger amputations in the United States. Though the digit amputated and zone of injury confer differing results for replantation, no study has assessed the effect of the specific digit and zone on the success of revision amputation. Identifying risk factors for unplanned secondary revision amputation based on injury patterns would allow for improved patient education and counseling and increased focus on prevention of secondary revision.

Methods
After IRB approval, our institution’s emergency department (ED) database was retrospectively examined for all patients presenting with flexor tendon zone-1 and -2 traumatic finger and thumb amputations from January 2010 to December 2015. Each patient was reviewed for demographic information, medical comorbidities, injury characteristics, site of initial definitive management (ED versus OR), and complications requiring unplanned secondary revision amputation. Conditional Cox Proportional Hazard regression with sandwich estimation, where fingers where nested within patients, was used to model hazard of unplanned secondary revision within 1 year of index procedure relative to zone of injury and specific digit amputated. Significance was established at p<.05 and all interval estimate were calculated for 95% confidence.

Results
537 patients with 677 digits were initially treated with primary revision amputation. 481 patients with 586 amputations were initially revised in the ED, while 56 patients with 91 amputations were initially revised in the OR. 74 patients with 83 amputations (78 zone-1, 5 zone-2) treated with primary revision amputations required unplanned secondary revision amputation.
amputations within 1 year of index procedure. With reference to the thumb, the index, middle and small fingers had a 5.3-fold (p=0.0059), 4.3-fold (p=0.0173), and 4.5-fold (p=0.0211) increased risk of secondary revision, respectively. The ring finger had a 3.1-fold increased risk, though this approached significance (p=0.0677). No increased risk in secondary revision was demonstrated when comparing injuries zone-1 and zone (p=0.4827).

Summary Points
• The index, middle, and small fingers have increased risk of unplanned secondary revision amputation in reference to the thumb
• No increased risk of unplanned secondary revision amputation was demonstrated comparing zones of amputation
• Patients presenting with traumatic digit amputations may be counseled on their risk of unplanned secondary revision based on specific digits involved.

Bibliography
Poster 097: The Cost-Effectiveness of Surgical Fixation of Distal Radius Fractures: A Computer Model-Based Evaluation of Three Operative Modalities

Category: Wrist

Level 2 Evidence

Grant Received from: T32 training grant (AR055885) from the National Institutes of Health

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Hypothesis
There is no consensus on the optimal fixation method for patients who require surgical management of distal radius fractures [1]. We used cost-effectiveness analysis to determine which of three modalities offers the best value: closed reduction and percutaneous pinning (CRPP), external fixation (EF), or open reduction internal fixation (ORIF). We hypothesized that ORIF would be the more cost-effective option in all scenarios.

Methods
We developed a state-transition Markov model that projected short- and long-term health benefits and costs in patients undergoing surgery for distal radius fracture. Simulations began at age 50 and were run over patients’ lifetimes. The analysis was conducted from a health care payer perspective, incorporating third-party payer and patient out-of-pocket costs, and a societal perspective, incorporating the additional costs of lost productivity and unpaid caregiving. We estimated transition probabilities and quality of life values from the literature and determined costs from Medicare reimbursement schedules in 2016 U.S. dollars. Suboptimal postsurgical outcomes were determined by rates of reduction loss (CRPP 3.7%, ORIF 0.9%, EF 8.9%) and orthopaedic complications (CRPP 24.8%, ORIF 15.7%, EF 25.9%). Estimated procedural costs were $7,638 (CRPP), $10,167 (ORIF), and $9,886 (EF). Outputs were total costs and health outcomes measured in quality-adjusted life-years (QALYs), discounted at 3% per year. We considered willingness-to-pay thresholds (WTPs) of $50,000 and $100,000. We conducted deterministic and probabilistic sensitivity analyses to evaluate the impact of data uncertainty on cost-effectiveness results.

Results
From the health care payer perspective, CRPP dominated (i.e. was less costly and more effective than) ORIF and EF. From the societal perspective, the incremental cost-effectiveness ratio (ICER) for CRPP compared to ORIF was $20,218 per QALY; EF remained dominated by CRPP and ORIF.
From both perspectives, ORIF had a higher rate of major non-operative complications compared to CRPP, owing mainly to a higher rate of non-operative nerve injury or neuropathy. These specific complications drive the lower quality of life for ORIF versus CRPP. In probabilistic sensitivity analysis from both health care payer and societal perspectives, both CRPP and ORIF were cost-effective roughly 45% of the time.

**Summary Points**
- While CRPP demonstrates the greatest likelihood of being cost-effective, such likelihood does not exceed 50%.
- Valuing lost productivity and unpaid caregiving from the societal perspective reveals ORIF to be the least costly option.
- Given current level of uncertainty in data, CRPP and ORIF offer similar value and surgeons should discuss procedure choice based on patient and surgeon preferences.

**Bibliography**
Poster 098: Characteristics of Radiocarpal Dislocations at a Level 1 Trauma Center: a 9 Year Review

Category: Wrist

Evaluation/Diagnosis;Treatment;Prognosis/Outcomes
Level 4 Evidence

James P. Hovis, MD
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Hypothesis
Radiocarpal dislocations are uncommon. Due to this rarity, they are not entirely defined. It would be advantageous to investigate radiocarpal dislocations at a high volume level 1 trauma center to further elucidate the injury.

Methods
After IRB approval, a retrospective review of 20 patients presenting to a level 1 trauma center over 9 years with radiocarpal dislocations was performed in order to distinguish epidemiology, injury mechanism, appearance, associated injuries, Injury Severity Score (ISS), length of hospital stay (LOS), mortality, treatment, complications, and need for subsequent procedures. Patients were located by searching the trauma registry for ICD-9 codes specific to the injury. Peri-lunate and lunate dislocations were excluded.

Results
Average patient age was 39.3 years. 85% of injuries were high energy mechanisms. 80% were closed injuries. Average LOS was 10.45 days and average ISS was 17.75. There were no associated mortalities. 85% of injury patterns fit the classification described prior by Dumontier with bony injuries outnumbering isolated ligamentous injuries. Surgical intervention was the primary treatment and was driven by injury pattern. Complications encountered were infection and inability to close surgical wounds primarily. Removal of hardware was the most common subsequent procedure required.

Ipsilateral upper extremity fractures or dislocations, high energy lower extremity long bone fractures, neurovascular trauma, and tendon injuries about the hand/wrist were commonly associated. The ISS and LOS were both lower in closed injuries than open injuries, but this was not statistically significant (ISS p=0.15; LOS p=0.06). Radiocarpal dislocations involving wrist fracture had a longer LOS compared to isolated ligamentous dislocations, but this was not statistically significant (p=0.53). The ISS for dislocations with wrist fracture and isolated ligamentous dislocations were similar and not statistically significant (p=0.91).
Summary Points

- Radiocarpal dislocation patterns in our series lend support to the Dumontier classification.
- They are characterized as high energy injuries seen more commonly in young males and frequently involving related visceral or long bone trauma.
- Neurovascular and bony/soft tissue wrist injuries, especially distal radioulnar joint injuries can be associated.
- ISS and LOS are variable and do not appear to have any significant relationship to injury characteristics.
- Infection, distal radioulnar joint instability, inability to primarily close surgical wounds, and need for removal of hardware were seen in our series and can guide providers in setting expectations for patients.
- This study substantiates prior literature on radiocarpal dislocations and can help providers improve patient outcomes by further elucidation of the topic.
Poster 099: Does Distal Fixation Matter? A Biomechanical Comparison of Bridge Plate Fixation for Distal Radius Fractures

Category: Wrist

Treatment; Surgical Technique; Basic Science
N/A - not a clinical study

Grants Received from: (1) 2015 Fast Track Grant from the American Foundation for Surgery of the Hand (AFSH). (2) 2016 Industry Grant from Trimed Inc.

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Hypothesis
Internal distraction plating can be used to treat highly comminuted distal radius fractures. Currently, there is no consensus with regards to distal fixation of the distraction plate. The purpose of this study was to compare the biomechanical properties of second versus third metacarpal distal fixation with the hypothesis that placement of the distraction plate at either metacarpal would result in similar biomechanical properties.

Methods
Biomechanical evaluation of the radiocarpal spanning distraction plate comparing second versus third metacarpal distal fixation was performed in 10 matched-pair cadaveric specimens. Using a custom 3-dimensionally-printed osteotomy jig, a dorsal wedge osteotomy centered 2 cm proximal to the lunate fossa articular surface was created to simulate an unstable extra-articular distal radius fracture. A 2.7mm/3.2mm distal radius bridge plate was used for all cadaveric testing (Trimed, Valencia, CA). Each fixation construct underwent cyclic loading for 500 cycles in flexion and 500 cycles in extension with a 50N force at 2Hz. Load was measured off the test stand and displacement was recorded using a microtransducer at the fracture site. After cyclic loading, each specimen was loaded to failure. The stiffness, maximum displacement, and load to failure were compared between the two groups. A P-value < 0.05 was considered significant.

Results
Cyclic loading in flexion demonstrated that distal fixation to the third metacarpal resulted in greater stiffness compared to the second metacarpal (Figure 1). No significant difference in stiffness was noted in extension (Figure 1). Maximum displacement in flexion was 2.32 ±0.93 mm and 1.53 ±0.61 mm at the second and third metacarpal, respectively (P=0.15). Maximal
displacement in extension was 1.76 ±0.66 mm and 1.28 ±0.59 mm at the second and third metacarpal, respectively (P=0.25). The average load to failure was 152.7N ± 50.2 with distal fixation at the second metacarpal and 177.7N ± 52.3 at the third metacarpal (P=0.463).

**Summary Points**

- Fixation to the third metacarpal results in greater stiffness at the fracture site in flexion. This is likely due to greater plate-to-bone contact along the radial metaphysis with distal fixation to the third metacarpal during compression (flexion) (Figure 2). There was no difference in stiffness in tension (extension) because stiffness is largely provided by the screw pull out strength in this direction.
- The treating surgeon should chose distal metacarpal fixation primarily based on fracture pattern, alignment, and soft-tissue integrity. If a stiffer construct is desired, consideration can be given to place the radiocarpal spanning plate at the third metacarpal.
Hypothesis
Maximizing screw length for the fixation of a simulated scaphoid fracture model leads to greater interfragmentary compression in comparison to screws fixed with shorter lengths.

Methods
Sixty-four (n=8 for each of four screw lengths and two screw geometries) polyurethane foam models were cut to 24mmx10mmx10mm. A proximal fracture was simulated with a transverse cut along the 5mm length of the block. A HCS was inserted in the center of the scaphoid so that compression would occur at the simulated fracture site. Screws of 10mm, 18mm, 20mm, and 24mm length were each respectively tested for interfragmentary compression along the fracture site. A fully threaded screw (FTS) (Acumed) and central threadless screw (CTS) (Stryker) were inserted according to manufacturer’s protocol until the screw head was flush with the top block. Interfragmentary compression force was collected 60 seconds after fixation. Independent sample t-test and one-way analysis of variance were performed to assess differences between the fixation methods at each of the simulated fracture locations. Significance was set at p<0.05.

Results
A significant effect of HCS geometry (p<.0001) on interfragmentary compression was found for the fixation of 5mm proximal fractures. CTS geometry generated significantly greater (p<.0001) interfragmentary compression than FTS geometry for 10mm and 18mm HCS lengths, respectively; however, there was no significant difference between geometries for 20mm and 24mm HCS lengths. Additionally, a significant effect of screw length (p<.0001) was found for the fixation of 5mm proximal fractures. There was no significant difference between fixation utilizing a 20mm and 24mm HCS. Fixation utilizing a 10mm HCS generated significantly less interfragmentary compression than fixation utilizing a 20mm or 24mm HCS. When accounting
for both screw length and geometry, an 18mm CTS generated greater interfragmentary compression than a 20mm and 24mm FTS; there was no significant difference in compression between an 18mm CTS and a 24mm CTS.

**Summary Points**

- The CTS has larger pitch and deeper thread depth than the FTS; this may aid in generating greater compression for proximal fractures when fixed with 10mm and 18mm HCS
- Centering a small screw (10mm) along a proximal fracture generates significantly less interfragmentary compression than a longer, non-centered HCS; this is due to less purchase being gained below the fracture site for fixation utilizing a small HCS (10mm)
- Balance between maximizing HCS screw length and centering the HCS is vital towards maximizing interfragmentary compression for the fixation of proximal fractures.

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1: Sugathan H et al. Injury Int J Care Injured. 2012; 205-208

Images
Poster 102: Scapholunate Reconstruction After Distal Radius Fractures

Category: Wrist

Evaluation/Diagnosis; Treatment
Level 3 Evidence

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Hypothesis
Radiographic diagnosis of scapholunate injury (SLI) in the setting of distal radius fractures is challenging. It remains unclear to what extent radiographic diagnosis of SLI by a radiologist influences surgical decision-making regarding treatment of SLI. We aimed to: 1. identify the number of times that concerns for the possibility of concurrent SLI in the setting of a distal radius fracture had been raised by the radiologists, 2. identify how often the radiologist’s diagnosis was confirmed by the treating surgeon, and 3. how many of the patients with a radiographic concern for SLI by the radiologist received operative treatment for the SLI.

Methods
Based on CPT-codes, we identified 2923 patients that were operatively treated for their distal radius fracture in 1 of 3 participating institutions in an urban city in the USA. We reviewed the medical charts of 654 patients who had a mention of SL distance in their radiography-, surgery-, or clinical notes. We then measured the SL-distance and recorded patient-, diagnosis-, and treatment characteristics of all these patients.

Results
Two hundred out of 2923 patients (6.8%) received a radiological diagnosis of SLI. In seven of these patients (3.5%), the surgeon confirmed the diagnosis of the radiologist. Four patients (2%) had operative repair of their SLI.

Summary Points
- Radiologists demonstrate a low threshold to identify SLI in the setting of distal radius fractures, while the number of SLI identified by the treating surgeon are a remarkably smaller number.
- In contrast to our previous publications, we no longer recommend routine exploration and repair for a radiographic appearance of SLI and propose an algorithm for assessment of SLI in the setting of distal radius fractures.
Poster 103: Long-term Outcomes of Uncemented Universal 2 Total Wrist Arthroplasty

Category: Wrist Treatment; Prognosis/Outcomes
Level 4 Evidence

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Arnold-Peter C. Weiss, MD

HYPOTHESIS
Total wrist arthroplasty (TWA) components are traditionally cemented into the radius and carpus. We hypothesized that uncemented TWA provides superior clinical results and several advantages over cemented TWA techniques at long-term followup.

Methods
From 2002 to 2014, 42 consecutive patients underwent uncemented TWA (39 primary and 3 revisions of a previously cemented TWA) with the Universal 2 implant (Integra, Plainsboro, NJ) with a press fit only by the senior surgeon. All patients were immobilized for 4 weeks post-operatively and then underwent progressive motion with hand therapy. Average post-operative clinical and radiological follow up was 10.1 years (range 2-14 years).

Results
Average age at surgery was 56 years with 36 females and 6 males. Indication for surgery was for severe pain secondary to rheumatoid arthritis (32), juvenile rheumatoid arthritis (1), psoriatic arthritis (1), and post-traumatic arthritis (8). The dominant wrist was involved in 60% (25) of the patients. 3 patients had previous cemented TWA which had dislocated, which were removed along with all cement and converted to an uncemented TWA. Active flexion/extension averaged 37° flexion and 29° extension. The final follow up mean Patient-Rated Wrist Evaluation (PRWE) scores were 23 +/- 6. 11 patients had mild occasional aching postoperatively, and 31 had no pain. Complications included carpal implant loosening in 3 patients that required surgical revision with an uncemented carpal component in 2 and a cemented carpal component in the other. Final radiographs demonstrated lucency along the carpal component in 11 patients and the radial component in 6 patients without evidence of loosening or implant migration.

Summary Points
Uncemented TWA appears to provide superior clinical results and several advantages over cemented TWA techniques:
• Bone ingrowth to the implant
• Significantly reduced dislocation rate (0% in this series)
• Theoretical decrease in complexity of future revision surgery
• 7.1% rate of component loosening without evidence of clinical loosening or implant migration.

Bibliography

Images
Poster 104: Extensor Retinaculum Reconstruction of the Distal Radioulnar Joint in Adolescents

Category: Wrist

Surgical Technique
Level 4 Evidence

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Hypothesis
This study characterizes the outcomes and complications of surgical reconstruction of distal radioulnar joint (DRUJ) instability using the extensor retinaculum (Herbert sling). Our hypothesis was that extensor retinaculum reconstruction is a reliable method of DRUJ stabilization in adolescents.

Methods
This was a retrospective study of all patients treated surgically using the Herbert sling for DRUJ instability at our institution from 1995 - 2015. The indication for surgery in all cases was DRUJ instability on physical exam, often in combination with other wrist pathologies. Medical records were reviewed and patients were contacted to participate in prospective completion of the QuickDASH questionnaire.

Results
We identified 25 subjects who underwent surgery at an average of 16.7 years of age (range 12-22 years). Preoperative symptoms were more commonly pain (96%) than feelings of DRUJ instability (44%), although all had instability on physical exam. Nine (35%) demonstrated limited supination preoperatively. Symptoms were present for a median of 9 months prior to surgery. Twenty-three subjects (92%) noted prior injury to that wrist, 17 of which were distal radius fractures. Surgery consisted of stabilization of the DRUJ using extensor retinaculum, in concert with other procedures to address all potential causes of the wrist pain (Table 1). Postoperatively, DRUJ stability was maintained in 24 of 25 subjects. Those subjects with limited supination improved from a preoperative average of 52 degrees to 86 degrees after surgery. Four subjects (16%) required additional surgery on the same wrist, including 1 removal of implant and 2 procedures for new injuries (one ECU stabilization and one TFCC repair). No subject experienced infection, nerve injury, or compartment syndrome. Of 15 patients who provided functional
outcome scores, median quickDASH score was 6.8 (range, 0 to 46), median work module score was 0 (range, 0 to 44), and median sports module score was 0 (range, 0 to 69) (Figure 1).

Summary Points

• DRUJ instability in adolescents is often preceded by wrist trauma, specifically fracture of the distal radius.
• The primary complaint in our subjects was pain, not necessarily instability. Surgeons must maintain a high level of suspicion to appropriately diagnose DRUJ instability.
• The Herbert sling technique using extensor retinaculum can successfully confer DRUJ stability in this population.
• Other causes of wrist pain should be addressed at the same operation, including TFCC repair, ulnar shortening, and ulnar styloid excision or repair, to aid resolution of symptoms.
Poster 105: Modified Sauvé-Kapandji Procedure for the Distal Radioulnar Joint Disorders of Osteoarthritis and Rheumatoid Arthritis

Category: Wrist

Treatment; Surgical Technique
Level 4 Evidence

Akio Minami, MD, PhD
Norimasa Iwasaki, MD, PhD
Yukinobu Kamiya
Yasuaki Tojo

Hypothesis
The Sauvé-Kapandji (S-K) procedure is a popular choice among several surgical procedures in the treatment of distal radioulnar disorders (DRUDs). We developed a modification of the S-K procedure. We used the resected fragment of the ulna to fit into any remaining space between the ulnar head and sigmoid notch to preserve extensor carpi ulnaris (ECU) tendon function as a wrist stabilizer and to maintain the transverse diameter of the distal radioulnar joint (DRUJ). We also used a half slip of the ECU tendon to stabilize the proximal ulnar stump. We want to report the 82–month postoperative clinical and radiographical results in 83 patients with DRUDs of OA and rheumatoid arthritis (RA) treated by the modified S-K procedure.

Methods
Eighty-three wrists in 40 men and 43 women with OA and RA of the DRUJ were treated by the modified S-K procedure. The average age at the time of operation was 59.1 years (range, 25-81). The OA of the DRUJ occurred in 71 wrists, 38 primary and 33 secondary. The RA of the DRUJ was in 12 wrists.

We evaluated the postoperative clinical results (pain, range of motion (wrist and forearm) and, grip strength), and radiographic findings.

Results
Pain improved in all patients after surgery but pain was elicited over 5 ulnar stamps by direct pressure. Both flexion / extension of the wrist and pronation / supination of the forearm had statistically significant improvement with the exception of flexion. Postoperative grip strength increased over the preoperative value with a statistical value.

Radiographically, arthrodesis of the DRUJ was confirmed in all wrists at least within 10 weeks. The stability of the proximal ulnar stump was maintained in 78 wrists. However, the drilled hole in the proximal ulnar stamp has broken in 10 wrists. In 5 among 10 wrists with breakage of the
drilled hole, the significant radioulnar convergence instability of the proximal ulnar stump were found.

Summary Points
Our method is very simple and useful in the treatment of distal radioulnar disorders of OA and RA. However, the site of the drilled hole on the proximal ulnar stump should be considered to stabilize the stump.
Hypothesis
Septic arthritis of the wrist can result in permanent damage to the joint. Timely diagnosis is crucial as urgent surgical debridement and initiation of antibiotics is needed. Although routinely in the differential diagnosis of atraumatic wrist pain, the incidence of septic arthritis is unknown. Moreover, unlike other large joints, there is no consensus on joint fluid cell count values considered pathognomonic for wrist septic arthritis, leaving history and physical exam as the gold standard for diagnosis. Therefore, the goal of this study was to better understand the incidence of septic arthritis of the wrist, and to identify clinical, serum, and joint fluid values that predict infection.

Methods
A ten-year review was conducted at a single urban hospital for patients presenting with a swollen painful wrist without trauma. From those records, patients with a joint fluid analysis were examined with regards to history, demographic and laboratory data.

Results
Of the 892 patients meeting the inclusion criteria, 1.5% were found to have wrist septic arthritis. From those with wrist aspiration performed, objective variables predictive of septic arthritis included: elevated serum white blood cells (WBC) above 11,000/mcL and a fever above 100.4 F within 24 hours of aspiration. Predictive demographic variables included a history of IV drug abuse and smoking. While a particular joint cell count analysis was not found to predict septic arthritis for all patients studied, an elevated joint WBC above 97,000/mm3 was significant when compared with cases of crystalline arthritis.
Summary Points

- Wrist septic arthritis is uncommon; however, laboratory data and patient factors may help to identify patients at risk.
- Wrist joint cell count analysis cannot reliably predict a septic wrist.
- Wrist joint gram stain, culture, and crystal analysis can more reliably predict a septic wrist and should be given priority when limited joint fluid is available.
Poster 107: Treatment of the Non-united Scaphoid: A Meta-analysis of the Last 20-Years

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes

Level 3 Evidence

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Hypothesis
Scaphoid fractures are the most common carpal fracture. Conservative treatment is sufficient in most cases, however up to 10% of these fractures may still progress to nonunion. Treatment is primarily operative, including non-vascularized bone grafting and vascularized grafting. We hypothesized that vascularized bone grafting had higher union rates than non-vascularized.

Methods
A comprehensive/systematic literature review of the past 20-years was performed to identify operative and nonoperative treatments of the scaphoid nonunion. A total of 10,823 studies were, level of evidence (LOE) of II or higher was used for operative treatments. Due to more limited research, we accepted non-operative studies with a LOE of III or greater. 20 studies (13 operative, 7 non-operative) were ultimately included in our final analysis (Figure 1).

Results
Using random-model-effects, the overall union rate for the vascularized graft cohort was 91.2% (95% Confidence Intervals (CI) of 86.9-94.7%) compared to 89.5% (95%CI of 76.5-97.8%), with non-vascular grafting and 90.1% (95%CI of 51.1-97.9%) when fixation was used without grafting. Time-to-union in vascularized grafting was on average 2.4 months compared to 3.4 months with nonvascular treatment, 3.3 months in non-grafting fixation. The vascularized graft group was the only group that provided sufficient information to perform statistical analysis in regards to gains in range of motion, and the improvements were significant for wrist extension; ulnar and radial deviation, and were not significant for volar flexion. In terms of grip strength, both cohorts significantly improved.

Summary Points
- Scaphoid nonunion fracture management has been a well-discussed topic in the last years.
• Our study concludes, with the highest-level evidence possible, that surgically managing the fracture may still be the best option to the patient.
• It also shows that, within surgical graft management, vascular grafts may provide both better union rates and faster union times than their non-vascularized homologs.
• Given the consistency of results showing similar union rates of various operative techniques, the best option for the patient may continue to be surgeon experience in each technique.

Bibliography

Images
Poster 108: Morphometric Variations of the Volar Aspect of Distal Radius

Category: Wrist

Anatomy
N/A - not a clinical study

Bong Cheol Kwon, MD, PhD

Hypothesis
There are significant morphometric differences in the volar aspect of distal radius between columns, genders, and races.

Methods
We analyzed a quantitative 3-dimensional CT scan acquired from 81 wrists of 81 Korean cadavers (38 male and 43 female). Using a 3D CAD software, we measured the volar surface angle (VSA), which was defined as the angle formed between the lines along the volar surface of the radius shaft and the radial metaphysis in the sagittal plane, at lateral and intermediate column (Fig. 1). The VSA was compared between the lateral and intermediate columns, and between men and women. We also compared the VSA between Koreans and Caucasians using data pooled from ours and three prior studies.1-3 We used the coefficient of variation (CV) to assess the variability of the morphometric parameters, and Cohen’s d to estimate the effect size of the difference in morphometric parameters.

Results
The average VSA of the lateral column was 22 ± 6°, and that of the intermediate column was 29 ± 8° in Korean (P<0.001), with the effect size for the difference being large (Cohen’s d, 0.96). Variability was high for both VSAs (CV, 26.6% for the lateral column and 26.5% for the intermediate column, respectively). Men had a significantly larger VSA of the intermediate column than women in Korean (31 ± 8° vs. 27 ± 6°, P<0.001), with a medium effect size (Cohen’s d, 0.64). However, the average VSA of the lateral column was comparable between men and women. Koreans showed significantly smaller VSA of the intermediate column than Caucasian (28 ± 8° vs. 34 ± 6°, P<0.001) with a large effect size (Cohen’s d, 0.81).

Summary Points
• The VSA of distal radius showed large variations and was influenced substantially by columns, genders, and races.
• Our findings suggest that sophisticated individualization is required in pre-operative planning including choice of volar locking plates for the treatment of distal radius lesions.
Bibliography


Images
Poster 109: Partial Extensor Tendon Lacerations in Zone V of Human Cadavers: A Biomechanical Study

Category: Wrist

Evaluation/Diagnosis; Treatment; Basic Science
N/A - not a clinical study

Christina Salas
Lauren Long
Benjamin Johnson
Patrick Gilligan
Jeremiah Johnson
Deana Mercer, MD

Hypothesis
There is a scarce amount of information surrounding the biomechanical consequences of partial extensor tendon lacerations. An expanse of literature is available for flexor tendon injuries and the biomechanical effects of these partial lacerations, but the direct clinical application of these studies to the extensor tendons remains unclear and controversial. Clinical studies are just beginning to emerge that compare the effects of repair versus conservative management, with the current guidelines indicating that repair should be done when the laceration size is 50% of the width of the tendon or greater. The goal of this study is to quantify the effects of partial extensor tendon lacerations (50% or greater) on finger extension and to characterize the method of failure.

Methods
Twelve fresh-frozen cadaver hands with forearms were used (mean age 55). The specimens were dissected to expose the extensor digitorum tendons of the middle and ring fingers. A “fight bite” was simulated at the dorsal aspect of the metacarpophalangeal joints through a transverse cut of 50-74% (middle) and 75-90% (ring). The specimens were fixed to a custom loading device. Extensor tendons were cyclically loaded using the following methodology: flexor tendons were loaded using 20 g weight, finger displaced to full extension, unloaded by 10mm displacement to position the finger at approximately 45 degrees, then cycled from 45 degrees to full extension (10mm amplitude) for 3000 cycles to simulate a 6-week post-operative period. After each 500 cycles, image data was captured to measure growth of the tendon laceration and angle of the finger using Image J. The force data versus time was obtained through an Arduino microcontroller and analyzed using MATLAB. We report the mean reduction in force for each group.
Results
The middle finger (50-74% laceration) saw an average reduction in peak force of 12N in the first 500 cycles with a complete loss of full extension from 1500 to 2000 cycles. The ring finger (75-90% laceration) saw an average reduction in peak force of 25N with a complete loss of full extension in the first 500 cycles. No specimens experienced complete rupture of the laceration during testing. The average increase in laceration length was 0.4 mm.

Summary Points
• Extensor tendon lacerations 50-90% do not fully rupture during a 6-week post-operative period, but propagation of the laceration during this time limits the ability to achieve full extension.
• Immobilization with limited activity during weeks 1-3 may promote healing without the need for operative intervention.
Poster 110: Ulnar Neck Fractures associated with Distal Radius Fractures

Category: Wrist

Treatment;Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
There is little published data to guide management of ulnar neck fractures associated with fractures of the distal radius. As unplanned surgery usually reflects adverse events and this injury combination is relatively uncommon, we used a large database to study the incidence of unplanned surgeries after surgical and nonsurgical treatment of distal metaphyseal ulna fractures associated with a distal radius fracture and to identify factors associated with these unplanned surgeries.

Methods
We identified 277 patients with an ulnar neck fracture associated with a distal radius fracture. Fifty-six (20%) fractures were initially treated operatively and 6 of these 56 (11%) had a second, unplanned surgery. Of the 221 initially non-operatively treated fractures only one (0.45%) had a subsequent unplanned surgery that seems unrelated to the fracture (ulnar nerve neurolysis).

Results
Bivariate analysis showed that younger age, open fracture, multifragmentary fractures and initial operative treatment of the ulnar neck fracture were significantly associated with unplanned surgery. A multivariable analysis was not feasible due to the small number of unplanned surgeries.

Summary Points
- Eighty percent of ulnar neck fractures associated with a fracture of the distal radius are treated non-operatively in our region and subsequent surgery for problems is very uncommon.
- Operative treatment and fracture complexity were associated with unplanned surgery, which reflects some measure of injury severity, technical inadequacy, and inherent problems associated with surgery (e.g. implant prominence).
Bibliography

Images
Poster 111: Risk Factors for Reoperation After Total Wrist Arthroplasty

Category: Wrist

Prognosis/Outcomes
Level 4 Evidence

Taylor Pong
Wouter F. van Leeuwen, MD
Kamilcan Oflazoglu
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Hypothesis
The purpose of this retrospective study is to determine the rate of reoperation and implant removal after total wrist arthroplasty (TWA). In this case series, we evaluated the demographic or surgery-related factors associated with an unplanned reoperation or implant revision after a TWA. We also studied the secondary question examining whether there were radiographic features that predicted reoperation or implant revision after a TWA.

Methods
We used CPT codes to identify all 29 consecutive TWAs performed at two academic medical centers between 2002 and 2015. We manually reviewed medical records to collect demographic (age, sex), patient- or disease-related (tobacco use, indication of rheumatoid arthritis, prior wrist surgery) and surgery-related (implant type). Reoperation was defined as any unplanned wrist surgery related to the TWA. We used a Fisher exact test to compare the proportions of categorical variables and a Mann-Whitney U test to compare the average age among wrists that did and did not undergo reoperation and implant removal, and calculated P-values.

Results
The rate of reoperation was 48% (14 of 29 TWAs performed); of which 34% (10 of 29) underwent implant removal. Of the 14 wrists that underwent reoperation, 5 wrists had component loosening, 4 had a tendon rupture, and 3 had an infection. Five patients had wrist surgery prior to their TWA, of whom 4 eventually had their implant removed (p = .036). No other factors were associated with reoperation or implant removal.

Summary Points
• Reoperation and implant removal after TWA are common.
• Prior wrist surgery is associated with implant removal after TWA.
Poster 112: Interposition Bone Grafting of Scaphoid Nonunions with Carpal Collapse: Overstuffing or Restoring Normal Anatomy?

Category: Wrist

Treatment;Prognosis/Outcomes
Level 4 Evidence

Guilherme Giusti, MD
Allen Bishop, MD
Alexander Shin, MD

Hypothesis
The purpose of this study was twofold: 1) to radiographically evaluate scaphoid length and carpal parameters before and after reconstruction of nonunions with interposition vascularized medial femoral condyle (MFC) bone graft without repair of the volar radiocarpal ligaments to determine if the scaphoid is “overstuffed” or if normal anatomy is restored, and 2) to determine the effect on ulnar translocation of non repair of the volar radioscapohcapitate and long radiolunate ligaments.

Methods
39 patients with established scaphoid nonunions and carpal collapsed were treated with interposition vascularized MFC bone grafts and the volar radioscapohcapitate and long radiolunate ligaments were not repaired. The pre and post operative radiographs and CT scans of the 39 patients were reviewed. 13 of these patients had contralateral wrist radiographs that were used for comparison. The scaphoid length, capitate-ulnar distance ratio (CUDR) and the modified carpal height ratio (MCHR) were measured pre and 3 months postoperatively; the radio-scaphoid (RS) and scaphoid-lunate angle (SL) were also measured. A comparison was performed for the 14 patients with contralateral wrist x-rays to determine the degree of “overstuffing” of the scaphoid as well as to evaluate for ulnar translocation associated with non repair of the volar radiocarpal ligaments.

Results
No significant changes were observed on CUDR and MCHR pre and post-operative. The length of the scaphoid significantly improved after reconstruction from 21.9±3.3 to 23.7±3.4mm on AP and from 24.0±2.2 to 27.7±2.8mm on lateral views (p<0.0001). The RL and SL angles also changed significantly after surgery from 27.9±10.6º to 11.2±15.6º and from 66.0±15.1º to 54.9±12.0º (p<0.0001) respectively. For the 13 patients with contralateral x-rays, no differences were seen on CUD, MCHR or scaphoid length on AP view however, the scaphoid length on lateral
view significant increased after reconstruction from 23.1±2.40 to 27.6±2.78mm and was significant longer that the contralateral side which measured 25.0±2.43mm (p<0.0001). The scaphoid was lengthened by approximately 9.6% compared to the normal contralateral side. The RL and SL angles decreased significantly after correction and were no different than the contralateral side (p=0.002).

Summary Points
• The used of vascularized MFC bone graft restored or increased scaphoid length by 9.6% of the contralateral side and restored normal carpal alignment.
• The non-repair of the volar radial carpal ligaments did not cause ulnar translocation carpal instability when scaphoid anatomy was restored or “overstuffed”.

Bibliography

Images
Poster 113: Does Partial capitate shortening for Kienböck disease enhance lunate fracture healing?

Category: Wrist

Treatment;Surgical Technique
Level 4 Evidence

Sayuri Arimitsu, MD, PhD
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Hypothesis
We developed a new operative procedure of capitate shortening, “partial capitate shortening (PCS)” for Kienböck disease, by which only the lunate facet of the capitate was osteotomised and shortened, leaving the scaphocapitate joint intact, and carpal collapse was prevented (Fig.1). We hypothesized that partial capitate shortening for Kienböck disease healed the lunate fracture regardless of the fracture location.

Methods
The 31 patients were traced for more than 2 years after partial capitate shortening. Postoperative follow-up period was 46 (24-122) months. Three patients of Lichman stage 2, twenty-four of 3A, and four of 3B were included and clinically and radiographically assessed. Clinical evaluation included pain, range of wrist motion, and grip strength. Carpal height ratio was radiographically evaluated to verify progression of disease during the follow-up course. The preoperative lunate fracture location and the postoperative healing of the lunate fracture was assessed on the radiographs and CT.

Results
We found PCS was clinically effective: excellent and good results were achieved in 14 and 16 cases, respectively, according to the Nakamura scoring system. The 23 of 31 patients had no pain and others had mild pain with strenuous activity postoperatively. There was a significant improvements in wrist extension from 46 to 65 degrees (p<0.05) and flexion from 37 to 49 degrees (p<0.05). Grip strength was also significantly improved from 47 to 87% to normal side (p<0.01).
Fractures were detected preoperatively in 28 cases and the fractures were located at the volar pole in 7 (Fig.2a), at the dorsal pole in 5 (Fig.2b), in the center along a coronal plane (coronal fracture) in 6 (Fig.2c), along an axial plane (transverse fracture) in 9 (Fig.2d), and in the ulnar side in 1 (Fig.2e). Overall Healing rate was 75% (21 of 28 fractures). All fractures other than 1 of 5 dorsal pole fractures, 5 of 6 coronal fractures and 1 of 9 transverse fractures healed. In the
coronal fracture the union rate was only 17% and the average of clinical score was 16.5, which was lower than the other 4 types of fractures.

Summary Points
· PCS was effective in the treatment of Kienböck disease: excellent or good results were achieved in 30 of 31 cases.
· PCS healed the lunate fracture well except coronal type fracture.

Bibliography
Images
Poster 114: Post-Operative Protection of Scapholunate Ligament Repairs: Is There an Alternative to Kirschner Wires?

Category: Wrist

Hypothesis
This study seeks to determine whether scapholunate ligament repairs can be adequately protected in the early post-operative period without the use of Kirschner wires (K-wires). We hypothesize that a construct consisting of two suture anchors placed in both the scaphoid and lunate tied together with strong non-absorbable suture can adequately temporarly protect scapholunate ligament repairs in the early post-operative period by allowing for less than 2 mm of gap formation across the scapholunate interval.

Methods
Four human cadaver upper extremities were disarticulated at the elbow. The scapholunate ligament was exposed through a dorsal approach and sharply dissected from its insertion on the scaphoid. Two suture anchors were placed ulnarly in the scaphoid within the dorsal side of the scapholunate articulation, and two were placed in a matching position on the radial side of the reduced lunate. After manual reduction of the scapholunate joint using K-wires, the matching sutures in the anchors were tied together with pre-loaded 2-0 Orthocord. The wrists were then immobilized with a plaster thumb spica splint and mounted on a custom jig. A cyclic tensile load from 0 to 20 lbs for 300 cycles was placed through the flexor tendons in order to simulate a clenched fist. Gap formation between the scaphoid and lunate was measured across the cycles.

Results
The scapholunate gap increased with cyclic testing and plateaued by the 50th cycle. The average gap was 0.5 mm. Neither the suture anchors nor sutures failed during testing. Gap formation across the scapholunate interval was less than 2 mm for all specimens tested.
Summary Points

• In this cadaveric model, simulated post-operative immobilization with a suture anchor construct and a plaster thumb spica splint prevents gapping across the scapholunate interval of more than 2 mm.
• Our findings suggest that a joined suture anchor construct can adequately temporarily protect a scapholunate ligament repair in the early post-operative period.
• Our suture anchor construct could allow for post-operative immobilization after scapholunate ligament repairs without the use of Kirschner wires, preventing common pin-related post-operative complications.
Poster 115: Ten Year Follow-up After Total Wrist Arthroplasty

Category: Wrist

Treatment; Prognosis/Outcomes
Level 4 Evidence

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Per Fischer, MD
Marcus Sagerfors, MD, PhD
Kurt Pettersson, MD, PhD

Hypothesis
Total wrist arthroplasty (TWA) is an option in the management of wrist arthritis. The aim of the study was to evaluate the long-term results of TWA.

Methods
In this cohort study, we followed 56 cases that underwent TWA (Avanta, Biax, Universal 2 and Maestro) between 2005 and 2006 at a single-center. Data was collected preoperatively and 10 years postoperatively. Patient-related outcome measures, grip strength, range of motion (ROM), VAS pain scores were analyzed.

Results
VAS pain scores and patient-related measures were significantly improved at the 10-year follow-up. Jamar grip strength was also significantly improved. ROM remained largely unchanged, except for extension which improved significantly at the 10-year follow-up. Five of 56 TWAs were revised. Five patients died of unrelated causes and 10 were lost to follow-up.

Summary Points
• This study shows good long-term results after TWA with a high level of patient satisfaction.
• The revision rate was acceptable.
Hypothesis
Flexor tendon rupture is a known complication of volar plate osteosynthesis of distal radial fractures. The Soong classification, which relates the position of the implant to the watershed line of the distal radius, has been previously reported as predictive of flexor tendon rupture. The authors investigate the predictive value of the Soong classification for predicting flexor tendon irritation and rupture and implant-related complications in a large population of distal radius fractures managed with volar plate fixation.

Methods
We performed a retrospective review of all patients undergoing volar plate fixation of distal radius fractures from May 2003 – May 2015 with clinical and radiological follow-up greater than six months following IRB approval. Data were reviewed, including: demographic factors, fracture and operative characteristics, post-operative implant-related and tendon-related complications, post-operative radiographic characteristics, and follow-up duration.

Results
659 patients with 682 distal radius fractures managed with volar plate fixation were reviewed. Mean duration of follow-up was 8.9 ± 0.5 months. Mean age was 56.5 ± 0.7 years. Female to male ratio was 3.22. The majority of fractures were AO class 23-C1 (32.3%) followed by 23-C2 (20.9%) and 23-A3 (13.9%). The incidence of tendon irritation and tendon rupture was 17 (2.5%) and 4 (0.6%), respectively. Tendon ruptures included: 2 flexor pollicis longus and 2 extensor pollicis ruptures. Tendonopathy or irritation included: extensor pollicis longus (7), flexor pollicis longus (4), extensor carpi radialis longus / brevis (3), flexor carpi radialis (2), and extensor digitorum communis (1). Implant removal for painful or symptomatic hardware was performed in 44 patients (6.7%). Mean radiographic parameters were radial inclination 21.9 ± 0.2 degrees, volar tilt 8.0 ± 0.2 degrees, ulnar variance -0.1 ± 0.1 mm, and intra-articular step-off > 2 mm in 0.5% of patients. Soong classification was 0, 1, and 2 in 35.6%, 59.7%, and 4.7% of patients,
respectively. Soong classification did not independently predict tendon rupture, tendon irritation, paresthesias, or implant removal.

Summary Points

- Tendonopathy and tendon ruptures are established complications following volar plate osteosynthesis, however the overall incidence is low.
- Soong classification did not independently predict tendon rupture, tendon irritation, paresthesias, or implant removal.
- Extensor tendon pathology occurred more commonly in this series, and is not accounted for by the Soong Classification.

Bibliography


Images

Category: Wrist

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
N/A - not a clinical study

Brent R. DeGeorge, Jr., MD, PhD
Holly K. Van Houten
Raphael Mwangi
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Hypothesis
Controversy exists in the management of distal radius fractures in the elderly population. The goal of this study was to compare the complications of non-operative versus operative management of distal radius fractures (DRFs) in patients over 65 years of age.

Methods
We performed a retrospective observational study using the OptumLabs Data Warehouse (OLDW) which is a national administrative claims database including commercially insured and Medicare Advantage patients. We identified all distal radius fractures of enrollees age 65+ years from 2009-2014. We descriptively compared fractures undergoing non operative and operative treatment including: external fixation (EF), closed reduction and percutaneous pinning (CRPP), and open reduction and internal fixation (ORIF). We performed linear regression analysis to assess complication rates across years (trends analysis).

Results
During the 6-year period, 14,448 DRF from 2009 - 2014. Short-term complications within 90 days of fracture identified an overall complication rate of 3.6% (522 fractures) and were similar across treatment modalities. The most common 1 year complications were stiffness (11.4%), CRPS (9.5%), carpal tunnel syndrome (7.6%), tendon complications (2.7%), arthritis-related complications (2.2%), hardware mechanical complications (2.1%), malunion (1.9%), and non-union (1.6%) [Figure 1]. Stiffness was increased with operative versus non-operative management (15.7% vs. 9.8%). Hardware complications were increased following operative management, however were the lowest with ORIF of the operative groups with 3.1% (97 of 3157), 4.9% (24 of 491), and 8.5% (23 of 271) for ORIF, CRPP, and EF, respectively, p < 0.01. Secondary surgical procedures were increased following non-operative (19.7%) compared with
operative management (14.7%), including corrective osteotomy, DRUJ arthroplasty, and carpal tunnel release [Figure 2].

Summary Points

- Operative management of DRF results in decreased fracture malunion rates and secondary surgical procedures at the expense of increased overall 1 year complication rates compared to non-operative treatment in patients over 65 years of age.
- Operative management of DRF should be carefully considered when discussing treatment options with patients over age 65.
Poster 118: New classification for the configuration of the distal radioulnar joint in patients with ulnar impaction syndrome

Category: Wrist

Evaluation/Diagnosis; Prognosis/Outcomes; Anatomy

N/A - not a clinical study

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Kee Jeong Bae, MD
Seok Woo Hong
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Hypothesis
The configuration of the distal radioulnar joint (DRUJ) is one of the important factors affecting the development of DRUJ arthritis after ulnar shortening. Although Tolat classified the configurations of DRUJ based on the shape of the sigmoid notch, they did not consider the shape of the ulnar head. The purposes of this study are to evaluate the configurations of DRUJ using 3D computed tomography (CT) and to suggest a new classification of the joint.

Methods
We retrospectively reviewed 26 wrists of 26 patients who were diagnosed with ulnar impaction syndrome and checked 3D CT of the wrist preoperatively. All CT images were imported into Mimics v10.1 software and the slope of the sigmoid notch in the distal radius and that of ulnar head were measured at the center of DRUJ. The slope of the sigmoid notch or that of the ulnar head was defined as the angle between the longitudinal articular line of the sigmoid notch or ulnar head and the anatomical axis of ulna. The slope was defined as positive when the longitudinal articular line was directed from distal ulnar to proximal radial side. We classified configurations of sigmoid notch and ulnar head into three groups; vertical (-5° 5°), and reverse oblique (slope < 5°), respectively.

Results
The slopes of the sigmoid notch and that of the ulnar head were not parallel. The slope of the sigmoid notch and that of the ulnar head ranged from -16.6° to 16.4° and from -24° to 17°, respectively. In the simulations of 2 mm ulnar shortening, there was no significant correlation between the slope of the sigmoid notch and the changes of joint space in the DRUJ at the center of DRUJ (p-value = 0.40). However, there was a significant correlation between the slope of the ulnar head and the changes of joint space in the DRUJ (p-value < 0.01).
Summary Points
• When we simulated the changes of the joint space in the DRUJ after ulnar shortening, the slope of the distal ulna was more important than that of the sigmoid notch.
• A new classification based on both the slopes of the sigmoid notch and the ulnar head seems to be more reasonable compared to the previous classification.
• An ulnar head of reverse oblique type can be a risk factor for the progression of DRUJ arthritis after ulnar shortening.

Bibliography
Poster 119: The Role of CT Scans in Diagnosing Scapholunate Ligament Injuries Associated with Distal Radius Fractures

Category: Wrist

Evaluation/Diagnosis;Treatment;Anatomy
Level 4 Evidence

Mary Kate Thayer, MD
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Hypothesis
Disruption of the scapholunate (SL) ligament is common in distal radius fractures, occurring in as many as 54% of patients(1), with a 3-fold increase in intra-articular fractures(2). As radiographic findings have not been shown to correlate with arthroscopically identified interosseous ligament injuries, we sought to investigate the effectiveness of CT scans at diagnosing static SL instability and identify fracture characteristics associated with SL widening.

Methods
Retrospective review of all CT scans performed in patients with distal radius fractures at our institution between 2007 and 2010 was performed. Characteristics for each fracture, including patient demographics, fracture pattern, ulnar variance, and articular step-off were recorded. Widening of the SL interval was evaluated on coronal images. The SL interval was then graded as normal (Grade 1), asymmetric (Grade 2), or wide (Grade 3). Asymmetric Grade 2 widening was defined as increase in the SL joint space as compared to the capito-lunate space, while Grade 3 widening was defined as joint space greater than 3mm. Chi-squared analysis was performed to identify fracture characteristics associated with abnormal SL widening on CT scan. Three independent observers compared 40 images at 1 month intervals to calculate intra- and inter-observer reliability.

Results
One hundred sixty-six CT scans of the distal radius were reviewed, with 143 intra-articular and 23 extra-articular fractures. Overall, 46 patients (27%) with asymmetric widening of the SL space were noted. Forty of these patients had Grade 2 widening and 6 had Grade 3 widening of greater than 3mm (Figure 1). Intra-articular fractures were associated with a higher rate of widening (31% vs 4%, p=0.007). Among intra-articular fractures, a sagittal split between the scaphoid and lunate facet was associated with SL widening (37% vs 20%, P = 0.024). There was a high
reproducibility in the grading of SL injuries using CT scans with an interobserver kappa of 0.73, and intra-observer kappa of 0.83.

Summary Points

• CT scans can demonstrate subtle static widening of the SL interval with high reproducibility.
• Intra-articular fractures, especially those with sagittal splits between the scaphoid and lunate facet, were associated with a higher rate of SL widening.
• The rate of SL injury detected on CT scan in our study is comparable to other published studies looking at arthroscopic findings.
• CT scans can be an effective screening tool for identifying patients who may benefit from arthroscopic evaluation at the time of surgery for diagnosis and treatment of concomitant SL injuries.

Bibliography


Images
Poster 120: The relative motion splint can tolerate active motion irrespective of wrist position: a cadaveric study

Category: Wrist

Treatment
N/A - not a clinical study

Cyril S. Gary
Jack Kanouzi
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Hypothesis
No consensus exists regarding optimal rehabilitation following extensor tendon injury and repair. The relative motion splint (RMS) represents one modality that allows for early active motion and consists of a finger yoke and wrist component, though clinical evidence has questioned the importance of the latter. This study investigates the biomechanics and the role of wrist position on the ability to tolerate active motion in the RMS.

Methods
Two fresh cadaver hands were mounted onto a testing apparatus (fig. 1) with the wrist in either a 20 degree extension or neutral splint. The long finger tendon was transected in zone VI, repaired with a running-interlocking horizontal mattress stitch, and placed in a yoke. Active motion was then simulated by applying extension loads to all tendons of the EDC simultaneously for sets of 25 cycles. The load was increased from 25N to 50N in 5N increments between each set for a total of six sets per wrist position. The repair was evaluated for gapping after each set. The index, ring, and short finger EDC tendons were then transected and also repaired. The fingers were tethered in flexion to restrict motion and then the force to 2mm gapping was measured in each individual finger tendon with its respective yoke in place. 2-sided unpaired t-tests were utilized for statistical analysis.

Results
No gapping in the long finger tendon was observed regardless of maximal load or wrist position after active motion. When the fingers were tethered and individual tendons loaded, the average force to 2mm gapping in the index, long and, and ring finger tendons was measured as 34.1N with the wrist in extension and 35.5N with the wrist in neutral (fig. 2, p = .814), demonstrating no difference between the two wrist positions. Summed across both wrist positions, the average force to 2mm gapping was found to be 29.2N, 41.0N, and 34.2N for the index, long, and ring
fingers respectively; the difference between the index and long fingers was statistically significant (p = .0451).

Summary Points
• This study demonstrates the ability of an extensor tendon repair to tolerate active motion in the RMS irrespective of wrist position.
• The findings support the use of a modified RMS (yoke with no wrist component).
• The difference in force to 2mm gapping between the index and long finger tendons suggests that the yoke component may be more beneficial for the long and ring fingers than the index.

Bibliography
Poster 121: Comparing Radiographic Reduction Parameters for Distal Radius Fracture Fixation Using Dorsal Bridge Plating to the Index and Middle Finger Metacarpals

Category: Wrist

Treatment;Surgical Technique
N/A - not a clinical study

Joseph M. Pirolo, MD
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Hypothesis
Dorsal bridge plating of distal radius fractures has been described using distal fixation to the index or middle finger metacarpal. We hypothesize that fixation to the index or middle finger metacarpal results in variations in distal radius reduction parameters based on different vectors of ligamentotaxis applied to the fracture site.

Methods
An extra-articular distal radius fracture model was created using 6 paired cadaveric specimens. Intra-operative distraction conditions were re-created by placing 10 pounds of traction via fingertraps to the index and middle fingers. The fracture was spanned using a dorsal distal radius bridge plate affixed distally to either the index or middle finger metacarpal (Figure 1). Radiographic parameters including radial inclination, volar tilt, as well as joint space at the radioscaphoid and radiolunate joints were measured in the native specimens and following fracture fixation to compare differences between the two plating constructs.

Results
Dorsal bridge plating restored radial inclination when applied to the index and middle finger metacarpals with no statistically significant difference between the two constructs (p = 0.44). Mean inclination in native specimens was 25.0°, and after fracture fixation to the index and middle finger metacarpals, this was restored to 23.5° and to 24.0° respectively. No differences were found (p = 0.38) between the groups in restoration of volar tilt, with a mean of 9.8° in native specimens and a mean of 3.7° and 3.0° after fracture fixation to the index and middle finger respectively. Similarly, there were no significant differences found in joint distraction across the radioscaphoid (p = 0.26) and radiolunate joints (p = 0.16) between the two constructs. After fracture fixation to the index metacarpal, mean radioscaphoid and radiolunate joint space increased by 1.8mm and 0.4mm respectively. When affixed to the middle finger metacarpal, mean radioscaphoid and radiolunate joint space increased by 1.6 and 0.6mm respectively.
Summary Points

• No differences in radiographic reduction parameters achieved were found when comparing dorsal bridge plating to the index or middle finger metacarpal in this cadaveric distal radius fracture model.
• Neither plating construct was particularly successful in restoring volar tilt.
• Regardless of which metacarpal is chosen when applying a dorsal bridge plate, adjunctive reduction techniques are critical.
• Anatomic safety considerations are likely more relevant when choosing whether to use the index or middle finger metacarpal rather than any differential efficacy in fracture reductions.
Poster 122: Impact of Screw Length on Fixed Proximal Scaphoid Fracture Biomechanics: In Vitro Study with Cyclic Loading and Load to Failure

Category: Wrist

Hypothesis
A longer centrally threadless headless compression screw will provide greater biomechanical stability for the fixation of proximal scaphoid fractures in comparison to shorter screws.

Methods
Eighteen, fresh frozen cadaveric scaphoids underwent an oblique osteotomy to simulate an oblique fracture 7mm distal to the scaphoid proximal pole. Each scaphoid was randomly assigned for fixation to one of 3 screw lengths (n=6 for each screw length) of a 2.5mm diameter centrally threadless headless compression screw: 10mm, 18mm, and 24mm length. Scaphoid distal pole was potted in epoxy putty with the scaphoid long axis 45° to the horizontal plane [1]. Each specimen was cyclically loaded for 1000 cycles with an 800Nmm bending moment, where the applied load (40.0N-66.7N) depended on the moment arm. Stiffness was calculated at the 1000th cycle. Each specimen was loaded to failure after cyclic loading. Failure was indicated by loss of fracture reduction or a proximal crack in the construct as a result of loading; this was defined by as a distinct decrease in the load-displacement curve. One-way analysis of variance tests were performed to evaluate differences in stiffness and load to failure. Power analysis to determine the number of samples needed was run and significance was set at p<0.05.

Results
No significant difference in stiffness at the 1000th cycle between different screw lengths was found. All specimens with 18mm and 24mm screw fixations withstood cyclic loading, however 1 specimen fixed with a 10mm screw failed during cyclic loading. Load to failure was significantly (p<.05) impacted by the screw length utilized for fixation, with longer screws having greater load to failure. A significant difference (p<.05) in load to failure between a 10mm screw and 24mm screw was found, however no significant difference (p=.606) occurred in load to failure between an 18mm and 24mm screw.
Summary Points
• This study examined the effect of screw length on bending stiffness during cyclic loading and load to failure for proximal pole scaphoid fractures.
• Screw maximizing length (24mm) within a specimen withstands significantly greater load to failure than a centered screw (10mm). 10mm screw gains less purchase in the bone on either side of the fracture compared to the 24mm screw.
• No statistically significant difference in load to failure between 18mm screw and a 24mm screw; occurring because the 18mm screw is more centered with respect to the fracture site compared to the 24mm screw.

Bibliography
Images
Hypothesis
Ulnar shortening osteotomy (USO) is a common procedure for the surgical treatment of ulnar impaction syndrome. Although the recommended amount of ulnar shortening varies in the literature, the consensus is to restore between neutral and 2 mm of negative ulnar variance. However, there is concern that increasing amounts of shortening to achieve this may lead to an increased risk of distal radioulnar joint (DRUJ) arthritis. The purpose of this study was to determine if a limited step-cut USO of 2-3 mm will provide symptom resolution in the treatment of ulnar impaction syndrome, regardless of pre-operative ulnar variance.

Methods
We retrospectively reviewed 164 consecutive patients diagnosed and treated for ulnar impaction syndrome with a limited step-cut USO between 2000-2010. Idiopathic ulnar impaction syndrome was diagnosed in 116 patients, while a post-traumatic etiology was seen in the remaining 48 patients. In all cases a limited step-cut USO of 2-3 mm was performed. Ulnar variance was assessed radiographically pre- and post-operatively with the pronated grip view in all patients. The mean pre-operative ulnar variance was +3.5 mm (range, +1 mm to +6 mm).

Results
The mean follow-up was 62.4 months (range, 24 - 86). Union of the osteotomy was achieved with a mean time of 8.2 weeks (range, 5-18 weeks), and at a rate of 98.78% (162/164 cases). There were two cases of nonunion, which required additional surgery. The mean postoperative ulnar variance was +0.2 mm (range, -1 mm to +1.5 mm) after a mean overall shortening of 2.5 mm. At final follow-up, asymptomatic degenerative changes at the DRUJ were noted by radiographs in 9 of the 164 patients (5.5%). In all patients, pain, range of motion, grip strength and Modified Mayo Wrist Scores significantly improved postoperatively regardless of the postoperative ulnar variance. There was no significant difference in asymptomatic postoperative
DRUJ arthritis between the postoperative negative, neutral or positive ulnar variance. Hardware removal was performed in twelve patients due to persistent plate-related symptoms (7.3%).

**Summary Points**

Limiting ulnar shortening osteotomy to 2-3 mm with the step-cut technique:

- Is effective for ulnar impaction syndrome regardless of pre-operative ulnar variance
- Provides excellent union rates and good to excellent functional results
- Results in lower rates of degenerative changes seen at the DRUJ compared to previous literature

**Bibliography**


Images
Poster 124: Corrective Osteotomy for Malunited Intra-articular Distal Radius Fractures: A Case Series

Category: Wrist

Treatment;Surgical Technique;Prognosis/Outcomes

Level 4 Evidence

Fiesky A. Nunez, Jr., MD, PhD
T. David Luo, MD
Elizabeth A. Newman, MD
Fiesky Nunez, Sr., MD

Hypothesis
We hypothesize that anatomic restoration of the distal radius articular surface after a malunited fracture results in improvement in pain and functional measures.

Methods
Seven consecutive patients (4 males, 3 females) presented to the senior author with intra-articular distal radius malunions and underwent corrective osteotomy between 2009 and 2014. A dorsal approach was used in four patients, a volar FCR approach was used in two patients and straight radial approach in one patient. The osteotomy was performed with small chisel and an oscillating saw and fixed with a combination of plate and compression headless screws when feasible. Demographic data, preoperative, and postoperative functional measures (range of motion, 10-point pain score, grip strength, and QuickDASH) were prospectively collected. Independent t-test was performed to compare preoperative measures between injured and uninjured sides. Paired t-test was performed to compare preoperative and postoperative measures. Pearson correlation coefficient was analyzed to determine the correlation of radiographic and postoperative function scores.

Results
Average age at time of surgery was 38 years. Average time between injury and corrective osteotomy was 10 weeks (6 - 20). Mean follow-up was 43 months (range 18-84). At follow-up compared to preoperative assessment, pain improved from 7.1 to 0.85 (p<0.001); QuickDASH scores improved from 38.7 to 11.6 (p<0.001); grip strength improved from 21 to 30 kg (p<0.01), which was equivalent to 91% of uninjured side. All range of motion measurements demonstrated statistically significant improvement except forearm pronation (p=0.25), which was relatively unaffected preoperatively. Restoration of ulnar variance and volar tilt demonstrated a very strong correlation with pain relief (r=0.89, p<0.01 and r=0.73, p<0.05). No
other radiographic measures significantly correlated with pain relief. Only one patient demonstrated radiographic osteoarthritis at final follow-up but had no complaints of pain.

Summary Points
- Early corrective osteotomy for intra-articular distal radius malunions results in functional improvement and significant pain relief.
- Patients regain the majority of their wrist range of motion and grip strength.
- Although restoring the articular surface should take priority, restoring ulnar variance and volar tilt should also be done when possible because these measures strongly correlated with alleviation of pain.

Bibliography
Images
Poster 125: Primary Treatment of Scaphoid Nonunions with Proximal Pole Avascular Necrosis with a Medial Femoral Condyle Free Vascularized Bone Graft

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes

Level 4 Evidence

Nicholas Pulos, MD
Kathleen M. Kollitz, MD
Allen T. Bishop, MD
Alexander Y. Shin, MD

Hypothesis
Several pedicled and free-vascularized bone grafts have been described for the treatment of scaphoid nonunions. The purpose of this study is to determine the outcome of free-vascularized medial femoral condyle bone grafts in the treatment of scaphoid nonunions with avascular necrosis. We hypothesize that this treatment restores scaphoid vascularity and architecture in patients who have documented avascular necrosis of the proximal pole resulting from scaphoid nonunion.

Methods
A retrospective review was conducted to identify all patients with scaphoid nonunions with avascular necrosis treated with a free-vascularized medial femoral condyle bone graft. Between June of 2006 and October of 2016, 32 patients were identified. Mean time from injury to surgery was 19.3 months. All patients had documented avascular necrosis of the proximal pole at the time of surgery evaluated by deflation of the tourniquet and lack of bleeding of the proximal pole. Union was defined as bridging trabeculae on plain radiographs and computed tomographic (CT) scan. Carpal indices, time to union, early functional outcomes and complications were recorded.

Results
All 32 patients treated with free-vascularized medial femoral condyle bone grafting healed at a mean of 15.9 weeks (range, 5 to 50 weeks). Radiographic evaluation demonstrated significant improvement from preoperative to postoperative scaphoid height to length ratio (0.75 and 0.63, respectively, p < 0.0001), lateral scaphoid angle (30.41 and 14.47 degrees, respectively, p < 0.0001), scapholunate angle (70.38 and 55.19 degrees, respectively, p < 0.0001), and radiolunate angle (19.5 and 4.2 degrees, respectively, p < 0.0001). There was a trend towards improved grip strength postoperatively. Eight patients underwent subsequent procedures of which two were
planned (2 planned Kirschner wire removals, 6 screw removals with or without bone grafting). One patient underwent scaphoidectomy and 4-corner fusion 15 months post-operatively after suffering a subsequent injury. There were no donor-site complications related to the vascularized bone graft harvest.

**Summary Points**
- We present the largest series to date of patients treated with free-vascularized medial femoral condyle grafts for scaphoid nonunions with documented avascular necrosis of the proximal pole.
- 100% of patients demonstrated radiographic healing on CT scan at a mean of 16 weeks after treatment with free-vascularized medial femoral condyle grafts.
- Free-vascularized medial femoral condyle grafts restore scaphoid vascularity and architecture, promoting union.

**Bibliography**

Images
Poster 126: The Effect of Tobacco Use on Four Corner Fusion

Category: Wrist

Prognosis/Outcomes
Level 3 Evidence

Margaret K. Jain, MD
Schwind Joshua, MD
Kyle A. Andrews, MD
Briana Stirling, BS
Abdul-Azim Mustapha, MD
Martin C. Skie, MD

Hypothesis
This study examined the effect of cigarette smoking in patients undergoing scaphoidectomy and four-bone fusion to determine its effects on union. We hypothesized that tobacco use would be a clinically and statistically significant risk factor for the development of non-union following four-corner fusion of the carpus.

Methods
A retrospective review was conducted of consecutive surgical cases of scaphoidectomy and four-corner fusions completed at our institution between 2001 and 2016. One-hundred and twenty-one procedures were performed in 119 patients (89 men, 30 women; mean age 50.1 years). There were 35 smokers in the study (28.9%). Diagnoses were scaphoid nonunion advanced collapse (SNAC, n=37, 30.6%), Scapho-lunate advanced collapse (SLAC, n=57, 47.1%) and arthritis not otherwise specified (n=27, 22.3%). Implants utilized for fusion included spider plates (n=102, 84.3%), Staples (n=14, 11.6%), cannulated screws (n=4, 3.3%), and K-wires (n=1, 0.8%). Medical, surgical records and radiographs were reviewed to determine rates of union. Minimum follow-up was 6 months (mean follow-up 31 months, range 6-154 months). Data was then analyzed using IBM SPSS Statistics software.

Results
Thirty-three wrists required revision for nonunion (27.3%). Nonunion rate in smokers was significantly higher than in non-smokers (40.0% vs 22.1%, p=0.045). The relative risk of nonunion with smoking was 1.811 (p=0.041), with an odds ratio of 2.351 (p=0.048). Multi-variant analysis did not show patient age and diagnosis of diabetes mellitus to be correlated with revision surgery for non-union.
Summary Points
- Perioperative smoking is a significant risk factor for development of subsequent nonunion.
- Nonunion rates for scaphoidectomy and four-bone fusion may be higher than previously thought.

Bibliography

Images
Hypothesis
For Kienböck’s disease, we performed combined therapy with non-concentrated bone marrow (BM) transplantation, low-intensity pulsed ultrasound (LIPUS), and external fixation. This treatment showed outcomes equivalent to those of other methods. We originally used non-concentrated BM from the radius, but began to use non-concentrated iliac BM in 2008 because of better marrow quality. This study presents the results of this series.

Methods
[Surgical and treatment protocols] Under general anesthesia, we inserted two pins into the second metacarpal and radial diaphysis to install a bridging external fixator. We created a 2-cm transverse incision over the lunate, retracted the extensor tendon with preservation of the joint capsule, and placed a radiolucent drill guide, based on our experience profile over the joint capsule. Next, we drilled three holes with a 2-mm diameter drill. We collected BM samples (approximately 5 mL) from the iliac bone by aspiration, and transplanted the non-concentrated BM into the lunate through the drilled holes to fill the space. The external fixator was placed in slight traction, with the wrist in a neutral position, and it was removed after 12 weeks. LIPUS therapy was introduced daily for 20 min. The period of LIPUS ranged from 3 days to over 4 months.
[Subjects] Treatment was performed in 16 patients (9 men and 7 women). The preoperative Lichtman stages were stage II in 5 cases, stage IIIa in 6 cases, and stage IIIb in 5 cases. We excluded the fragmented lunate cases. The mean age at surgery was 43 years (range 15–73 years), and the mean follow-up period was 36.0 months (range 12–72 months). The overall results were evaluated using the Mayo wrist score and the Nakamura scoring system for Kienböck’s disease.
**Results**
There was no wrist pain in 11 patients, and mild pain in 5 patients. The range of motion improved in 13 patients. The average grip strength increased from 42 to 78 % relative to the unaffected side. On roentgenograms, the carpal height ratio and Stahl index decreased slightly. The Nakamura score was excellent in 2 patients, good in 10, fair in 3, and poor in 1 patient. Fatty marrow was observed in 13 patients (81%) on performing proton density-weighted MRI (figure).

**Summary Points**
• With our strategy, the recovery of MRI signal was better than with other treatments for Kienböck’s disease.
• Our method may revitalize the necrotic lunate.

**Bibliography**

Images
**Poster 128: Association of Lunate Morphology with Carpal Mechanics in Scapholunate Ligament Injury**

*Category: Wrist*

Evaluation/Diagnosis; Prognosis/Outcomes; Anatomy

Level 4 Evidence

Eric Pang, MD
Nathan Douglass, MD
Robin Kamal, MD

**Hypothesis**

A previous study suggests type II lunate morphology (type 1 without medial facet; type II with medial facet) protects against development of dorsal intercalated segmental instability (DISI) in patients with scapholunate interoseous ligament (SLIL) injuries. We tested the null hypothesis that there is no relationship between lunate morphology and development of DISI with secondary analysis comparing the agreement of classifying lunate morphology based on the presence of a medial lunate facet, capitate-to-triquetrum (CT) distance, and magnetic resonance imaging (MRI).

**Methods**

We performed a retrospective chart review of patients with known SLIL injuries from 2001-2016. Operative reports were reviewed to confirm complete scapholunate SLIL injuries or the presence of scapholunate advanced collapse patterns. Posterior-anterior radiographs and MRI, when available, were evaluated independently by 2 reviewers. CT distances were measured as a secondary classification method. DISI and scapholunate instability was determined as radiolunate angle >15° and scapholunate angle >60° respectively. Differences between groups was determined using chi square analysis with significance set at p<0.05. Agreement between plain radiographs, MRI, and CT distance was calculated using the kappa statistic (k).

**Results**

Our search found 58/417 patients that met inclusion criteria. 41/58 (71%) had type II and 17/58 (29%) had type I lunates based on plain radiographs. There was no difference between groups in regards to DISI (p=0.33) or scapholunate instability (p=0.11) (Table 1). Observers had a moderate agreement with this technique (k=0.6459).

Using CT distance, observers had minimal agreement (k=0.251). Due to the minimal agreement we chose to use the results of the medial facet method of lunate classification for our analysis. Using MRI alone or correcting any discrepancy between plain film and MRI classification, using MRI as the standard, found 18/26 (69%) type II and 8/26 (31%) type I lunates with no difference
between groups in regard to DISI (p=0.15) or scapholunate instability (p=0.53). Agreement between MRI and medial facet radiographic assessment was almost perfect (k=0.8312). Of note, when radiographic identification was corrected using MRI as the gold standard for diagnosis, only 2 patients crossed over from the type I group to the type II group. This did not change statistical relationships.

Summary Points

- There is no differences in the development of DISI or scapholunate instability between patients with type I and type II lunates after SLIL injury.
- Further studies on the effects of lunate morphology on carpal kinematics may benefit from more accurate imaging techniques such as MRI or direct visualization.

Bibliography

Poster 129: Dorsal capsulodesis associated SL ligament reconstruction assisted by arthroscopy using the tendon graft by palmaris longus

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Marcio A. Aita, MD
Victor Bignatto Carvalho
Carlos Henrique Vieira Ferreira, MD
Gustavo Mantovani Ruggiero, MD
Andresa Ramires Hoshino, MD
Vivianeal Vesbernardo

COI
Consulting Fee: Arthrex®, Inc. (US$ 1250,00 per day)

Hypothesis
Is possible dorsal capsulodesis + SL ligament reconstruction assisted by arthroscopy?
Is possible shortening the rehabilitation time the SLIL?

Methods
From January 2015 to November 2016, 14 patients, adults, with SLIL grade III and IV by Geissler, who underwent surgical treatment with the SL reconstruction procedure assisted by arthroscopy, with the new technique proposed in this study. The parameters analyzed were: ROM (Range of motion), DASH (Disability Arm, Shoulder and Hand), VAS (Visual Analogue Scale), radiographic analysis (see SL Gap and DISI deformity) pre and post operative. Describe of the complications and time to work return.

Results
The follow-up time was 15 months [6 – 20]. The range of motion averaged 321° (96.9% of the normal side). VAS was 1.79 / 10 [1 – 6]. DASH was 6.50 / 100 [1 – 30]. The time to work return work was 4.42 [2 – 17] months. As for complications, one patient developed SLAC, and underwent four corner fusion one year after ligament reconstruction. Currently, he developed pain relief, and it is with a functional range of motion of the wrist, and has not yet returned to professional activities.
The SL range ("gap") preoperatively was 4.29 [2 – 7]mm, the postoperative period was 1.79 [1 – 4]mm. The DISI deformity was present in 10 patients, with SL angle > 70° (pre operative) and it was corrected after surgery, in all patients. SLAC stage I was identified in a patient. Arthroscopy
was performed in all cases. The SL instability was classified as Geissler grade III in 4 cases and grade IV in 10 cases.

Summary Points
- The choice the palmaris longus tendon graft, offers some advantages:
  - the diameter of bone tunnels may be minimal (2.5-3 mm), avoiding complications such as iatrogenic fractures or vascular lesions of carpal bones;
  - We believe that flexor carpi radialis tendon (FCR) is an important secondary stabilizer of the wrist, and when we preserve the FCR, we are aiding in the rehabilitation stages when using the dart throw movie;
- We believe that the reconstruction of both portions (dorsal and palmar) of the SL ligament, associated with linear dorsal capsulodesis, also fixation of the graft with specific screws, and with the application of dart throw movie (DTM) early in the period of immediate postoperative rehabilitation, decreases the immobilization period (of only two weeks in this present study), also the complication rates and allows an early return to social and professional activities.

Bibliography

Images
Poster 130: Proof of Concept: Fixation of Dorsal Lunate Facet Fragments in Distal Radius Fractures Through a Standard Flexor Carpi Radialis Approach

Category: Wrist

Treatment; Surgical Technique
Level 4 Evidence

Jonathan Lans
Jesse Jupiter, MD
Maria Josefina Alvarez
Sezai Ozkan

Hypothesis
Null Hypothesis: It is not possible to reduce dorsal ulnar lunate facet fragments in distal radius fractures through a standard flexor carpi radialis approach using a volar plate.

Methods
We retrospectively evaluated all patients with an operated distal radius fracture that had a dorsal ulnar corner fragment from 2007 to 2015 at a single institution. Indication for operative treatment was if the distal radius fracture required closed manipulation to achieve an acceptable anatomic position. We included 60 patients with a median follow-up of 44 weeks. We used the conventional volar longitudinal approach in between the flexor carpi radialis (FCR) tendon and radial neurovascular bundle. All patients were treated with a variable angle plate (VAP) and reduction of the dorsal ulnar lunate facet fragment was achieved using bone reduction forceps. Bone reduction forceps is an externally used device comprised of a tongue that is placed over the dorsal wrist to press the dorsal distal radius while the other pinpoint tongue is placed onto the VAP to create compression across the fracture. Fracture reduction was evaluated using pre- and direct postoperative computer tomography scans of the wrist measuring the articular gap and step. The range of motion was evaluated clinically by treating physician. Bivariate analysis was performed to compare pre- and postoperative radiographic measurements and to compare wrist range of motion.

Results
At final follow-up, the flexion, extension, pronation and supination were 92.1%, 96.4%, 99.7% and 99.3% of the unaffected side (p3mm. The average postoperative volar tilt was 3.96.9, where 36.1% had a volar tilt of 0. The average postoperative radial height was 12.03.2mm.
Summary Points

• 80% of the patients with a dorsal ulnar lunate facet fragment had fragment reduction.
• This study shows that dorsal ulnar lunate facet fracture fragments in distal radius fractures can be reduced through a standard FCR with help of intraoperative bone reduction forceps.

Bibliography


Images
Poster 132: Effects of depression on operatively treated distal radius fractures

Category: Wrist

Treatment; Prognosis/Outcomes
Level 2 Evidence

Hiroshi Yamazaki, MD
Fumihiro Isobe
ShunH ashimoto, MD
Toshiro Itsubo, MD
Shigeharu Uchiyama, MD
Hiroyuki Kato, MD

HYPOTHESIS
Psychologic factors are associated with clinical outcomes in musculoskeletal illnesses. There are few studies examine the relationship between depression and magnitude of disability after volar plate fixation of distal radius fractures (DRFs). The purpose of this study is to determine the association of pre- and post-operative depressive symptoms and disability in DRF patients.

Methods
80 adult patients with a displaced DRF treated with volar plate fixation were prospectively enrolled. We recorded pre- and post-operative depressive symptoms measured by Center for Epidemiologic Studies Depression (CES-D) and outcome measured by Patient-Rated Wrist Evaluation (PRWE) at baseline (week 0), and at 3, 6, 12 and 24 weeks. The CESD Scale consists of 20 questions answered on a 4-point Likert scale (0 indicating “rarely” and 3 “most of the time”), resulting in a score from 0–60 with a higher score indicating more depressive symptoms. We also collected demographic variables including patient age, sex, body height and weight, dominant hand involvement, type of fracture, interval between injury and operation, and injury compensation status. All potentially influencing factors were entered in a multiple linear regression model looking for predicting factors of the outcome variables (PRWE) 24 weeks after surgery.

Results
The mean CES-D scores and prevalence of depression (16 points or greater on the CES-D questionnaire) were 9.0 (SD: 8.2) and 14.9% at baseline, 10.8 (8.2) and 23.9% at 3 weeks, 9.8 (7.8) at 14.8% at 6 weeks, 7.8 (6.5) and 12.6% at 12 weeks, and 6.8 (6.7) and 7.5% at 24 weeks, respectively. The average CES-D score and prevalence of depression decreased significantly at 24
weeks (p < 0.05). Multivariate regression analysis indicated that CES-D scores at 3 and 6 weeks were independently associated with PRWE scores at 24 weeks.

Summary Points

- We found a positive association between depression and disability after volar plate fixation of DRFs.
- Depressive measures may be used as a screening tool to predict outcome after surgical treatment of DRFs.
Poster 133: Functional and kinematic analysis of a wrist radial hemiarthroplasty design

Category: Wrist

Evaluation/Diagnosis;Basic Science
Level 5

Per Fischer
Kurt Pettersson
Eric Wagner, MD
Alexander W. Hooke, MA
Marco Rizzo, MD

Hypothesis
A radial hemiarthroplasty could obviate difficulties related to distal component loosening of the total wrist arthroplasty. The aim of this study is to investigate kinematically, the feasibility of a new design for radial wrist hemiarthroplasty.

Methods
Six, fresh-frozen cadaveric wrist specimens were used. Testing was performed on the native wrist, after insertion of a radial hemi-arthroplasty with intact proximal carpal row (Hemi) and with proximal row carpectomy (Hemi+PRC). Each wrist was fixed to an experimental table with the tendons of the extensor carpi radialis longus (ECRL), extensor carpi radialis brevis (ECRB), extensor carpi ulnaris (ECU), flexor carpi radialis (FCR), flexor carpi ulnaris (FCU), and abductor pollicis longus (APL) attached to the apparatus. Range of motion, axis of rotation, and muscle moment arms were recorded in manually controlled movements in wrist flexion/extension, radial/ulnar deviation, dart throwers motion, and circumduction.

Results
A statistically significant decrease in flexion range of motion occurred between the intact and Hemi conditions and between the intact and Hemi+PRC conditions with no significant differences in flexion range of motion occurring between the Hemi and Hemi+PRC conditions. No statistically significant changes in range of motion occurred in extension, radial deviation, ulnar deviation, flexion/ulnar deviation component of the dart throw, extension/radial deviation component of the dart throw, or circumduction functional tests.

Summary Points
- This study indicates that the new wrist radial hemiarthroplasty can produce a stable wrist with range of motion similar to the native wrist.
• Overall, wrist kinematics appears to be equally acceptable in hemiarthroplasty with and without resection of the proximal row.

Bibliography
Images
Poster 134: Immobilization Following Volar Plating of Distal Radius Fractures: A Randomized-Controlled Trial.

Category: Wrist

Treatment; Prognosis/Outcomes
Level 2 Evidence

Gabriel J. Bouz, BA
J. Ryan Hill, BS
Ali Azad, MD
William Pannell, MD
Ram Kiran Alluri, MD
Alidad Ghiassi, MD

Hypothesis
No consensus exists regarding the optimal postoperative splinting position to expedite return to function following volar plate fixation of distal radius fractures. The purpose of this study was to test the hypothesis that immobilization in supination would result in superior clinical outcomes compared to standard immobilization in a short arm volar splint with no restriction of forearm range of motion.

Methods
A randomized-controlled trial was conducted. All patients greater than eighteen years of age undergoing volar plate fixation for a distal radius fracture were eligible for participation. Patients were excluded if they had an open fracture, concomitant injury to either upper extremity (UE), or functional deficit of either UE. Patients were randomized to 1) immobilization in maximal supination using a plaster sugartong splint (experimental), or 2) no restriction of supination/pronation using a plaster short arm volar splint (control). The operating surgeon was blinded to each patient’s postoperative immobilization assignment until the procedure was completed. PRWE and DASH functional outcome scores, VAS pain scores, forearm and wrist range of motion, and grip strength were recorded at two and six weeks postoperatively. All measurements were conducted by a physician blinded to the patient’s splint assignment. Range of motion and grip strength were assessed as a percentage of the contralateral extremity. A student’s t-test was used to compare mean values of all outcome measures at each time point, with statistical significance set at P < 0.05.

Results
Forty-six patients were enrolled in the study. Twenty-eight were immobilized with a short arm volar splint and eighteen were immobilized in supination with a sugartong splint. Complete six-
week follow-up data was obtained for thirty-one patients. There were no statistically significant differences in VAS, PRWE, and DASH scores, or range of motion and grip strength measurements between the study groups at two and six weeks postoperatively (Table 1).

Summary Points

• Range of motion, grip strength, and patient-rated subjective outcome measures were similar regardless of immobilization technique in patients with a distal radius fracture stabilized with a volar plate.

• Surgeons can elect to use the standard-of-care postoperative immobilization modality of their preference following volar plate fixation without compromising short-term return to function.
Poster 135: Clinical evaluation before and after the removal of the volar locking plate in distal radius fracture

*Category: Wrist*

Treatment; Prognosis/Outcomes

Level 4 Evidence

Hideyuki Mizushima, MD

**Hypothesis**

Patients with distal radius fracture who undergo treatment with a volar locking plate occasionally exhibit problems of the flexor pollicis longus (FPL), including friction, pain, and contracture of the thumb. In this report, we describe the clinical outcome before and after the removal of the volar locking plate in distal radius fractures.

**Methods**

We reviewed all cases wherein the author was involved in the removal of the distal radial volar locking plate between January 2009 and July 2015. A total of 77 patients were included, including 21 men and 56 women. The average patient age was 56.8 years (range, 17–83 years). The mean duration of implantation was 32.9 weeks (range, 11–91 weeks). The duration of follow up after plate removal was 22.4 weeks. The reasons for hardware removal included pain, difficulty in thumb or wrist movement, and the patient’s desire.

**Results**

Symptoms related to the FPL were observed in 24 patients. Among these patients, pain was observed during active thumb motion in 14 and difficulty in thumb movement was encountered in 13. Remarkable intraoperative findings at the FPL were noted during plate removal in 16 patients. The FPL was damaged superficially in 5 patients and the FPL tendon adhered to the surrounding tissue in 16 patients. In all these cases, the symptoms present before plate removal disappeared after plate removal. Of the patients who did not report difficulty in thumb movement, 67% could move the thumb more easily after the removal of the volar locking plates. Hand 20—an illustrated, self-administered questionnaire comprising 20 short and easy-to-understand questions for assessing upper limb disorders—was administered to all the patients. The average score after plate removal (9.7) was significantly lower than that before plate removal (23.3; p < 0.001). Moreover, the arc of dorsi-flexion at the wrist after plate removal was significantly greater than that before plate removal.
Summary Points
The removal of the volar locking plate facilitates a reduction in friction at the FPL as well as the removal of mass formation due to plate implantation. Hence, plate removal could lead to a good outcome, including ease of thumb movement, good range of motion at the wrist, and suitable Hand 20 scores. Therefore, removal of the volar locking plate should be considered as early as possible once union of the fractured bone is achieved.
Poster 137: Measurements Performed on Plain Wrist Radiographs as a Basis for Mechanical Analysis

Category: Wrist

Basic Science
N/A - not a clinical study

Ronit Wollstein, MD
Raviv Allon
Aviv Kramer

Hypothesis
The basis to understanding the biomechanics of the wrist is delineating the anatomy. We described two wrist structural types centered on the morphology of the midcarpal joint. The purpose of this study was to further describe these two wrist patterns using multiple measurements performed on plain wrist radiographs.

Our hypothesis: we can describe the two distinct anatomical patterns using radiologic measurements independent of the midcarpal joint.

Methods
A database of 171 normal adult wrist posteroanterior (PA) radiographs was evaluated for: radial inclination, radial height, radial length, ulnar variance, volar tilt, d2/w2, lunate and capitate type. We measured and calculated the percent of the distal capitate facet that articulates with the lunate, the scapholunate ligament, scaphoid and trapezoid. Wrist type 1 was defined as a lunate type 1 and a spherical distal capitate articulation. Wrist type 2 included a lunate type 2 and a flat distal capitate articulation.

Results
Type 1 and 2 wrists differed in the length of the capitolunate joint within the midcarpal joint. Specifically type 1 wrists were positively associated with a larger distance of the facet between the capitate and the distal lunate (p=0.01), a shorter articular facet (line) between the lunate and proximal hamate (p=0.004). They also differed in the length of the middle carpometacarpal (CMC) joint. Specifically the length and percent circumference (of capitate) of the articular line between the distal capitate and the base of the middle metacarpal base was longer in type 1 wrists (p=0.004).

In type 1 wrists we found a positive association between the lengths of the articulation between the capitate and the base of the third metacarpal and the articulation between the capitate and the lunate (p=0.03) and a negative association with the articulation between the capitate and the hamate (p=0.02). In type 2 wrists we found a positive association between the lengths of the
articulation between the capitate and the hamate and the articulation between the capitate and the scaphoid, the facet between the capitate and the base of the ring and index metacarpals.

**Summary Points**

- We were able to describe the two wrist patterns by differences in the CMC joints as well as the facets between the capitate and the hamate and scaphoid bones.
- These findings should be translated into 3-dimensional structures to evaluate the true contact areas.
- These results can be used in finite element analysis to estimate the transfer of forces in different wrist patterns.

**Bibliography**


Images
Poster 138: Symptoms and radiological evaluations of the distal ulnar stumps after the Sauvé-Kapandji procedure or Darrah procedure for treatment of rheumatoid arthritis.

Category: Wrist

Treatment; Prognosis/Outcomes
Level 4 Evidence

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Kousuke Iba, MD
Megumi Hanaka, MD
Takuro Wada, MD

Hypothesis
We have performed the Sauvé-Kapandji (S-K) procedure and Darrach procedure without stabilizing the proximal ulnar stump. In this study, we investigated symptoms and radiological findings of the ulnar distal stump. We hypothesized that the instability would occur, but not be symptomatic.

Methods
A total of 35 patients with rheumatoid arthritis who underwent the S-K procedure or the Darrach procedure without stabilizing the proximal ulnar stump were evaluated retrospectively. Demographic data is summarized in Table 1. The pain over the ulnar stump region was assessed at 3, 6 and 12 months after surgery. Radiological assessment was performed in the standard posteroanterior view after surgery and at the final follow-up. The ulnar distance (UD) between the articular surface of the wrist and the distal ulnar stump and the radioulnar distance (RUD) between the radius and proximal stump of the ulna was measured. Tapering was defined if the width of the proximal ulnar stump was less than 50% of a diameter of the ulna. The UD and RUD were compared between the S-K group and the Darrach group and analyzed using the Mann-Whitney rank test. P-values less than 0.05 were considered significant.

Results
In the S-K group, the ulnar stump pain at 3 and 6 months after surgery was founded in 3 and 1 wrists, respectively. While, in the Darrach group, those was founded in 3 wrists at 3 months after surgery but none at 6 months after surgery. No patients complained the ulnar stump pain at 12 months after surgery in both groups. Data on radiological measurements is presented in Table 2. The tapering of the proximal ulnar stump was noted in 30.3% of the S-K group and 44.4% of the Darrach group. In the Darrach group, extensor tendon ruptures occurred in one patient. The UD of this patient was 19.5 mm immediately after surgery.
Summary Points

- The pain over the ulnar stump region was disappeared within 6 months, although the instability remained.
- Extensor tendon rupture following the Darrach procedure occurred. An ulnar osteotomy at about 25mm proximal to the articular surface of the wrist was previously recommended (1).
- Even though many soft tissue stabilization techniques for the distal ulnar stump is advocated (2), the results of this study indicate that stabilization of the proximal ulnar stump may not be necessary but we have to beware of the amount of resection of the distal ulna.

Bibliography
2: Minami et al. J Hand Surg Am. 2006;31(3):440–4

Images
Poster 139: Incidence of Distally Migrating Cortical Fragments in AO Type C Distal Radial Fractures

Category: Wrist

Evaluation/Diagnosis
Level 4 Evidence

Masato Okazaki, MD
Kenichi Tazaki, MD, PhD

Hypothesis
To clarify the incidence of distally migrating cortical fragments in AO type C distal radial fractures

Methods
Among 161 distal radial fractures internally fixated with a volar locking plate between April 2014 and March 2016 at our hospital, 111 AO type C fractures were included in this retrospective study. All but one had preoperative CT scan. Age at the time of surgery was 17 to 93 (average 62) years. Fractures were classified as type C1 in three, C2 in 41 and C3 in 66, and were displaced dorsally in 88, palmarly in 19 and axially in three. We looked for “distally migrating cortical fragments”, defined as cortical fragments originating from the distal radius penetrating into the radiocarpal joint or migrating distally adjacent to the capsule.

Results
We found fragments penetrating into the radiocarpal joint in seven fractures and fragments migrating distally adjacent to the capsule in three fractures. Fragments were seen in nine dorsally displaced fractures and an axially displaced fracture. There were another 17 fractures of which the fragment migrated distally, but did not penetrate into the joint, and therefore were not counted. Fragments were excised in four fractures and reduced in one fracture. In other five fractures, the fragment was ignored due to location and/or amount of penetration, or overlooked. In all cases, excluding the ignored cases, we confirmed that chondral component was not included in the fragment and consisted mainly of cortical bone.

Summary Points
- We found distally migrating cortical fragments in 9.0% of AO type C distal radial fractures internally fixated with a volar locking plate, although they are not well documented in the literature.
- The fragments consisted mainly of cortical bone presumably originating from the dorsal radial metaphysis.
- CT scan was useful in detecting the fragments.
Poster 140: Dorsal Plating for Defined Fracture Pattern of the Distal Radius

Category: Wrist

Treatment; Prognosis/Outcomes
Level 4 Evidence

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Eliana Petrucelli, MD
Gerardo L. Gallucci, MD
Ezequiel Ernesto Zaidenberg, MD
Pablo De Carli

Hypothesis
There are some fracture patterns where a volar plate could not allow enough stability or even fixation to treat the fracture. The purpose of this study was to evaluate the results and complications of such pattern of fractures treated with dorsal plating.

Methods
A retrospective review was performed during a 6 years’ period. Inclusion criteria included those related to the patient and treatment, and those related to the fracture pattern:
Patient and treatment: adult patients (18 years of age or older), internal fixation with dorsal plating (dorsal plate, column fixation, or dorsal fragment specific fixation), twelve months minimum of follow-up.
Fracture pattern: displaced central articular fragment, volar distal fracture trait not enough to allow volar fixation, displaced dorsal-ulnar fragment (die-punch), dorsal comminution without a volar fracture (Barton’s fracture).
Radiographic extra-articular and intra-articular parameters were measured pre and postoperatively.
Clinical evaluation was performed. Active range of motion of the wrist in flexo-extension, radial and ulnar deviations and pronation and supination were measured. Grip strength was measured with a dynamometer. Both AROM and grip strength were measured bilaterally and compared with the healthy side.
Patient-reported outcomes measure was performed with the DASH questionnaire and the PRWE score, and the visual analogue scale for pain at rest and during activities (range 0 to 10).
Complications were recorded in every case.
Statistical analysis
Continuous variables are described as mean and standard deviation. Nominal and ordinal variables are described as percentages.

**Results**
During the studied period 679 fractures were operated on. Twenty patients (3%) fulfilled the inclusion criteria, with a mean age of 52 (SD 17.2) years. Nine fractures were classified as B and 11 C Type. Mean follow-up was 32 months (SD 13.6). Three patients had dorsal plate, 11 had specific fragment fixation and 6 had column fixation technique. Mean postoperative range of motion compared with the contralateral side was: 79% for flexion, 88% for extension, 92% for radial deviation and 87% for ulnar deviation, both supination and pronation recovered 98%. Average VAS at rest was 0 (SD 0.2) and during activity was 1.6 (SD 2). The average DASH was 15 (SD 21). Mean PRWE Score was 11 (SD 16). Articular step-offs were reduced in all patients. Ten patients had plate removal. No patients had extensor tendons rupture.

**Summary Points**
- In defined pattern of articular distal radius fractures, dorsal plating of the radius gives good objective and subjective clinical results.
- Closed follow-up or patient education remain the best modality to diagnose extensor tendon irritation to avoid their rupture.

**Bibliography**
Images
Poster 141: Morphologic characteristics of the sigmoid notch of the distal radius in patients with avulsed triangular fibrocartilage complex from the ulnar fovea

Category: Wrist

Anatomy
Level 2 Evidence

Yukinori Tsukuda, MD, PhD
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Hypothesis
Stability of the distal radioulnar joint (DRUJ) is primarily controlled by the soft tissues, especially the triangular fibrocartilage complex (TFCC), including the radioulnar ligaments. Nevertheless, osseous constraints also contribute ~20% of the total stability [1]. We hypothesized that patients with avulsed TFCC from the ulnar fovea have a characteristic morphology at the sigmoid notch of the distal radius.

Methods
We included 31 wrists of 30 patients (10 women; 20 men) with TFCC injury at the ulnar fovea diagnosed arthroscopically. The preoperative axial CT images of the affected wrists were reviewed. We also included 38 wrists of 38 patients (8 women; 30 men) who underwent wrist CT for various diagnoses without obvious DRUJ injuries as controls. Patients with fractures of the radius or ulna, osteoarthritis of the DRUJ, and history of any wrist surgery were excluded from this study. Using the axial CT images of the DRUJ, we classified the patients into 4 groups according to the type of sigmoid notch, namely flat face sigmoid, ski-slope sigmoid, “C” type sigmoid, and “S” type sigmoid, as described by Tolat and colleagues [2] (Figure 1). We also measured the tilting angle, depth, and width of the sigmoid notch. Statistical analysis was performed using the Fisher’s exact test or paired t-test (p < 0.05).

Results
The proportions of flat face sigmoid, ski-slope sigmoid, “C” type sigmoid, and “S” type sigmoid in the patients with TFCC injuries were 26%, 58%, 3%, and 13%, respectively, whereas those in the control group were 32%, 18%, 26%, and 24%, respectively (p < 0.05) (TABLE 1). Significant differences were noted in the tilting angle (TFCC injury: 80°; control: 83°, p = 0.033), depth (TFCC injury: 1.2 mm; control: 1.5 mm, p = 0.031), and width (TFCC injury: 2.0 mm; control: 1.4 mm, p = 0.044).
Summary Points
• The proportion of ski-slope sigmoid was significantly higher in the patients with TFCC injuries at the fovea than in those without.
• The patients with TFCC injuries had a tendency to have a more dorsally tilted and shallower sigmoid notch.
• Individuals with ski-slope or dorsally tilted sigmoid notch could be at risk for TFCC injuries at the ulnar fovea.

Bibliography

Images
Poster 142: Generation of a novel multiphasic scaffold using 3D-printing for scapholunate ligament reconstruction

Category: Wrist

Hypothesis
We hypothesize that it is possible to create a multiphasic bone-ligament-bone (BLB) scaffold similar to the dorsal scapholunate interosseous ligament (SLIL). It will then be feasible to seed the scaffold using cell sheet technology to create a composite tissue that can be implanted for clinical use.

Methods
Multiphasic bone-ligament-bone scaffolds modelled from the dorsal component of the SLIL were 3D-printed with medical grade polycaprolactone (PCL). These simulated a bone-ligament-bone (BLB) construct with two bone compartments bridged by aligned PCL fibers mimicking the architecture of the native ligament studied from cadaveric specimens. Mechanical tensile testing, in vitro and in vivo characterisation of the constructs were conducted. The cell sheets were formed by seeding human bone marrow mesenchymal stem cells into 12-well plates and incubating for 21 days. Upon maturation, the cell sheets were harvested and placed into the ligament compartment of the multiphasic scaffold. Bone morphogenetic protein (BMP) was incorporated into the bone compartment to stimulate osteogenesis. In total, 36 samples were ectopically implanted into six athymic rats and harvested at two and eight weeks.

Results
Mechanical testing of the BLB scaffolds showed that they were capable of withstanding normal physiological forces. The in vitro study revealed that the harvesting and cell sheet placement did not compromise cell viability. In vivo study in the rats demonstrated that the scaffold was biocompatible and displayed good tissue integration and vascularization in the subcutaneous
interface. Upon ectopic implantation for two and eight weeks, bone formation and ligament remodeling was observed in the corresponding compartments.

Summary Points

- Various tenodesis procedures for reconstruction of scapholunate instability fail to restore normal carpal kinematics.
- It is possible to synthesize a 3D-printed BLB graft with structural and mechanical properties similar to the dorsal SLIL.
- The artificial scaffold may provide an alternative to current techniques for reconstruction of scapholunate instability.
Hypothesis
In this study, we describe histologic evidence of trauma to the posterior interosseous nerve (PIN) during creation of the 3-4 portal for wrist arthroscopy. It is our hypothesis that the PIN is traumatized much more often than previously reported.

Methods
14 fresh frozen cadaveric wrists were mounted on a custom built frame that simulated a wrist arthroscopy traction tower. After the 3-4 portal was created in the usual manner, the skin was dissected off to identify possible trauma to the PIN. Specimens were categorized into those where there was clearly no trauma to the PIN and those where trauma was possible. In the cases where trauma was possible, we harvested the PIN with a cuff of the proximal edge of the portal and examined the cross sectional histology of the most distal sections for the presence of neural tissue.

Results
There was clearly no trauma to the PIN in 3 of the wrists during the creation of the 3-4 portal. In the remaining 11 wrists with possible trauma to the PIN, we identified axonal tissue on histological examination at the proximal edge of the 3-4 portal in 7 of these specimens. In summary, 7 out of 14 or 50% of our specimens had visual and histological evidence of trauma to the PIN.

Summary Points
- Based on the findings of this study, there may be many more injuries to the PIN during routine wrist arthroscopy than have been previously reported.
- These findings may suggest that transection or injury to this nerve may not lead to any clinical sequelae.
• However, if there is an instance where a patient has persistent, otherwise unexplained dorsal wrist pain following a wrist arthroscopy procedure, iatrogenic neuroma of the PIN may be responsible and should be considered
Poster 144: Computed tomography for the evaluation of scaphoid fractures: Utility of reformation in the long axis and radial images of the scaphoid

_Hypothesis_

The purpose of this study is to investigate the utility of reformatted CT imaging to diagnose scaphoid fractures, including occult scaphoid fractures and classify the fracture types for treatment decision.

_Methods_

Fifty-seven patients (median, 31 years old; range, 10-85) were included in this retrospective study. Between 2011 and 2014, they underwent CT for screening of scaphoid fractures or to diagnose their fracture types in our institution. Obtained images were sent to a workstation and 3 types of multi-planar reconstruction (MPR) images, which are along planes relative to the wrist (CT-wrist; Fig. 1a-c), the long axis of the scaphoid and radial scaphoid (CT-scaphoid; Fig. 1c-f) were reconstructed. CT-wrist only and the combination of CT-scaphoid and CT-wrist were interpreted independently by two orthopedic surgeons to diagnose scaphoid fractures, which were confirmed by magnetic resonance imaging or follow up medical records. Sensitivity, specificity and accuracy for both groups were analyzed using the McNemar test. The diagnoses of fracture type based on Herbert classification were performed using each group of images. The interobserver agreement was evaluated using Kappa statistics.

_Results_

Of the 57 patients, scaphoid fractures were confirmed in 49 patients, 32 with non-displaced types and 17 with displaced types, and 8 patients had no fractures. The sensitivity, specificity, and accuracy of CT-wrist only and the combination of CT-wrist and CT-scaphoid in diagnosing fractures by first observer were 92%, 98%, 75%, 100%, 89% and 98%, and by second observer were 88%, 92%, 100%, 100%, 89% and 93%, respectively. According to the McNemar test, there
was significant difference in accuracy by the first observer (p<0.05). The kappa scores were 0.58 for CT-wrist and 0.79 for the combination of CT-wrist and CT-Scaphoid.

**Summary Points**

• CT-scaphoid images gave more useful information for evaluating scaphoid fractures and classification of fracture type.

**Bibliography**


Images
Poster 146: Scapholunate Ligament Reconstruction Using Tendon Autograft and 3.5 mm Fork-tip Interference Anchors

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes
Level 3 Evidence

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Hypothesis
Ideal reconstruction of the scapholunate ligament and restoration of normal carpal kinematics remains an unsolved problem in hand surgery. We propose that early radiographic and clinical results of a newly described dorsal reconstruction method using fork tip interference screws and tendon graft augmented by an internal brace will compare favorably to the three ligament tenodesis (modified Brunelli) technique.

Methods
The electronic medical record database at our institution was queried for CPT codes 25320 and 25670 and we identified six patients that had dorsal reconstruction of a chronic scapholunate ligament injury using fork tip interference anchors and tendon graft augmented with an internal brace (dorsal reconstruction). The early radiographic and clinical outcomes of these patients were evaluated and compared to three ligament tenodesis reconstructions performed at our institution. A comparison of radiographic and clinical parameters between and within groups was performed using the Mann Whitney U Test and Wilcoxon Signed Rank Test, respectively. For all tests, a significance threshold of 0.05 was used.

Results
Pre-operative, immediate post-operative and final radiographs were available for all 12 patients and the average follow-up for final radiographs was 9.9 months (min. 4.0) in the three ligament tenodesis group and 6.9 months (min. 2.7) in the dorsal reconstruction group. There was no difference in the change in radiographic parameters between pre-operative, immediate post-operative and final radiographs when comparing between groups (Table 1). Within group comparison demonstrated that in the dorsal reconstruction group there was significant correction of scapholunate and radioscaphoid angle from pre-operative (76.2 deg and 65.5 deg, respectively) to final radiographs (70.3 deg and 57.4 deg, respectively).
respectively) to immediate post-operative radiographs (52.5 deg and 47.8 deg, \( p = 0.04 \) and 0.029, respectively). Neither group demonstrated a significant correction in radiographic parameters at final follow-up (Table 2). One patient in the dorsal reconstruction group developed stage II scapholunate advanced collapse after a motor vehicle crash.

**Summary Points**
- Early follow-up of dorsal reconstruction of the scapholunate ligament with interference screws and tendon graft augmented by an internal brace compares favorably to the three ligament tenodesis procedure and has a low incidence of complications.

**Bibliography**

Images
Poster 147: Comparison of Bridging Versus Neutralizing Long Volar Plate Constructs in the Treatment of Metadiaphyseal Distal Radius Fractures

Category: Wrist

Treatment; Prognosis/Outcomes
Level 4 Evidence

Abdo Bachoura, MD
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John Lubahn, MD

Hypothesis
Bridging versus neutralizing long volar plate constructs result in similar radiographic outcomes and the need for additional surgery.

Methods
Patients with a metadiaphyseal distal radius fracture treated with a long volar metadiaphyseal plate at one institution were assessed. Group A patients were treated with a bridging construct across the metadiaphysis while patients in group B underwent anatomic reduction of the comminuted metadiaphysis with lag screws to restore the radial bow. Patient demographics, AO fracture classification, radiographic parameters and additional surgical treatment were compared. Fisher’s exact test and an unpaired t test were used. Statistical significance was set at p<0.05.

Results
Group A included 9 patients (8 males, 1 female, mean age 57 years) compared to 6 patients in group B (4 males, 2 females mean age 42 years; p=0.002). There were no statistical differences in follow-up duration (Group A 237 days; Group B 125 days, p=0.41), the proportions of open fractures (Group A 5/9; Group B 2/6) or associated ulna diaphysis fractures (Group A 3/9; Group B 1/6). All group A fractures were classified as AO type 23C while group B included 3 type 23A and 3 type 23C fractures, p=0.044. Group A fractures collapsed more than Group B fractures as assessed by increase in ulnar positive variance after initial fixation (3.3mm vs. 2.3mm, p=0.52). There were no statistical differences in articular step-off less than 2mm, or radial inclination, radial height, volar tilt (Group A 22°, 10mm, 8°; Group B 21°, 14mm, 10°); however, the radial bow was restored in all group B fractures, and 3/9 group A cases, p=0.028. In group A, 2 patients underwent a Darrach procedure and 1 patient underwent ulnar shortening osteotomy, while no patients in group B underwent additional procedures.
Summary Points

- Comminuted metadiaphyseal fractures of the distal radius progressively collapse 2-3mm after initial fixation, thus increasing ulnar positive variance.
- Relative to bridging constructs, the restoration of the radial bow and metadiaphyseal pedestal with lag screws and a long volar plate did not appear to significantly protect from progressive distal radius collapse.
- Radial bow may not be adequately restored using bridging constructs alone. The clinical significance of this deficit has not yet been assessed in this study.
- Due to progressive collapse of type 23C fractures of the distal radius, ulnar sided wrist pain requiring further surgical treatment may develop.

Bibliography

Images
Poster 148: Evaluation of dorsal screw penetration and extensor tendon disorder by using the dorsal tangential view after volar plating of distal radius fractures

Category: Wrist

Evaluation/Diagnosis; Prognosis/Outcomes
Level 3 Evidence

Katsunori Ohno, MD, PhD

Hypothesis
We hypothesized that dorsal screw penetration (DSP) after volar plating may not be largely attributable to extensor tendon irritation or rupture.

Methods
This prospective study evaluated 119 patients who underwent volar plating. All patients completed at least 6 months of follow-up. The screw length was measured with a depth gauge, and the absence of dorsal cortex penetration was confirmed with lateral and oblique fluoroscopic views. Screws that were 2 mm shorter than the measured values were selected. After skin closure, the dorsal tangential view (DTV) was obtained such that the dorsal cortex of the distal radius could be positioned with 15° inclination to the vertical x-ray beam. For assessing the DSP site on the DTV image, the dorsal surface of the radius was divided into the radial and dorsal sides at the Lister tubercle, and each was further divided equally into 2 regions. These 4 regions were called zones 1 to 4 (Z1–Z4) from the radial side, and the DRUJ was called zone 5 (Z5) (Fig. 1). DTV films were obtained immediately postoperatively and at the final follow-up. According to the DTV findings, all cases were divided into 2 groups: those that showed DSP at the immediate postoperative period and/or final follow-up (group 1) and those that did not (group 2) both at the immediate postoperative period and final follow-up. Loss of volar tilt (VT), radial inclination (RI), ulnar variance (UV), radial height (RH), and preoperative AO classification were also assessed. At each visit, the patient was asked about dorsal wrist discomfort and examined for the presence of extensor tendon irritation or rupture.

Results
Of 119 patients, 12 (10.1%) showed DSP, with 13 screws (3 in Z1, 0 in Z2, 5 in Z3, 4 in Z4, and 1 in Z5) penetrating (Table 1). There was no difference in zones at the time of the operation and final follow-up in any of the patients, and DSP was most frequently observed in Z3. There was no extensor tendon irritation or rupture in group 1. There were 2 EPL ruptures and 2 cases of dorsal wrist discomfort in group 2 (107 patients). The average VT loss, RI, UV, RH, and AO classification were not statistically significant between the groups (P > 0.05).
Summary Points

- DSP occurs regardless of fracture type or the extent of correction loss.
- DSP may occur even with shorter screws; however, it may not be largely attributable to extensor tendon irritation or rupture.

Bibliography


Images
Poster 149: Carbon Fiber Reinforced Implants In Distal Radius Fractures

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Grant Received from: Carbofix

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Hypothesis
CFR-polyetheretherketone (PEEK) implants offer improved fracture visualization and comparable outcomes in distal radius fracture fixation

Methods
After IRB approval, a prospective study of distal radius fractures managed surgically with a 2.4mm CFR-PEEK precontoured volar distal radius locking plate was conducted over a 2 year period. The indication for using this implant was surgeon preference. Time to radiographic healing as well as validated clinical outcomes (DASH) were documented. The results were compared to reported studies in literature.

Results
Seventeen patients underwent fracture fixation with CFR-PEEK implants. All patients were clinically and radiographically healed at 6 week follow-up. Nine patients completed 3 month postoperative questionnaires demonstrating average SF-12 score to be 39 and DASH score to be 32. This demonstrated a decrease of 3 points on the SF-12 scale and increase of 20 points on the DASH score for the 8 patients with preoperative scores available for comparison. Complications included one case of improper plate positioning due to intraoperative visualization as well as a plate fissure from excessive screw torque. There was no associated delay in healing with these cases.

Summary Points
While the CFR-PEEK used offered the advantage of radiolucency, possibly improving intraoperative fracture visualization, the radiolucent nature of the plate was associated with a learning curve for optimal implant positioning. No previous cases of broken hardware have been
reported, however our intraoperative plate fracture demonstrated brittle failure instead of plastic deformation. We now use a torque limiter for screw application. The CFR-PEEK distal radius plate is a viable option for selected distal radius fractures amenable to volar plate fixation, and a learning curve of implant use may be experienced.

**Bibliography**
Images
Poster 151: Clinical Outcomes of Novel Total Wrist Arthroplasty: A Minimum 5-Year Prospective Study in Patients with Rheumatoid Arthritis

Category: Wrist

Treatment;Prognosis/Outcomes

Level 4 Evidence

Yuichiro Matsui, MD, PhD
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Norimasa Iwasaki, MD, PhD

Hypothesis

We developed a novel semi-constrained wrist prosthesis adopting dart-throwing motion to limit stress on surrounding soft tissues and performed a prospective study on the outcomes of total wrist arthroplasty (TWA) in patients with rheumatoid arthritis (RA). We hypothesized that the clinical and radiographic evaluations at short-term (1.5 years) and medium-term (>=5 years) follow-up would demonstrate the clinical efficacy of the prosthesis for wrists with advanced RA.

Methods

The present study was conducted on 20 wrists in 20 patients (5 men, 15 women) with RA indicated for TWA, with a mean age of 64 years (range, 50–84). Preoperative Larsen classification showed grade IV in 16 wrists and grade V in four wrists. Between 2010 and 2012, TWA with the novel wrist prosthesis was performed at two institutions. The data at 1.5-year follow-up were available for all 20 patients, and those from the last follow-up (mean 67 months, range 60–84 months) for 16 patients. VAS, range of motion, Figgie score, DASH questionnaire score, and plain radiographs were assessed preoperatively, 1.5 years postoperatively, and at last follow-up (>=5 years). The appearance of radiolucent lines (>=2 mm), osteolysis, or subsidence was defined as radiographic loosening. Statistical comparisons were performed using unpaired t-tests. The significance level was set at P =5 years) of the TWA demonstrated the clinical efficacy of the prosthesis in patients with RA.

Bibliography


Images
Poster 152: Optimization of the screw length for the volar locking plate using three-dimensional preoperative planning in distal radius fractures.

Category: Wrist

Treatment;Surgical Technique;Prognosis/Outcomes
Level 3 Evidence

Yasukazu Totoki, MD
Yuichi Yoshii, MD
Tomoo Ishii, MD

Hypothesis
A three-dimensional (3D) digital pre-operative planning system for the osteosynthesis of distal radius fractures was developed. We hypothesized that the use of 3D digital planning is useful to choose proper implants for the fracture management. The objective of this study was to evaluate the screw choices of 3D planning for the osteosynthesis of distal radius fractures and compare with the screw choices of the conventional method.

Methods
Forty-nine wrists of 47 distal radius fracture patients who underwent osteosynthesis using volar locking plates were evaluated. Thirty wrists in the plan group utilized 3D digital preoperative planning, and nineteen wrists in the control group utilized standard preoperative assessment on plain radiographs and CT scans. In the plan group, the 3D preoperative planning was performed prior to the surgery. Referring to the un-injured wrist X-ray, the reduction was simulated with 3D image in the plan group. The implant choice and placement also simulated on the 3D image. During the surgery, the operator performed the reduction and the placement of the plate while comparing images between the pre-operative plan and fluoroscopy. The screw sizes were determined by intraoperative measurement in reference to the preoperative plan. The distal screw lengths and the anteroposterior diameter of the radius along the axis of the distal screws were measured. The ratios of the screw length and radius diameter were evaluated. The screw/radius ratios within the range of 0.75-1.00 were considered appropriate. The screw choices less than 0.75, or greater than 1.00 were considered inappropriate. The rate of appropriate screw choices were compared between plan and control groups.

Results
There were 215 and 139 screws in the plan group and the control group, respectively. The average of the screw/radius ratios were 0.90 +/- 0.09 and 0.92 +/- 0.08 for the plan group and the control group, respectively. The results of appropriate screw choices were 86.1% (185 screws) and 74.8% (104 screws) in the plan group and the control group, respectively. The inappropriate
screw choices were 14.0% (30 screws) and 25.2% (35 screws) in the plan group and the control group, respectively. There was a significant difference between plan group and control groups for the appropriate screw choices (P<0.05).

**Summary Points**

- The 3D preoperative planning increase appropriate screw choices compared to the control group. Three dimensional digital preoperative planning was useful for the optimization of the screw lengths for the osteosynthesis of the distal radius fractures.
Hypothesis
Fractures of the lunate bone are a rare entity that is not well studied. Not all fractures of the lunate bone can be grouped according to the current classification. We hypothesize that appreciation of the three dimensional characters of lunate fractures and its correlation with clinical outcomes will lead to the development of a better treatment directed classification.

Methods
A retrospective chart review of thirty one patients with lunate fractures was done that were treated at our institution during the period between 2005 and 2015. Patients’ demographic characteristics, mechanism of injury, management, outcomes and complications were documented. CT scans were studied and reconstructed using Materialise’s Interactive Medical Imaging Control System program (Materialise, Leuven, Belgium) (Fig. 1) and the fracture patterns were studied and classified according to the classification by Teisen and Hjarbaek, then correlated with clinical outcomes.

Results
Twenty seven patients were males and four were females. Mean age was 33.6 years. Eleven patients had a low energy trauma (such as a fall on the outstretched hand) and the remaining twenty had a high energy trauma (such as motorcycle accident or fall from a height). Seventeen (55%) had isolated lunate fractures and fourteen (45%) had associated injuries in the wrist and/or hand. Twenty patients were treated operatively and eleven were treated conservatively. Complications noted were avascular necrosis in two patients, non-union in three patients, dorsal intercalated segment instability in four and chronic pain in six. By studying the fracture patterns we were able to classify twenty three fractures. Thirteen fractures were type 1, eight were type 3, one was type 4 and one was type 5. Eight fractures were unclassifiable either due to a unique pattern (as shown in figure 2, where a depression of the superior articular surface exists together with the volar fragment) or due to the complex or combined fracture patterns. The two
patients that developed avascular necrosis had an unclassifiable fracture type with volar and dorsal components.

Summary Points

- We conclude that CT imaging is a must in diagnosing fractures of the lunate and appreciating the fracture pattern.
- Advanced imaging and three dimensional reconstruction dictate the need for a new classification for lunate fractures to accommodate the newly identified fracture patterns.
- The characteristics of the fracture can aid in determining the prognosis, which was the worst in fractures involving both the volar and dorsal poles according to this study, thus disrupting the blood supply completely and ultimately leading to avascular necrosis.

Bibliography

Images
Poster 154: NiTiNOL Low Profile Multi-pronged Memory Metal Staple in Small Bone Fusion

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

John Faillace, MD

COI
Royalty: BioPro, Inc.
Receipt of Intellectual Property Rights/Patent Holder: BioPro, Inc

Hypothesis
Use of low profile multi-pronged NiTiNOL memory metal staple rapidly achieves a high rate of union for small bone arthrodesis in the wrist and hand.

Methods
32 consecutive patients from two surgeons using the implant in different states were collected. Age averaged 51 years old (range 19 to 75, median 53) There were 25 men and 7 women. Four patients had concomitant procedures (not including scaphoid excision or radial styloidectomy.) Inclusion Criteria: limited fusion in the wrist. Grip and pinch measurements were obtained in the office on each visit and the QuickDASH was also administered. Determination of adequate fusion was based on radiographs and clinical exam. The implant was considered a failure if union was not achieved within 12 weeks.

Results
100% of patients achieved union, usually within 6 weeks. The average length of follow up was 13 months. The average QuickDASH score decreased from 66 to 53 and the grip improved from 65% of the unaffected limb to 100% of the unaffected limb. There were 3 removals, all had achieved union.

Summary Points
- Low-profile NiTiNOL multi-pronged staples are an effective way to achieve fusion between the small bones of the wrist and hand with a low complication rate.
- Meticulous removal of cartilage and appropriate treatment of the subchondral bone as well as the use of bone graft is required for ANY arthrodesis to be successful.
- The average age (51) is comparable to other studies evaluating Four-Corner arthrodesis.
Bibliography
Images
Hypothesis
Pisotriquetral joint disorders, such as osteoarthritis, are often overlooked as causes of ulnar-sided wrist pain. After failure of non-operative management, excision of the pisiform may be indicated and this is classically addressed through an ulnar-sided, volar approach at the wrist. Arthroscopic evaluation of the pisotriquetral joint has been described, though the safety and efficacy of pisiform excision via arthroscopy has not been studied.

Methods
After IRB approval, chart review was performed on patients who had undergone arthroscopic pisiform excision in a single surgeon’s practice from 2000 to 2016. Surgical records, progress notes, and therapy notes were evaluated for intraoperative and postoperative complications, functional scores and status, and further treatment including revision surgery, injections, or therapy.

Results
Eight patients (9 wrists) underwent arthroscopic pisiform excision for either pisiform fracture nonunion (2 wrists) or pisotriquetral arthritis (7 patients). Concomitant conditions were treated during the same arthroscopic procedure in 6 of 9 wrists (67 %) including debridement/repair of the triangular fibrocartilage complex in four wrists, one ulnar shortening osteotomy, and one ulnotriquetral ligament repair. The average age of the patients was 59 (range 36-78 yrs) and 89% were female. Average follow-up after surgery was 11 months (range 3-36 mos). Patients were treated non-operatively for an average of 8.6 mos (SD ±4.8 mos) prior to treatment. One partial ulnar nerve laceration occurred intraoperatively and was repaired via open volar approach. Postoperatively, three additional wrists (33%) experienced ulnar nerve paresthesias that resolved after an average of 6.7 mos. Visual analog scores decreased from 7.5 preoperatively to
2.3 postoperatively. If the patients were working preoperatively, they returned to work in an average of 1.5 months.

Summary Points

- Arthroscopic pisiform excision is effective at reducing pain from pisotriquetral arthritis and other pisotriquetral joint disorders
- The ulnar nerve in Guyon’s canal and the dorsal branch of the ulnar nerve are at high risk of injury from arthroscopic pisiform excision and arthroscopic portal placement, respectively
- Wrist arthroscopy is useful and safe for visualizing the pisotriquetral joint and treating concomitant pathology, though excision of the pisiform should be performed through an open approach

Bibliography


Images
Poster 156: Predictive Value of Distal Radial Metaphyseal Tenderness to Diagnose Occult Distal Radius Fractures

Category: Wrist

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Level 3 Evidence

Steven Z. Glickel, MD
Lauren Hinojosa, MD
Elaine Balutis, MD
Louis W. Catalano, III, MD
O. Alton Barron, MD

Hypothesis
We hypothesized that persistent distal radial metaphyseal tenderness two weeks after acute injuries is predictive of an occult fracture.

Methods
Twenty-nine adult patients presented after acute trauma with distal radial metaphyseal tenderness and initial plain radiographs and/or fluoroscopic images that did not show a distal radius fracture. Patients were reevaluated clinically and radiographically at approximately two weeks after initial presentation. Patients with persistent distal radial tenderness and negative radiographs underwent an MRI to definitively diagnose an occult distal radius fracture. We calculated sensitivity and positive predictive value for persistent distal radial metaphyseal tenderness using a 95% confidence interval and standard formulas. Both radiographs and MRI were utilized as our endpoint diagnosis for a distal radius fracture.

Results
We diagnosed 28 occult distal radius fractures, 8 by follow up radiograph and 20 by MRI scan. Positive predictive value for patients who completed the protocol was 96%. One patient who did not have an occult distal radius fracture had a fracture of the ulnar styloid.

Summary Points
• Tenderness of the distal radial metaphysis following wrist injury is strongly suggestive of a distal radius fracture even if normal plain radiographs or fluoroscopic images do not show a fracture acutely.
Bibliography
Images
Poster 157: Defining the Anatomy of the Dorsal Scapholunate Interosseous Ligament with Use of High Frequency Ultrasound Imaging  
*Category: Wrist*  

Evaluation/Diagnosis;Anatomy  
Level 2 Evidence  

Mary Claire Manske, MD  
Jerry I. Huang, MD  

**Hypothesis**  
The anatomy of the scapholunate interosseous ligament (SLIL) has been described qualitatively in great detail, with recognition of the dorsal component as the most important for carpal stability. The purpose of this study is to provide a quantitative description of the anatomy of the dorsal SLIL, and to present the use of high frequency ultrasound imaging to evaluate the scapholunate ligament.  

**Methods**  
We recruited 20 volunteers (40 wrists) without hand or wrist complaints to participate in the study. A high frequency ultrasound was used to evaluate the dimensions of the dorsal SLIL, and the scapholunate interval. Next, 12 cadaveric wrists were utilized for ultrasound evaluation, followed by open dissection to analyze the dorsal SLIL morphology including length, thickness, and location of insertions on the scaphoid and lunate bones.  

**Results**  
In the 40 volunteer wrists, the mean dorsal SLIL length was 7.54 mm and thickness was 1.81 mm. The mean scapholunate interval was 4.97 mm dorsally and 2.50 mm centrally. In the cadaveric specimen, on ultrasound imaging, the mean dorsal SLIL length was 6.23 mm and mean thickness was 1.63 mm. With gross dissection, the mean length measured 6.45 mm and mean thickness measured 1.58 mm. There was a moderately strong correlation with respect to dorsal SLIL length between ultrasound and gross measurements (R = 0.48) and poor correlation when looking at SLIL thickness (R = 0.28). On ultrasound imaging, the SLIL insertion was 1.04 mm and 2.21 mm from the articular margins on the scaphoid and lunate, respectively, compared to 1.59 mm and 2.64 mm, respectively on open dissection measurements.  

**Summary Points**  
- We found an approximate dorsal SLIL length of 6-8mm and thickness of 1.5-1.8mm.
- The dorsal SLIL originates on the dorsal ulnar aspect of the scaphoid, between 1.0-1.5mm from the articular surface, and inserts over the dorsal horn of the lunate, approximately 2.2-2.5mm from the articular surface.
- These parameters may be useful in treatment of SLIL injuries to restore the native anatomy.
- High-frequency ultrasound imaging is effective for assessment of dorsal SLIL anatomy.

**Bibliography**

Images
Poster 158: Pain Management for Distal Radius Fracture ORIF
Category: Wrist

Treatment; Prognosis/Outcomes
Level 4 Evidence

Steven Niedermeier, MD
Sonu Jain, MD
Krystin Hidden
Aroh Pandit

Hypothesis
Distal radius fractures remain one of the most common operative injuries to the upper extremity. Postoperative pain medication regimens vary, depending on patient factors, perioperative anesthetics, and physician preference. Opioids remain a common choice for pain control despite the current trend toward abuse and overdose. The purpose of this study is to evaluate common post-operative pain medications prescribed for open reduction internal fixation (ORIF) of distal radius fractures in relation to the number of physician hotline phone calls regarding pain control post-operatively. We hypothesize that a more formal, standardized post-operative pain protocol will decrease the number of patient calls due to poor pain control and increase overall patient satisfaction.

Methods
A retrospective chart review was conducted for consecutive outpatient and short stay procedures for ORIF of distal radius fractures from December 1, 2012 through December 31, 2014. Patient demographics, fracture laterality, severity of fracture (based on CPT® code), pre-operative mood disorder, type of operative anesthesia, and post-operative oral pain medications were recorded. Simple descriptive proportions and statistics were used with a z-test significance value of < 0.05.

Results
58 patients were identified as having had an ORIF of a distal radius fracture. 24 patients received oxycodone-acetaminophen (Percocet®), 11 received oxycodone, 7 received hydrocodone-acetaminophen (Norco®), 17 received combination of short- and long-acting narcotic analgesia, and 18 patients received NSAIDs in addition post-operatively. 13 patients called the physician hotline regarding poor pain control (22 total calls) within 21 days of surgery (range = 1-21 days). Of the 13 patients who called regarding pain control, 10 patients (77%) received narcotics alone and 3 patients (23%) received a combination of narcotics and NSAIDs (p = 0). Despite the number
of calls regarding pain control, only 2 patients (3%) required a refill of narcotic analgesia post-operatively.

Summary Points

- A standardized protocol for preoperative expectations, peri-operative discharge instructions, and postoperative pain management may help alleviate the physician hotline phone calls received and increase overall patient satisfaction.
- Adding an anti-inflammatory in the acute post-operative setting may help with immediate objective pain control after surgery.
- Type of general anesthesia, the use of regional anesthesia, and previous diagnosis of a mood disorder were not correlated with phone calls regarding pain control or need for a refill of narcotic pain medication.

Bibliography

Images
Poster 159: The cause of Extensor Carpi Ulnaris tendinitis is maintained in the groove. -Kinematic analysis of the Extensor Carpi Ulnaris tendon during forearm pronation and supination by MR imaging

Category: Wrist

Evaluation/Diagnosis
Level 4 Evidence

Toshikazu Tanaka, MD, Ph.D
Takeshi Ogawa, MD, PhD
Sho Kohyama, MD
Kazuki Oyama, MD
Naoyuki Ochiai, MD, PhD

Hypothesis
We hypothesized that extensor carpi ulnaris (ECU) tendinitis is caused by the dynamic state of the ECU tendon in the groove. Therefore, this study aimed to compare the relationship between the positions of the ECU tendon and sheath in patients with triangular fibrocartilage complex (TFCC) injury and patients with ECU tendinitis.

Methods
We reviewed 14 patients with TFCC injury (group T) who had a fovea sign and distal radioulnar joint instability, and 13 patients with ECU tendinitis (group E) who had positive synergy test and hyper-supination test results. Rheumatoid arthritis, traumatic history and infection was excluded in the study Images were obtained using high-resolution magnetic resonance imaging (1.5-T Gyroscan NT Intera) with a 47-mm microscopy surface coil. Using the Picture Archiving and Communication System, the groove depth and width, carrying angle, and radius of the curvature were measured from the slice in which the ulnar head was the largest. The following measurements were obtained: ECU-I, the distance from the ulnar side of the groove to the ulnar side of the ECU tendon, and ECU-II, distance from the radial side of the ECU groove to the radial side of the ECU tendon (Figure 1). Distribution of the groove shape was divided into three types based on the position of the deepest point: type U, ulnar; type M, middle; and type R, radial. The Student t test and m×n analysis of variance were used to analyze the data, and p<0.05 was considered significant in all analyses.

Results
There was no significant difference between the two groups in the groove depth and width, carrying angle, and radius of the curvature. There was a significant difference in the ECU-I during supination between groups (group E, 0.15 and group T, -3.33; p=0.001). There was no difference
in the ECU-I during pronation and ECU-II during pronation and supination between the two groups. Regarding distribution of the groove shape, there was no significant difference between the two groups.

**Summary Points**

- Positions of the ECU tendon and sheath were maintained in the groove in group E compared to group T.
- To treat ECU tendinitis should be released the sheath or loosed the tension in a sheath, not fixed ECU into the sheath.
Poster 161: Conservative treatment for isolated distal ulnar fractures with early exercise of the forearm

Category: Wrist

Treatment
Level 4 Evidence

Taku Suzuki, MD, PhD
Takuji Iwamoto, MD, PhD
Naoto Inaba, MD
Kazuki Sato, MD, PhD

Hypothesis
Distal ulnar fractures are often accompanied by distal radial fractures, but the management of the ulnar fracture is controversial. Clinical outcomes of the distal ulnar fracture are affected by the condition of the fracture and reduction of the radius. Hence, accurate evaluation of the outcomes should be performed for cases of isolated distal ulnar fracture. The aim of this study was to evaluate the clinical and radiographic outcomes for isolated distal ulnar fractures treated conservatively with early motion of the forearm.

Methods
Ten patients with a mean age of 65 (37 to 89) years, with isolated distal ulnar fractures, were followed prospectively for a mean of 21 (14 to 26) months. A short arm cast was applied to the wrist for three weeks while permitting rotational motion of the forearm. Active flexion and extension of the wrist were initiated after the cast was removed. Outcome measures at final follow-up included active wrist range of motion, grip strength, and complications. Radiographic deformity of the ulna was evaluated at initial injury and at final follow-up.

Results
The range of motion of the injured wrist relative to that on the uninjured side averaged 96% in flexion, 99% in extension, and 100% in pronation and supination. None of the patients complained of ulnar wrist pain or instability of the distal radio-ulnar joint. The mean angular deformity and the lateral shift of the ulnar shaft significantly improved based on a comparison between initial injury and final follow-up.

Summary Points
- Conservative treatment with early motion of the forearm provides good results for isolated distal ulnar fractures.
Poster 162: Central-depression fragments of intra-articular distal radius fractures

Category: Wrist

Evaluation/Diagnosis
Level 4 Evidence

Tadanobu Onishi, MD
Shohei Omokawa
Takamasa Shimizu
Yasuhiro Tanaka

Hypothesis
The purpose of this study was to analyze 3-D CT images of intra-articular distal radius fracture, focusing on central-depression fragments which are difficult to reduce by applying traction only. We hypothesized that the presence of central-depression fragments would be related to specific comminuted fracture patterns and the magnitude of intra-articular displacement.

Methods
We analyzed 145 consecutive intra-articular distal radius fractures at our institution using both 3-D and multiplanar reconstruction CT images. We evaluated the location of fracture lines and documented the fracture fragments based on modified fragment-specific classification system (Fig. 1a). We focused on centrally depressed fragments, and recorded the location, size and maximum displacement of each fragment. Displaced central and sigmoid notch fragments without ligamentous attachment were defined as a central depression fragment. We expressed the fragment size as maximum height (volar to dorsal) and width (ulnar to radial) and measured the maximum displacement as the sum of the gap and step-off by Cole’s arc method. The fragment location of central depression was divided based on the ratio of occupation in either the scaphoid or lunate facet, and size and magnitude of displacement of each depressed fragment were measured using multiplanar CT images.

Results
Eleven central depression fragments were found in eight wrists. All of the fragments were depressed relative to the marginal fragments, and the mean depth of displacement was 4 mm (range: 2–10). Five fragments involved the scaphoid facet (mean size: 8×9 mm), and six involved the lunate facet (mean size 7×9 mm) (Fig. 1b). Displacement of fragment in scaphoid facet (mean depth: 6 mm) was significantly larger than that in lunate facet (2 mm) (p < 0.05) (Table. 1). The presence of central-depression fragment had a positive correlation with number of other intra-articular fragments and presence of a volar rim fragment (r = 0.39 and r = 0.34, p < 0.001).
Summary Points

- Central-depression fragments were found in 6% of intra-articular DRFs, and were likely to occur with volar rim fragments in severely comminuted fractures.
- Preoperative recognition and surgical intervention of central depression fragments are necessary by fluoroscopic or arthroscopic procedure because these fragments have little effect of ligamentotaxis.
- Magnitude of displacement in scaphoid facet fragments were significantly larger than that in lunate facet. Based on this result and previous biomechanical study in which 1 mm of scaphoid fossa depression had significant effects, anatomical reduction of scaphoid facet is crucial to minimize the risk of postoperative osteoarthritis.

Bibliography


Images
**Poster 163: 4DCT Analysis of Carpal Malalignment after Distal Radius Fracture Malunion**

*Category: Wrist*

Evaluation/Diagnosis; Basic Science  
N/A - not a clinical study

Satoshi Oki  
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Takuji Iwamoto, MD, PhD  
Masahiro Jinzaki  
Kazuki Sato, MD, PhD

**Hypothesis**
We hypothesized that patient with wrist snapping has carpal malalignment and aimed to describe detailed kinematics of the lunate and scaphoid during wrist motion using 4DCT analysis.

**Methods**
Subject  
We enrolled the patient who was 21 years old male with history of distal radius fracture which was treated nonoperatively. His chief complaint was dorsal wrist pain during dorsiflexion of the wrist. Wrist range of motion was full, however, during dorsiflexion, depression of the dorsal protrusion around the lunate was observed with click sensation. The x-ray showed 21° of dorsiflexion.

4DCT  
4DCT of the wrist was performed on a Toshiba Aquilion ONE (Toshiba America Medical Systems Corporation). Fifty-one frames of 320 slice-CT (0.5mm thickness) were obtained during 10 second. During the examination, the patient was instructed to extend the both wrists in the same manner to reproduce snapping wrist in the affected side in the gantry. This study was approved by our institutional review board.

Data analysis  
From the CT DICOM data, surface data of the scaphoid, lunate, distal radius, and proximal third metacarpal bone were reconstructed. The surface data of the scaphoid, lunate, and radius were matched with each frame respectively by using iterative closest point algorithm.  
Extension/Flexion, radial/ulnar inclination, pronation/supination of the scaphoid and lunate with respected to the radius were calculated. Wrist extension/flexion was defined as the angle between the long axes of the distal radius and proximal third metacarpal bone. The contact area
between the radius and lunate just before and after the wrist snapping were calculated by measuring surface-to-surface distance.

**Results (Figure 2)**
During the exam, wrist was extended from -27° to 48° of extension in the affected side. The wrist snapping was observed between 25-32° of extension. During the snapping, lunate showed 18° of extension, 3mm of volar translation. After wrist snapping, the dorsiflexion of the lunate was much larger than the intact side. Before the wrist snapping, the lunate contacted with the dorsal lunate facet of the radius. After the wrist snapping the lunate contacted with the center lunate facet of the radius. On the other hand, scaphoid kinematics showed no significant difference.

**Summary Points**
- We described carpal bone kinematics during wrist snapping phenomenon.
- Before wrist snapping, the lunate contacted with the radius in the dorsal lunate facet and located dorsal position to the radius.
- After the wrist snapping lunate positioned similar AP position as the intact side, however, lunate dorsiflexion became much larger.

Category: Wrist

Treatment
Level 4 Evidence

Sezai Ozkan
Ritsaart F. Westenberg, MD
Chaitanya S. Mudgal, MD

Hypothesis
Closed reduction and percutaneous pinning (CRPP) is losing popularity as a treatment modality for the treatment of distal radius fractures. However, in select cases, CRPP may have advantages relative to open reduction and internal reduction. We aimed to retrospectively assess the outcomes after CRPP for the treatment of distal radius fractures.

Methods
We used billing records to identify all skeletally mature patients with a distal radius fracture who were treated with CRPP by a single surgeon at a level I trauma center in an urban city in the USA. We included 34 patients in this study with a mean age of 47 years (range 22 – 85 years). Eighty-two percent (n=28) were female and the majority of the patients (n=25; 74%) had an AO-Muller type C fracture. The mean duration of follow-up was 19 weeks (range 6 – 89 weeks). We manually assessed the charts, operative reports and radiographs of each of these patients and recorded basic demographics, trauma characteristics, treatment characteristics, and outcomes. We measured radiographic parameters of the radius fractures on the pre-reduction and the final follow-up radiographs.

Results
All patients had a good or excellent range of motion regarding forearm rotation, and almost 80% had good or excellent range of motion regarding flexion or extension of their wrist (Table 1; Figure 1). In one patient, there was a concern for a pin tract infection 5 weeks after pin placement, which was treated by pin removal. One patient had a concern for pin tract infection, and one patient had subcutaneous migration of a pin, which were both treated by pin removal.

Summary Points
- CRPP is a good option in patients with few and sizeable fracture fragments in patients with a distal radius fracture.
• CRPP should be considered as an effective tool to restore radiographic parameters and functional outcomes.
Hypothesis
In a previously performed study by Coppage et al(1) the authors proposed a simple tool for assessing the likelihood of nonunion in operatively treated scaphoid fractures. They found that at 6 weeks patients with = 2mm of osseous bridging in = 14% of coronal and = 27% of scaphoid sagittal cuts on CT ultimately went on to heal. In the current study we hypothesize that this assessment tool has good inter-rater reliability for easy application in the clinical setting.

Methods
Four blinded orthopaedic surgeons, two CAQ certified hand surgeons in practice for > 10 years and two orthopaedic hand surgery fellows, at a single academic institution retrospectively reviewed coronal and scaphoid sagittal CT scans of ten consecutive scaphoid fractures treated with single screw fixation. Raters recorded cuts in which there was = 2mm osseous bridging across the fracture site on coronal and scaphoid sagittal views (Figure 1). Inter-rater reliability was determined using kappa coefficients.

Results
The inter-rater reliability among attending observers was moderate with a kappa of 0.547 for sagittal cuts and 0.600 for coronal cuts (SE 0.080 and 0.069 respectively with p-value 0.000). The inter-rater reliability among fellow observers was only fair with a kappa of 0.325 for sagittal cuts and 0.318 for coronal cuts (SE 0.063 and 0.072 respectively with p-value 0.000). However when fellow and attending observations were combined reliability was again increased to moderate (Table 1).

Summary Points
• This method of measuring osseous bridging in operatively treated scaphoid fractures is a reliable assessment tool.
• For fellows or young attending surgeons bridging can be more difficult to assess for some fracture patterns and consultation of more experienced colleague will increase reliability.
• This simple and easily applicable tool allows prediction of likely progression to union that will better inform clinical decision making in the management of these fractures.

Bibliography
Images

Category: Wrist

Surgical Technique;Anatomy
Level 4 Evidence

Dirk Jurgens van der Spuy, MD

Hypothesis
The scapho-lunate ligament is a C-shape ligament with a dorsal component, (traditionally accepted as a key component) membranous part and a volar component (which importance is recently recognised). Reconstruction of the complete ruptured ligament, with reducible carpus and insufficient tissue is challenging: The 3/4 extensor inter-retinacular structural T-shape graft is an excellent anatomical and biomechanical auto-graft to reconstruct all three components of the Scapho-lunate ligament.

Methods
Patients were selected according to the Garcia-Elias category of a complete tear of the Scapho-Lunate ligament tear, reducible carpus and insufficient tissue to reconstruct the ligament.
Twelve patients satisfied these criteria and reconstruction of the Scapho-Lunate ligament was augmented with the 3-4 Inter-retinacular structural T-shape graft. The graft is harvested from the dorsal roof of the extensor retinaculum of the third and fourth compartment (which forms the horizontal part replacing the dorsal part of ligament) in continuity with wall between third and fourth compartment with periosteal sleeve, forming the vertical component of T-shape graft. The vertical leg forms an excellent accurate anatomical spacer between scaphoid and lunate and the fixation point is more volar restoring a better centre of rotation and reconstruction of the volar part of the ligament.
Informed consent was obtained pre-operatively with measurements of range of motion, grip strength and radiological scapho-lunate interval paired with mini-DASH scoring and compared with results three months post surgery.

Results
Early results show no donor site morbidity, improved grip strength and improvement of instability symptoms with stable scapho-lunate interval radiologically.
Summary Points

- Augmentation with the 3,4 Extensor Inter-retinacular graft provides a very good reliable anatomical graft with no donor site morbidity.
- The extensor retinaculum roof (horizontal part of graft) provides excellent replacement of the dorsal part of ligament with the vertical component reconstructing the membranous and volar components of the ligament.
- Reconstruction of the scapho-lunate ligament should respect the normal space between scapho-lunate ligament and incorporate a more volar stabilisation point.
Poster 167: Midcarpal Fusion: Clinical and Radiological Evolution after Minimum 3 years follow-up

*Category:* Wrist

Treatment; Surgical Technique; Prognosis/Outcomes

Level 4 Evidence

Pablo De Carli, MD
José Ignacio Oñativia, MD
Agustin Donndorff, MD
Gerardo L. Gallucci, MD
Jorge Boretto, MD

**Hypothesis**
Mid term follow up of midcarpal arthrodesis has good clinical results and no symptomatic secondary arthritis.

**Methods**
We treated 27 patients with midcarpal arthrodesis since May 1998.
Inclusion criteria were: patients with more than 3 years follow-up evaluation and operated in our Institution.
Three patients were excluded because failed final evaluation; another 2 for incomplete clinical charts and 11 had less than 3 years follow-up.
Eleven patients were included in this study. Eight were men; mean age was 47 years old (16-66) and average follow-up 6.7 years (3 to 15). Patient’s charts were reviewed for preoperative pain according to Visual Analogue Scale (VAS), both at rest and with activity. All patients had midcarpal arthrodesis. Two had lunocapitate fusion with scaphoid and triquetral resection; the other 9 had 4 corner fusion with scaphoid resection.
We evaluated pain using VAS, final limitation in wrist range of motion, and grip strength both relative to the contralateral side. Subjective function was assessed by QuickDASH and Functional VAS. Radiologically, we evaluated lunocapitate angle of fusion, arthritis signs of luno radial joint final wrist x-rays measured with Raim Viewer program.
Statistical analysis was performed with T non parametric test for preoperative and final postoperative variables. This was done with the SPSS Statistic 17.0 program. Significant values were p < 0.05.

**Results**
Pain improved from a preoperative VAS 5.5 ± 3.3 at rest and 8 ± 1.7 with activity to 0 ± 0 (p < 0.05) and 1.6 ± 2.7 (p < 0.05) postoperatively. The mobility the patients lost was 39%.
flexoextension and 45% radio ulnar deviation. Final QuickDASH was 10. Functional VAS improved from preoperative 4.1 ± 1.7 to final follow-up 8.1 ± 1.4 (p < 0.05). The grip strength was 92% compared to the contralateral side. Radiologically postoperative Radiocapitate angle was between 7º of flexion to 21º of extension. No statistical difference in clinical results was found between this fusion angles. Four patients didn’t show changes in radiolunate joint space; in the remaining seven, this joint was narrowed. We found no difference in clinical results between these 2 groups of patients.

Summary Points
- Midcarpal fusion improves pain significantly, retaining acceptable range of motion.
- These results remained after 3 years follow-up.
- Radiolunate joint space suffers progressive narrowing with more than 3 years after operation. However, this radiologic finding had no clinical correlation, at least after a mean of 6 years follow-up. scores and grip strength were significantly improved and remained after minimum 3 years follow-up.

Bibliography

Images
Hypothesis
Rupture of the flexor pollicis longus (FPL) tendon is a known complication after volar locking plate (VLP) for distal radius fractures (DRF). Recent investigations demonstrate that plate positioning contributes to risk of tendon rupture, however, the impact of plate design has yet to be established. This study uses ultrasound to compare two different plate designs for their effect on FPL pathology; we hypothesized that the plate with a FPL-sparing design would decrease ultrasound signs of FPL irritation as compared to a standard plate (Figure 1).

Methods
We retrospectively reviewed patients who underwent DRF fixation with either standard or FPL-sparing plate design by the same manufacturer (Medartis, Basel, Switzerland) and identified 17 patients with Soong grade 1 plate prominence to undergo wrist ultrasound irrespective of clinical symptomatology. All ultrasound exams were performed within two years of surgery by a fellowship-trained musculoskeletal radiologist. Sonographic measurements included presence of FPL tenosynovitis, plate-tendon distance and cross-sectional area of the FPL tendon. Radiographic measures included plate-volar rim and plate-critical line distances. Data was analyzed using independent t-tests, Mann-Whitney U for non-parametric data, and Fisher’s exact test.

Results
Eight patients had DRF fixation with standard plate while nine patients underwent fixation with the FPL-sparing plate. Results are summarized in Table 1. Standard and FPL-sparing plates were similarly radiographically prominent by Soong grade,(2) plate-volar rim and plate-critical line distance. Sonography demonstrated FPL tenosynovitis in 37.5% (n=3) of patients in the standard plate group vs. 11.1% (n=1) in the FPL-sparing group (p=0.2) and the distance from the plate to
the tendon was 0.1 mm (range, 0-1.8 mm) and 0.4 mm (0-5 mm), respectively (p=0.82). The FPL tendon had a larger cross-sectional area in patients with the standard plate (11.8 mm2) when compared to the FPL-sparing group (10.4 mm2), however, this was not statistically significant (p=0.35).

Summary Points
• Ultrasound can be used to detected subclinical signs of FPL tendon irritation in patients at risk for FPL rupture after VLP.(5)
• In this small, ongoing cohort with radiographically equivalent plate position, there is a trend towards decreased ultrasound evidence of FPL tenosynovitis and decreased CSA of FPL in the FPL-sparing plate patients.
• Continued recruitment will determine if plate design plays a distinct and statistically significant role in tendon irritation that may help guide clinical decision-making regarding hardware removal to prevent tendon rupture.

Bibliography
Images
Poster 169: Steroid injection for extensor carpi ulnaris tenosynovitis

Category: Wrist

Treatment
Level 4 Evidence

Katsuhisa Tanabe, MD, PhD

Hypothesis
Steroid injection for the extensor ulnaris (ECU) tenosynovitis is effective at a long-term as well as a short-term follow-up.

Methods
We treated thirty consecutive patients with ECU tenosynovitis. The patients were 12 men and 18 women with an average of 51 years old (age; 17 to 78). Steroid injection in the ECU tendon sheath was done in 26 patients. For steroid, triamcinolone acetonide, bethamethasone or methylprednisolone acetate suspension was used. In three cases, wrist splints were subscribed as well as steroid injection. We asked patients to revisit our clinic less than in a month after the injection and assessed the short-term result of steroid injection. For a long-term follow-up study, we investigated wrist pain, activity of daily living and side effects of injections by a phone call to each patient.

Results
22 patients visited our clinic 11 to 70 days after the first injection. In all the 22 patients, wrist pain decreased and in 12 patients, pain disappeared completely. Among them, 18 patients did not required further treatments. One patient had steroid injection again and did not visit anymore. Three patients had recurrence of pain 5 months to a year later and had steroid injection again. Among them, two patients did not require further treatment and one patient visited again and had one more injection a month later.
We could survey 20 patients by a phone call except ones whom we could not contact. The follow-up period after the last injection was 8 months to 9 years (mean; average; 3 years and 6 months and mean; 3 years). At the final follow-up, 12 patients had no pain, 5 patients had mild pain but no disturbance of ADL and did not need further treatment, and 3 patients had moderate pain (VAS scale 5-7) and have some disturbance of ADL but did not want to have surgery.
Among 3 patients with recurrence and additional injections, two had moderate pain at the final follow-up.
Summary Points
Steroid injection for ECU tenosynovitis was effective at a short-term and even at a long-term follow-up, and the wrist pain was limited in most patients. Nevertheless, three of 20 patients have moderate pain at a long-term follow-up. We suggest conservative treatment with steroid injection with or without orthosis for ECU tendinitis as a first-line treatment. A small portion of patients may require surgery for the residual pain.

Bibliography
Images
Poster 170: Distal Radius Nonunion: Subjective Hand Functional Impairment and Mid Term Results after Radial Consolidation

Category: Wrist

Treatment; Prognosis/Outcomes
Level 4 Evidence

Pablo De Carli, MD
Nicolas Atala, MD
Maria Laura Tripodi, MD
Gerardo L. Gallucci, MD
Agustin Donndorff, MD
Jorge Boretto, MD

Hypothesis
Treatment of Distal Radius non union, stabilizing the wrist either by radius reconstruction or by partial or total wrist fusion improves subjective previous deteriorated hand function.

Methods
We operated fifteen patients with Distal Radius Non Union between 2005 and 2012.

Inclusion criteria for this study were
- patients with complete clinical and functional preoperative evaluation charts
- Radius non union surgical treatment, either by reconstruction or wrist fusion
- minimum follow up of 3 years.

Preoperative and final evaluation data included:
- function according to DASH score
- Visual Analogic Scale (VAS) both for pain and function
- Swanson Scale for pain.
- Signs of Complex Regional Pain Syndrome – pain at rest and finger stiffness. The possibility of closing completely the fist was recorded as a sign of finger stiffness.

Initial and final X rays were AP and lateral. CT scan was taken in case of doubt of bone union or for distal fragment size evaluation. Final union was evaluated with plain X rays.

Results
Ten patients met inclusion criteria: 7 were female. Patients age averaged 65 years old (52-85).

Preoperative pain resulted in VAS 7.2 (8 of 10 patients had VAS 7 or higher)
Four had pain at rest, 2 with light tasks, 3 with moderate efforts and one with strong efforts.
Only 3 of 10 patients could make a fist reaching the palm of their hand with the tip of the finger, due both to hand edema and finger stiffness and pain.

Initial DASH was average 62 (22-89)

In six cases radius non union was treated with radial reconstruction using internal fixation and bone graft. Four cases had a salvage procedure: two Radio-Lunate-Scaphoid arthrodesis and two Total Wrist Arthrodesis.

Final follow up was 75 months (43 to 125). Pain resulted in VAS 0.3 (0 to 1). Five patients had no pain at all, and 5 had light pain with great efforts. All could make a complete fist touching the palm with all the fingers and no one had signs of Complex Regional Pain Syndrome. Final DASH averaged 11 (0 to 20). Final functional VAS averaged 8 (5 to 10)

Summary Points
- Distal Radius Non Union carries a significant functional impairment not only in the wrist but also in the hand.
- Achieving Radius stabilization, either by Radius reconstruction or by partial or total wrist arthrodesis, resulted in significant improvement in hand function and in pain relief.

Bibliography
Poster 171: Approach to the Fixation of a Scaphoid Waist Fracture, Perpendicular to the Fracture – Cadaver Model

Category: Wrist

Treatment; Surgical Technique
N/A - not a clinical study

Grant Received from: Thammasat University Research Fund, Bangkok, Thailand

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Hypothesis
The majority of waist fractures of the scaphoid have been found to be horizontal oblique. In these fractures, screw fixation along the longitudinal axis of the scaphoid is at a great angle to the fracture and may be less efficient. Our hypothesis was that it is possible to place a screw perpendicular to the horizontal oblique fracture from a volar as well as a dorsal approach. This approach may differ from the common approaches used today.

Methods
Computed tomography (CT) of 12 cadaver wrists were performed in three positions – maximum flexion, neutral position, and maximum extension. The scans were evaluated using a 3D model, including simulation of transverse (90-degree) and horizontal oblique (60-degree) fractures and depiction of possible screw axes, examining the possible approaches for its insertion. The location of possible entry points for the preferred approaches was measured as well.

Results
The preferred approach for perpendicular screw placement in transverse (90-degree) fractures was found to be proximal-dorsal or transtrapezial in flexed or neutral positions and distal in the extended position (volar to volar-radial trapezium). For a horizontal oblique (60-degree) fracture, the best approaches were proximal-dorsal in flexion or transtrapezial in the extended or neutral positions (through the radio-volar trapezium). In these approaches, the screw could be placed perfectly perpendicular and in the center of the fracture in all specimens (p<0.001). The entry point was either a mean of 7 mm from the volar-radial trapezial edge distally, 2 mm radial to Lister's tubercle axis along the joint line in a neutral position or 12 mm proximal to the dorsal apex of the scaphoid ridge if performed through an open approach.
**Summary Points**

- It is possible to place a perpendicular screw in the center of a horizontal oblique waist fracture using a proximal-dorsal approach in flexion or a transtrapezial approach in neutral or extension.

**Bibliography**


Images
Clinical results of Sauve-Kapandji procedure

**Category:** Wrist

**Treatment; Surgical Technique**
Level 4 Evidence

**Hypothesis**
In the Sauvé-Kapandji (S-K) procedure, bone graft is not required.

**Methods**
Twenty patients, including 5 males and 15 females, who underwent the S-K procedure in our department were enrolled. Mean age at surgery was 68.4 years (44 to 85 years). The mean postoperative observation period was 22.0 months (2 to 53 months). Underlying diseases were rheumatoid arthritis of the wrist (14 patients), ulnocarpal abutment syndrome (4 patients), and ulnar head dislocation (1 patient). In all patients, an Acutrak 4/5® screw was used to fix the distal radioulnar joint surgically without bone graft. As outcome measures, we compared the preoperative and postoperative range of motion (ROM), carpal height ratio (CHR), ulnar translation index (UTI), and palmar carpal subluxation ratio (PCSR) measured with simple radiographs. In addition, we confirmed the presence or absence of bone union at final follow-up.

**Results**
Mean ROMs (°) of palmar flexion, dorsiflexion, forearm pronation, and forearm supination increased from 55.4, 45.8, 78.9, and 78.5 preoperatively to 62.1, 52.0, 82.5, and 83.8 postoperatively, respectively. There was no significant difference between the two groups. CHR and UTI were 0.48 ± 0.06 and 0.30 ± 0.07 preoperatively and 0.43 ± 0.09 and 0.34 ± 0.06 at final follow-up, respectively; this difference was significant (p < 0.05). PCSR was 0.22 ± 0.06 preoperatively and 0.22 ± 0.06 at final follow-up; this difference was not statistically significant. Although only 16 of 20 patients achieved bone union, no screw loosening or ulnar head dislocation occurred, and no patient underwent reoperation.

**Summary Points**
- Although the S-K procedure, which we have performed to date, is simple and does not require bone graft, some patients did not achieve bone union.
In the S-K procedure, some patients may require a bone graft, although no effect on wrist function was observed even in case of non-union.
Hypothesis
The Henry approach is now the gold standard for distal radius fracture fixation.
The aim of this work was to evaluate the feasibility of a minimally invasive Henry approach (15 mm) in a series of 144 cases of distal radius fracture.

Methods
All patients were operated using the same minimally invasive technique.
According to the AO classification, there were 83 type A fractures, 2 type B, and 59 type C.
A volar plate was used in all cases.
Skin closure without drainage was performed.

Results
The mean follow up was 4.1 months.
The final size of the incision was on average 16.1 mm. Mean Pain score was 1.8. The Quick DASH score was average 25. Average range of motion was more than 85% and global force of the hand was 67% compared to contralateral side. On X ray, the mean radial slope was 22°, the mean radial tilt was 8.3° and the mean radioulnar variance/index was -0.4 mm.
There were 9 cases of Complex Regional Pain Syndrom type I, which all resolved. Specific complications included 2 secondary displacements and 9 tenosynovitis cases. Two intra articular DRUJ screws had to be removed at 3 months. One epiphyseal screw required removal 1 month postoperative due to loosening.

Summary Points
- Distal radius fracture fixation using a minimally invasive Henry approach is a reliable and reproducible procedure with few complications
- It allows anatomical reduction of the distal radius fractures including intraarticular ones
- It can be associated with arthroscopy, scaphoid screw fixation or even percutaneous pinning
Bibliography

Images
Poster 174: Vascularized metatarsal head transfer to reconstruct the lunate fossa

Category: Wrist

Hypothesis
Can a vascularized osseochondral graft from the great toe improve range of motion and decrease pain after reconstructing the lunate fossa?

Methods
Here we present a case of a 16 year-old right hand dominant male who presented with distal radius malunion and cartilage loss within the lunate fossa. He underwent vascularized osseochondral graft from the proximal phalanx of the great toe. Using volar and dorsal approaches to the distal radius, dorsal opening wedge osteotomy and iliac crest bone grafting were performed. A volar plate was placed for fixation. We then harvested the vascularized graft from a dorsal incision on the foot. A periosteal pedicle to the proximal phalanx was identified and traced back to the dorsalis pedis. The vessels to the flap were then anastomosed to the radial artery. Tendon interposition was performed using a toe extensor to decrease donor site morbidity.

Results
At 6 month follow up the patient had minimal pain and range of motion was 60 degrees of volar flexion and 30 degrees of dorsiflexion. X rays indicated bony healing. He was able to ambulate without pain.

Summary Points
Poorly managed die-punch distal radius fractures represent a difficult problem in that there are limited options for cartilage reconstruction. Current standards of care include total versus partial arthrodesis, which are not ideal a young person who needs to maintain range of motion. The vascularized proximal phalanx head provides a new reconstructive option for cartilage reconstruction of the distal radius. This method relieves pain while preserving range of motion.
Poster 175: Medial Femoral Trochlea Grafting for Scaphoid Nonunion: A Quantitative Anatomical Approach

Category: Wrist

Treatment;Anatomy;Basic Science

N/A - not a clinical study

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Hypothesis
Treatment of scaphoid proximal pole (SPP) nonunion with a vascularized osteochondral graft from the medial femoral trochlea (MFT) has recently been described. The purpose of this study was to test, using a quantitative anatomical approach, the hypothesis that the convex curvatures of the SPP and MFT are congruent.

Methods
A distal femur and an ipsilateral scaphoid were dissected from 12 donors (six males, six females; average age 78.5 years) and scanned with computerized tomography (CT). For each bone, a 3D mesh surface model was created from the CT scans and the region corresponding to the articular surfaces of the SPP and MFT were digitally ‘dissected’ (Figure 1a). In a virtual environment (and following prior descriptions of the grafting procedure), the isolated SPP and MFT were superimposed such that the radio-ulnar (RU) axis of the SPP was aligned with the proximodistal (PD) axis of the MFT near the proximal-most medial margin of the latter (Figure 1b). The superimposed SPP was then used as a guide to further resect the MFT (rMFT) into a suitable size and shape to mimic the operative harvest of a graft. The radius of curvature (RoC) of the RU and PD axes of the SPP and rMFT, respectively, as well as their corresponding perpendicular axes (i.e., anteroposterior [AP] and mediolateral [ML], respectively), were calculated (Figure 1c). RoCs were compared between the SPP and rMFT using paired t-tests.

Results
Despite large variation between individuals, especially in the rMFT, the RoC of the SPP RU and rMFT PD axes were not significantly different (p=0.06). In contrast, the RoC of the SPP AP and rMFT ML axes were significantly different (p=0.005) (Figure 2).
Summary Points

- For most individuals, the radio-ulnar curvature of the SPP is congruent with the proximodistal curvature of the MFT.
- For nearly all individuals, the anteroposterior curvature of the SPP is not congruent with the mediolateral curvature of the MFT.
- Articular surface incongruity of both functional axes in some individuals may limit improvements in wrist function following this grafting procedure.
- Preoperative anatomical screening with low-dose imaging to assess articular surface congruency may help identify optimal candidates for this procedure.
- While short-term results following MFT vascularized osteochondral grafting for SPP nonunion have demonstrated positive outcomes in retrospective clinical studies, more research is needed to elucidate the long-term efficacy of this procedure for wrist function.

Bibliography
Poster 176: Vascularized Medial Femoral Trochlea Flap Reconstruction: Clinical Outcomes and Perspectives

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Craig Lehrman, MD
Allen T. Bishop, MD
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Hypothesis
The purpose of this study was to evaluate the outcomes and complications of the MFT in reconstruction of articular defects of the scaphoid and lunate.

Methods
A retrospective review was performed of all patients who underwent a MFT for articular reconstruction of the scaphoid and lunate over a 2 year period by the senior authors (ATB, AYS). Demographics and follow-up data were evaluated including all complications and time to union. Pre-operative and post-operative measurements including ROM, grip strength, pain scores, and donor site morbidity were all assessed. Surgical technique described.

Results
Computed tomography imaging was used to confirm healing in all patients. There were 4 cases of scaphoid nonunion and 3 cases of Kienbock’s. There was a 71% success rate defined as bony union. Average age was 25.8 (17-42). The average follow-up time was 16 months (12-23 months). There were no smokers. A screw was used for fixation in 5 of the 7 patients, k-wires in the others. The average age for the success group was 21 compared to 37 in the failure group. The pre- and postoperative goniometric measurements did not reach statistical significance.

Summary Points
- The MFT provides a motion sparing alternative to other described procedures for articular disorders of the scaphoid and lunate
- The anatomy of the descending genicular system relating to the medial femoral condyle flap has been well studied. Less is known regarding the perforator anatomy of the MFT
- There is no long-term data with only 2 institutions reporting their outcomes. We had a 71% success rate in our series indicating that more studies are needed to optimize outcomes. Patient selection is a key to success.
Poster 177: 4-year Outcomes of Midcarpal Hemiarthroplasty for Wrist Arthritis

Category: Wrist

Treatment, Surgical Technique
Level 4 Evidence

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Hypothesis
The purpose of this study is to review the medium term postoperative outcomes of patients with wrist arthritis treated with a novel midcarpal hemiarthroplasty (1). We hypothesized that midcarpal hemiarthroplasty would improve range of motion and grip strength of patients with wrist arthritis, with a complication profile comparable to alternative solutions for wrist arthritis.

Methods
Following IRB approval, 11 male and 9 female patients (age 23-74 years) were treated by a single surgeon with a hemiarthroplasty designed to replicate the midcarpal joint. Patients were evaluated objectively with grip strength, wrist range of motion and serial radiographs, and subjectively surveyed with DASH and MAYO scores. Data were analysed using the Kolmogorov-Smirnov and the Shapiro-Wilk test of normality. A paired-samples t-test was used to determine whether there was a statistically significant mean difference between pre- and post-operative results using an alpha value of p = 0.05.

Results
Surgical time averaged 54 minutes (range 45-66 minutes). At an average of 4.3-year follow-up, range of motion had increased by a mean 37 degrees in flexion-extension (p<0.05) and 11 degrees in radial-ulnar deviation (p<0.05), when compared to pre-op range of motion. Mean grip strength also statistically improved post-operatively from 14.1kg to 20.8kg (p <0.007). The DASH score showed a significant mean improvement from 50.3 to 23.7 (p<0.05). The mean MAYO scores improved significantly from 34.1 preoperatively to 66.5 at latest follow-up (p<0.05).

Three patients had a manipulation under anaesthesia for stiffness. Two patients were revised to a total wrist arthroplasty and one to a wrist fusion.
Summary Points

- Midcarpal hemiarthroplasty provides improved wrist range of motion, grip strength and outcome scores when compared to preoperative values.
- Its 4-year complication profile was comparable to those of other surgical options for patients with wrist arthritis. (2)
- These data compare favourably to a recent series of 215 total wrist arthroplasties that showed no pre- to post-operative improvement in ROM. (3)
- Advantages of this approach include the avoidance of a distal component, retention of the native distal carpal row, as well as the option for a total arthroplasty or fusion should revision be required.
- Wrist hemi-arthroplasty is not FDA approved in the United States.

Bibliography


Images
Poster 178: Trends and Demographics in the Utilization of Total Wrist Arthroplasty

Category: Wrist Treatment
Level 4 Evidence

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Joseph Bosco

Hypothesis
Health disparities exist among many patient populations, with race, payer status, hospital size and access to teaching versus non teaching hospitals potentially affecting whether certain patients have access to the benefits of total wrist arthroplasty (TWA).

Methods
The National Impatient Sample Database (NIS), which is the largest publically available all payer database, was queried from 2001 to 2013 for TWA using the ICD-9 code 81.73. Patient-level data included age, sex, race, payer status, and year of discharge. Hospital-level data included hospital bed size, location, teaching status, and region. Hospital bed size categories were defined as follows: small (1-49 beds), medium (50-99 beds), and large (100+ beds).

Results
There were 1,223 patients identified who underwent TWA during the study period. Total number of procedures decreased from 88 TWAs in 2001 to 65 in 2013. This represented a 26% decrease in utilization. The yearly volume ranged from 38 in 2005 to 128 in 2007. The majority of patients were ages 50-59 (24.8%) followed by ages 70-79 (24.3%). There was an overall female predominance in gender distribution (71%) compared to male (29%). Analysis of ethnicity revealed that whites comprised 63.1% of TWA procedures, 9.2% African-American/Black, 5.4% Hispanic, 0.9% Asian, and 0.8% Native American. The insurance status of patients undergoing TWA included Medicare (54.1%), private insurance (31.6%), Medicaid (5.7%), and self-payers (0.73%). One hundred fifty three (12.5%) TWAs were performed at small-volume hospitals, 325 (26.6%) at medium-volume hospitals, and 744 (61.1%) at large-volume hospitals. With respect to regional demographics, TWA was performed more frequently in the South (32.1%) in comparison to the Midwest (30.7%), West (19.4%), and Northeast (17.9%). Hospitals were also stratified based on teaching status. Analysis showed that the majority of TWA procedures were performed
at urban teaching hospitals (61.1%), followed by urban non-teaching hospitals (25.3%), and lastly, rural hospitals (13.6%).

Summary Points
- The NIS database shows a downward trend of total wrist arthroplasty utilization of 23% from 2001 to 2013
- The majority of patients who underwent total wrist arthroplasty had Medicare (54.1%) or private insurance (31.6%) indicating that payer status influences treatment.
- The majority of total wrist arthroplasties were performed at urban teaching hospitals indicating treatment most often at academic centers of excellence.

Bibliography

Images
Poster 179: The Use of a Distal Ulna Vascularized Graft for Complex Distal Radius Fracture Non-unions

Category: Wrist

Treatment;Surgical Technique;Anatomy

Level 4 Evidence

Greg Merrell, MD
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Hypothesis
A distal ulna vascularized graft, based on the pronator and interosseous membrane, is a useful salvage alternative for complex distal radius non-unions.

Methods
This is a retrospective study of three patients treated between 2003 and 2012. Indications for this procedure include distal radius fracture or non-unions with at least 3-4 cm of shortening or bone loss and an unsalvageable DRUJ. The surgical technique relies on the vascular bundle of the pronator quadratus and dorsal oblique arterial anastomosis between anterior and posterior interosseous arteries running along the interosseous membrane as the pedicle. A dorsal approach is employed with initial exposure of the distal radius non-union site, the radial aspect of the pronator quadratus, and the interosseous membrane. The distal radius is cut flush back for transfer of the distal ulna flap. The distal ulna is exposed through an ulnar and dorsal dissection, and the ulnar aspect of the pronator quadratus is identified and protected. The appropriate length of the distal ulna is resected and rolled into the defect. Wrist fusion can follow for stabilization if the radial carpal joint is compromised.

Results
Three patients received a distal ulna vascularized graft with wrist fusion for distal radius non-union following complex distal radius fracture. For their initial fracture, two patients had an open-reduction internal fixation (ORIF) and one patient had external fixation with percutaneous pinning. Patients subsequently experienced significant radial shortening and ulnocarpal abutment. After placement of the distal ulna graft, one patient required additional bone grafting at the proximal juncture. All patients achieved successful union.
Summary Points

- Non-union with segmental loss of the distal radius fracture may require a free vascularized graft to achieve healing and stabilization. Often in these patients the distal ulna and DRUJ are not salvageable. This technique provides a local pedicled graft, which may provide a more reliable and less technically demanding alternative.
- A previous report of a vascularized distal ulnar graft requires an intact palmar arch with ligation of the proximal ulnar artery and requires identification and dissection of a singular vascular pedicle.
- The pronator pedicle ulnar graft described here technically is less demanding and provides for a more redundant vascular pedicle as the pronator and interosseous membrane contain several vessels to the distal ulna.
- A distal ulna vascularized graft based off the pronator quadratus and interosseous membrane is a reliable approach in difficult situations for non-union of the distal radius with segmental bone loss.

Bibliography


Images
Poster 180: Biomechanical Comparison of Metaphyseal and Diaphyseal Ulnar Shortening Osteotomy: A Cadaveric Study

Category: Wrist

Treatment; Surgical Technique; Anatomy
N/A - not a clinical study

Grant Received from: AFSH Andrew Weiland Grant

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Hypothesis
Metaphyseal ulnar shortening osteotomy allows more shortening than diaphyseal osteotomy with less stress on soft tissues.

Methods
10 cadaver arms were fixed though the proximal ulna to a wooden surgical board in order to use as the static end. Metaphyseal osteotomy was performed and torque required for sequential shortening was recorded until maximum shortening was achieved. A 3.5mm plate was used to fix the resected bone and restore normal anatomy; axial compression was performed to ensure restoration of original length. An orthogonal 2.7mm plate was added depending on cadaver bone quality to ensure stable fixation. Diaphyseal osteotomy was then performed, measurements were done in the same manner with 1) interosseous membrane intact, 2) with the central band released and 3) with extensive interosseous membrane and muscles attachments release. A Futek load cell sensor was used to measure torque required for shortening.

Results
One way ANOVA demonstrated that metaphyseal osteotomy allowed more shortening than diaphyseal osteotomy with the interosseous membrane intact (9.1mm vs 6.9, p < 0.01) and with central band release (9.1mm vs 7.4mm, p < 0.05) but similar shortening when extensive interosseous membrane and muscle release was performed (9.1mm vs 8.6mm, p = 0.5). Small difference was found in torque required to obtain shortening at each site and with sequential releases but this was not statistically significant.
Summary Points
- This cadaveric study demonstrates that metaphyseal ulnar osteotomy allows greater shortening than diaphyseal osteotomy but no significant difference was found in torque required to achieve such shortening.
- Sequential release of the interosseous membrane permits increased shortening at the diaphysis but the extensive soft tissue release required to make a significant difference is not compatible with real life clinical application.

Bibliography
Poster 181: The Prevalence of Radiocarpal and Midcarpal Arthritis: A Radiographic Evaluation

Category: Wrist

Evaluation/Diagnosis; Anatomy

Level 4 Evidence

Andrew J. Miller, MD

Hypothesis
Scapholunate advanced collapse (SLAC) has traditionally been viewed as the most common pattern of wrist arthritis. The purpose of this study was to determine the radiographic patterns and specific locations of radiocarpal and midcarpal joint osteoarthritis (RC/MC OA). We hypothesized that the SLAC pattern would represent the most common pattern of degeneration, and that RC/MC OA would be greater with increasing age and male gender.

Methods
A total of 1007 wrist radiographs were screened for the presence of RC/MC OA by the senior author. Three fellowship trained hand surgeons then evaluated patients with RC/MC OA and identified the location of the degenerative changes using a numerical system of seven zones. In addition, the observers then determined if the arthritic patterns fell under a SLAC or scaphoid nonunion advanced collapse (SNAC) category.

Results
Forty-nine x-rays in 47 patients with RC/MC OA were identified. Contrary to previous literature, the SLAC pattern of degeneration did not represent the majority of observed changes, with only 24 patients (49%) demonstrating changes consistent with this pattern. Almost one third of the patients with RC/MC OA had degenerative changes present at either the radiolunate or scaphocapitate articulations in the absence of radioscaphoid degenerative changes. Logistic regression demonstrated that women have a lower risk of arthritis compared to men (odd’s ratio 0.306, p < 0.05). Increasing age was positively correlated with presence of arthritis with (odd’s ratio 1.05, p < 0.05).

Summary Points
- Contrary to previous literature, our cohort demonstrated that less than 50% of wrist OA fell into the category of SLAC arthritis.
- Degenerative involvement of the radiolunate and scaphocapitate joints is often present in the absence of radioscaphoid OA.
- Advanced age and male gender are correlated with increased incidence of wrist arthritis.
Bibliography
Images
Hypothesis
Proximal pole scaphoid fractures represent a challenging surgical problem for hand specialists. They are at high risk for delay in diagnosis, leading to historically poor union rates after standard fixation, especially if surgery occurs more than 4 weeks after injury. In this scenario of delayed union, there are some proponents for vascularized bone graft from distant sites, with high reported union rates. These procedures are associated with significant donor site morbidity. We present a large patient cohort of proximal pole scaphoid fractures treated with primary open reduction internal fixation (ORIF) and autograft bone using a novel retrograde trough technique.

Methods
A retrospective review of all proximal pole scaphoid fractures occurring at our institution between December 2008 and November 2014 was performed. Cases were included only if treated more than 8 weeks after injury. All patients underwent a novel technique with cancellous autograft introduction via a distally-based dorsal trough during their surgical fixation. 19 patients were included in the final cohort. CT imaging was routinely obtained postoperatively and was reviewed for signs of healing. Patient demographics, time to diagnosis, mechanism of injury, and union rate based on post-operative CT findings were determined.

Results
Our cohort consisted of 19 proximal pole scaphoid fractures, all of which were “delayed unions” at least 8 weeks after injury. The mechanism of injury was low energy in all cases. Two patients had been treated with screw fixation through a standard dorsal approach by an outside surgeon prior to presentation. The remaining 17 patients had no prior surgical history. CT imaging was obtained postoperatively in 100% of patients. The union rate based on CT imaging was 94.74%. Persistent nonunion occurred in one patient (5.26%) who was the only smoker in the cohort.
After smoking cessation, this patient went on to revision scaphoid fixation with iliac crest autograft harvest and ultimately union was achieved.

**Summary Points**

Proximal pole scaphoid fractures have notoriously low union rates with standard surgical repair, particularly when diagnosis is delayed. We present a large series of proximal pole scaphoid fractures treated >8 weeks after injury. Using a distally based trough and retrograde cancellous autograft introduction, we achieved a 94.74% union rate. Given the high union rate reported here, surgeons should consider this procedure as an alternative to the morbid vascularized bone graft procedures that are popular for delayed union cases.

**Bibliography**


Images
Poster 183: Association between ulna styloid fracture and bone mineral density in patients with distal radius fracture

Category: Wrist

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Level 2 Evidence

Takuya Yoda

Hypothesis
Association between ulnar styloid fracture (USF) and osteoporosis is unclear. We hypothesize that the bone mineral density (BMD) of patients with distal radius fracture (DRF) and USF are lower than patients with only DRF.

Methods
Forty five consecutive patients from 50 to 89 years with DRF are enrolled. Fractures due to high-energy injuries were excluded. The patients were classified as 24 with USF and 21 with non-USF. They were measured the BMD in their spine, hip and distal radius by dual energy x-ray absorptiometry. Furthermore they were also measured ulnar variance on anteroposterior radiographs. The BMD and value of ulnar variance were compared with USF group and non-USF group. Independent t-test was used for statistical analysis.

Results
The BMD of hip in USF group was significantly lower than in non-USF group. In addition, the ulnar variance of USF group was significantly larger than in non-USF group. There is no significant difference in the BMD of lumbar spine and distal radius.

Summary Points
• The association between BMD of the lumbar spine and radial deformity have been reported. The association between BMD of the ulna and ulnar styloid fracture have also been clarified.
• There is a significant association between BMD of the hip and USF in low energy DRF.
• The patients with DRF and USF are considered to be osteoporosis.

Bibliography
Hypothesis
Most of triangular cartilage complex tears (TFCC) were detached from ulnar styloid process (Palmer’s classifications; 1B) which cause ulnocarpal instability and ulnar side wrist pain. In tears of TFCC, various operative techniques have been introduced to improve stability and ulnar side pain. In this study, we report clinical results for the patients with a peripheral TFCC tear who were treated with arthroscopic assisted repair and tightening of ulnar collateral ligament (UCL) and arthroscopic debridement.

Methods
From March 2014 to November 2016, we examined 55 patients who has ulnar side wrist pain and TFCC foveal avulsion around ulnar styloid process. All patients underwent magnetic resonance imaging for diagnosis of peripheral TFCC tear, and were performed by arthroscopic debridement of fibrillated TFCC and arthroscopic assisted UCL repair and tightening. We measured preoperative visual analyzed scale (VAS) score and clinical outcomes including postoperative VAS score, grip strength, wrist ranges of motion, and DASH scores 6 months after operation.

Results
There was significant difference between the preoperative VAS score and the postoperative VAS score, that the preoperative VAS score averaged 6.9±2.3, however the postoperative VAS score averaged 2.4±1.7 in these 35 patients (p value<0.05). No significant relationship was found between preoperative and postoperative clinical outcomes including grip strength, wrist ranges of motion, and DASH scores.

Summary Points
- Arthroscopic assisted repair and tightening of UCL with arthroscopic debridement in peripheral triangular fibrocartilage complex tears could improve postoperative wrist pain
without notable complications. This operative technique can be an effective method to improve ulno carpal stability and to decrease ulnar side wrist pains in peripheral TFCC tears.

Bibliography

Images
Poster 185: Triangular Fibrocartilage Complex Repair and ulnar variance (systematic review)

Category: Wrist

Treatment;Prognosis/Outcomes
Level 4 Evidence

Ki Jin Jung, MD
Jae-Whi Nho

Hypothesis
This systematic review was conducted to identify the impact of ulnar variance on the outcomes after repair of peripheral traumatic tears of the triangular fibrocartilage complex (TFCC).

Methods
A systematic literature search of the medical literature about peripheral tears of the TFCC was performed. We selected seven studies comparing clinical outcome and ulnar variance in patients with Palmer 1B TFCC tears. We evaluated quality of the articles using both the Structured Effectiveness Quality Evaluation Scale (SEQES) and Sackett’s Level of Evidence (LOE). The outcomes were objective or self-assessment scoring systems for the function of the hand, wrist, or upper extremity.

Results
Seven articles were evaluated. The SEQES scores varied from 19 to 28, with a mean of 23. Five studies reported no significant association between ulnar variance and clinical outcome, and 2 studies reported a significant association. In cases of the distal radioulnar joint (DRUJ) being stable, there was no relationship between ulna length and clinical outcomes, while in cases of including DRUJs that were unstable, there was significant association between ulnar variance and clinical outcome.

Summary Points
This study suggests that DRUJ stability is an important factor for the differences in outcome of TFCC repair for patients with ulnar-positive variance. Further studies are necessary to determine whether ulnar shortening osteotomy has an added value in stabilizing the DRUJ and protecting the TFCC repair in patients with ulnar positive variance and DRUJ instability.

Bibliography
1: Trumble TE, Gilbert M, Vedder N. Arthroscopic repair of the triangular fibrocartilage complex. Arthroscopy : the journal of arthroscopic & related surgery : official publication of the


Poster 186: Effect of Sarcopenia on the Functional Outcome after Surgery for Distal Radius Fractures

Category: Wrist

Treatment; Prognosis/Outcomes
Level 2 Evidence

Young Hak Roh
Hyun Sik Gong, MD
Goo Hyun Baek

Hypothesis
Sarcopenia, the loss of skeletal muscle mass and consequent loss in muscle function associate with aging, is common in the elderly and is associated with adverse health outcomes such as disability, falls and fracture. However, the clinical significance of sarcopenia on outcomes after orthopedic surgery has not yet been well investigated. This study compares the functional outcomes after surgery for distal radius fracture (DRF) in patients with or without sarcopenia.

Methods
Forty-two patients with sarcopenia and DRF treated with volar plate fixation were matched for age and sex with 42 control patients without sarcopenia. The researchers conducted functional assessments (wrist range of motion, grip strength, and Michigan Hand Questionnaire [MHQ]) 6 and 12 months after surgery, and radiographic assessments (radial inclination, volar tilt, ulnar variance, and articular congruity) 12 months after surgery.

Results
The sarcopenic group showed a significantly lower recovery of grip strength than that of the control group, and the recovery of MHQ score was significantly greater in the control group than in the sarcopenic group throughout 12 months. There was no significant difference in the range of motion between the groups. The radiologic outcomes showed no significant difference between the groups in terms of volar tilt, radial inclination or ulnar variance.

Summary Points
- Sarcopenic patients are at risk for poor functional recovery after surgery for DRF compared with age and sex matched controls, even when they have similar radiologic outcomes.
Bibliography


Images
Poster 188: Reproducibility of Three Dimensional Digital Preoperative Planning for the Osteosynthesis of Distal Radius Fractures

Category: Wrist

Treatment; Surgical Technique; Anatomy
Level 4 Evidence

Yuichi Yoshii, MD
Yasukazu Totoki
Takuya Kusakabe
Tomoo Ishii

Hypothesis
A three-dimensional (3D) digital pre-operative planning system for the osteosynthesis of distal radius fractures was developed. We hypothesized that the use of 3D digital planning is useful to reproduce the reduction shape and the implant placement for the fracture management. The objective of this study was to evaluate the reproducibility of 3D planning for the osteosynthesis of distal radius fractures by comparing pre- versus post-operative reduction and implant placement.

Methods
Twenty wrists of 20 distal radius fracture patients who underwent osteosynthesis using volar locking plates were evaluated. The 3D preoperative planning was performed prior to the surgery. Referring to the un-injured wrist X-ray, the reduction was simulated with 3D image. The implant choice and placement also simulated on the 3D image. During the surgery, the operator performed the reduction and the placement of the plate while comparing images between the pre-operative plan and fluoroscopy. The screw sizes were determined by intraoperative measurement in reference to the preoperative plan. Preoperative planning and postoperative reductions were compared by measuring volar tilt and radial inclination of the 3D image. In addition, implant placement in the preoperative planning and postoperative results were compared by measuring distance from articular surface of distal radius to the distal edge of locking plate, center locations of the plate at distal and proximal screw levels. Intra-class correlation coefficients (ICCs) of the volar tilt, radial inclination, and implant placement were evaluated.

Results
The results of volar tilt were 11.4+/-2.7 degrees and 10.8+/-2.8 degrees in the preoperative planning and postoperative 3D images, respectively. The results of radial inclination were 21.6+/-3.9 and 21.3+/-3.0 in the preoperative planning and postoperative 3D images, respectively. The
ICCs were 0.64 (P<0.01) and 0.62 (P<0.01) for the volar tilt and radial inclination, respectively. For the implant placement, the ICC for the distance from articular surface to the distal edge of the plate was 0.63 (P<0.01). The ICCs of the center locations of the plate were 0.22 (P=0.17) and 0.19 (P=0.21) for the proximal and distal screw levels, respectively.

**Summary Points**

- Significant correlations of the volar tilt and radial inclination for the pre- and post-operative 3D images were observed.
- 3D preoperative planning provides good reproducibility of reduction shape. On the other hand, there is room for improvement in the implant placement.
- Three dimensional digital preoperative planning was useful for the visualization of reduction for the osteosynthesis of the distal radius fractures.
Poster 189: A radiocarpal ligament reconstruction using brachioradialis for isolated and traumatic ulnar translation of the carpus: showed new technique and a case report.

*Category: Wrist*

Evaluation/Diagnosis; Treatment; Surgical Technique
Level 4 Evidence

Marcio A. Aita, MD
Gustavo Mantovani Ruggiero, MD
Rafael Saleme Alves, MD
Daniel Schneider Ibáñez

**Hypothesis**
Is possible ligament reconstruction in treatment the ulnar translation?
Could this technique avoid arthrodesis, arthritis, stiffness?

**Methods**
Inclusion criteria were age older than patients in the Ambulatory Surgery of the Hand this Institution, diagnosed with ulnar translation of the carpus

Study Design: Case report and describe the new technique.

These patients do surgical treatment using the BR tendon graft for reconstruction of the ulnar translation of the carpus

Dorsal and radial approach longitudinal major 10 cm in the affected forearm

Dissection of the subcutaneous tissue plane, the radial artery and the radial nerve in his sensory branch

Visualization and dissection BR tendon from its insertion on the styloid radius until its transition miotendinous closely forearm. Not detaching it in any way.

The work-up tunnel oblique radius proximally and distally in the scapho’s radius fossa with specific drill, under indirect fluoroscopy view.

It also prepares the tunnel scaphoid, dorsal to palmar and the capitate, dorsal to palmar.

Put of the tendon graft through the tunnel radial scaphoid and capitate using specific guide wire.

Graft fixation with 2 specific anchors, one scaphoid and another in the third metacarpal, straining the system in order to stabilize the carpal bones.

Perform the radial and ulnar deviation and observe the correct position of the carpal bones, to guarantee the stability of this joint.

Fixation of the wrist with transarticular external fixation with two pins Schantz in radius and two in the
third metacarpal.
Achievement of hemostasis, cleaning and suturing in layers of surgical approach the radius and ulna and occlusive dressing
After the procedure, patients must remain immobilized with an external fixator for 8 weeks. Subsequently, we should perform rehabilitation in occupational therapy.

Results
After 12 months by procedure the patient showed range of motion of the 70° flexion, 50° extension, 20° of radial deviation and ulnar deviation of 30°. Forearm and fingers full mobility. The correction of ulnar translation was complete and, so far, no clinical signs nor radiographic joint arthritis. DASH score was 5, VAS was 0 and the grip strength was 82% of the unaffected side.

Summary Points
- Our opinion is that radiolunate arthrodesis should be reserved for patients
- with signs and symptoms of osteoarthritis
- The method is safe, but the stability obtained and the clinical and functional results were satisfactory to the patient, improving
- their quality of life.

Bibliography

Images
Poster 190: 2 Year Clinical and Radiographic Outcomes of Aptis Distal Radioulnar Joint Arthroplasty

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Patrick Brannan, MD
Alan Ward, MD
R. Glenn Gaston, MD
Chris Chadderdon, MD
Julie Colantoni, MD

Hypothesis
The purpose of this study is to evaluate the two year clinical and radiographic outcomes of patients diagnosed with arthritis and/or instability of the distal radioulnar joint (DRUJ) that underwent a total distal radioulnar joint (APTIS) arthroplasty.

Methods
Retrospective analysis was performed on a consecutive series of patients with minimum two year follow up. A database query was performed based upon ICD-9 codes for distal radioulnar joint arthritis/instability. Included were patients with greater than two years of follow up. The primary outcome variable was implant survival with implant loosening or revision as endpoint. Quantitative secondary outcome variables included Visual Analog Scales (VAS), Disability of the Arm, Shoulder and Hand (DASH) scores, Patient Rated Wrist Evaluation (PRWE), and Mayo Wrist Scores. Clinical outcome data points including range of motion, grip/pinch strength, and torque were measured at follow up and compared to the nonoperative extremity. Radiographic data including DRUJ morphology and complications related to the prosthesis were assessed. This included ulnar stem lucency, loosening, pedestal formation, osteolysis, and perforation. The radial component was assessed for screw malposition, cap/screw loosening, peg lucency, and plate malposition.

Results
20 patients (13 female, 7 male) with a mean age of 57 years were assessed at mean of 41 months follow up (range 23-72 months). 12/20 previously underwent elbow/wrist procedures. No patients required component revision. One patient underwent reoperation secondary to refractory tenosynovitis of the 5th dorsal compartment. Post operative VAS scores were 2.0 and 3.8 for rest and activity, DASH score was 32.9, PRWE score was 58.4 (Pain 23.7, Function 34.7), and Mayo wrist score was 63. No patients had post operative DRUJ instability. Post operatively,
range of motion was assessed for flexion, extension, radial/ulnar deviation, and pronation/supination. There was no statistically significant difference in wrist flexion/extension, ulnar deviation, and supination compared to the nonoperative extremity. Pronation differed from the nonoperative extremity by a mean of 6 degrees. 4/20 patients had radiographic lysis around the collar of the ulnar component (20%). There was no progressive lucency, loosening, or pedestal formation surrounding the ulnar component. 1/20 radial plates was malpositioned and showed evidence of screw loosening. There was no evidence radial peg lucency or cap loosening.

Summary Points
- There were no revisions in a two-year cohort of patients undergoing DRUJ arthroplasty
- Established outcome measures yielded satisfactory clinical results
- Intermittent radiographic osteolysis surrounding the ulnar collar had no bearing on clinical outcomes

Bibliography
Images
Poster 191: Distal Radioulnar Joint Outcome Following Galleazzi Lesions: 11 Years Follow Up

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Pablo De Carli, MD
Jorge Boretto, MD
Agustín Donndorff, MD
Veónica A. Alfie, MD
Gerardo L. Gallucci, MD
Eliana Petrucelli, MD

Hypothesis
To evaluate clinical, radiological and tomographic long-term evolution of the distal radioulnar joint (DRUJ) in Galeazzi lesions treated with open reduction and internal fixation of the radius component and indirect reduction of DRUJ dislocation.

Methods
We retrospectively evaluated patients with Galeazzi lesions. Inclusion criteria were: patients older than 18; treated with anatomical Open Reduction and Internal Fixation of radial fracture, nonsurgical reduction of DRUJ dislocation and more than 6 years follow up.
We evaluated pain using the Visual Analog Scale (VAS) and Swanson Scale; function was assessed by DASH score. Wrist range of motion was measured with a manual goniometer and grip strength with a Jamar Dynamometer, both bilaterally. DRUJ piano key sign was tested bilaterally with the wrist in neutral rotation, maximum pronation and maximum supination.
Bilateral AP and lateral X-rays were taken at final follow-up; ulnar dorsal subluxation was measured with respect to the radial axis on lateral X-rays. Radial shortening was evaluated measuring bilateral ulnar variance. DRUJ arthritis was classified following Knirk and Jupiter’s scale.
CT scans of both wrists were taken in three positions – neutral rotation, supination and pronation. On the axial slices, distal radioulnar joint subluxation was evaluated using the Mino and radioulnar ratio methods. DRUJ arthritis signs were recorded.

Results
Fourteen patients met the inclusion criteria; average follow-up was 11.5 years (6 to 18). Twelve were male and the mean age was 38 years (18 to 59).
The final evaluation revealed nine patients without pain; three had pain with heavy tasks, and two with moderate efforts. Final pain intensity according to the VAS was on average 0.3 (0 to 3). Average DASH was 3 (0 to 9).

Wrist flexion-extension was 98%, lateral deviation 95% and pronosupination 97%; grip strength was 77%. Three patients had clinical instability, but none produced pain.

Final X-rays showed one patient with dorsal radioulnar subluxation. However, CT scans showed no cases of DRUJ subluxation. The average final ulnar variance was 0 mm on the injured side and -0.5 mm on the contralateral wrist.

Six patients had radiologic arthritis grade II and two had grade I. The remaining six patients had no signs of arthritis either in X-rays or CT scans.

**Summary Points**

- Clinical and radiological long-term results showed a stable DRUJ.
- Even when almost half of the patients had secondary arthritic changes, they had no significant subjective or objective clinical repercussions.

**Bibliography**

Poster 192: Early results of combined treatment of extensor carpi ulnaris instability and triangular fibrocartilage complex injuries in patients with distal radio-ulnar joint instability

Category: Wrist

Evaluation/Diagnosis; Treatment
Level 4 Evidence

Ellen Lee, MD
David M. K. Tan, MBBS, MRCS

Hypothesis
TFCC repair alone is not enough to address DRUJ instability in patients with TFCC injury and ECU instability.

Methods
Fifteen patients with DRUJ instability, periphreal TFCC tears, and ECU subluxation failed to regain satisfactory function after an average of six months of therapy. There were ten males and five females with an average age of 28 years-old. They were managed with arthroscopy, open TFCC repair or thermal shrinkage, and ECU subsheath reconstruction. We compared their pre-operative pain, range of motion, grip strength and Mayo Modified Wrist Score (MMWS) to post-operative values at their most recent clinic review. Their follow-up period ranged from 3.5 months to 2 years (average 10 months) after surgery.

Results
All patients were pain free at most recent review. Pre—operative and post-operative range of motion was recorded in 12 patients, 9 of which had improved. Grip strength was improved in 8 of 10 patients. The two patients with weak grip were 4 months post-operative and still undergoing therapy for strengthening. Pre-operative MMWS could be computed in 9 patients. The average score was fair at 69 points. All 9 patients had prospectively collected parameters to compute for the post-operative MMWS. This improved to an average of 93 points. The average post-operative MMWS for all 15 patients in this study was 92 points. Two patients who were four months post-operative had ECU adhesion. This presented as limitation of wrist flexion and radial deviation and was addressed by stretching during therapy.

Summary Points
- Reported re-operation rates for DRUJ instability after TFCC repair are 12 to 17 %.
  Authors postulated that this is related to inadequacy of repair and most patients went on to DRUJ ligament reconstruction.
• We surmise that TFCC repair alone may not be always sufficient in restoring DRUJ instability; hence it is important to restore all anatomic stabilizing structures across the DRUJ, instead of just repairing the TFCC alone.
• We started reconstructing the ECU subsheath in addition to TFCC repair or thermal shrinkage in our group of patients who had DRUJ instability with concomitant TFCC injury and ECU instability and failed average of 6 months of therapy.
• Addressing ECU subluxation with TFCC injury allowed our patients with DRUJ instability to return to their pre-injury level of function.

Bibliography
5: MacLennan et al. Diagnosis and anatomic reconstruction of extensor carpi ulnaris subluxation. J Hand Surg 2008;33A:59-64
Images
Poster 193: Comparison between dynamic compression plate and locking plate in osteotomy for Kienbock’s disease

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Michio Sano, MD, PhD
Tomokazu Sawada, MD, PhD
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Hypothesis
Whether dynamic compression plate (JMM-KYOCERA OSR plate) could hasten bone union after radius osteotomy for Kienbock’s disease in comparison with locking plate.

Methods
During 2011 and 2016, We performed radius shortening wedge osteotomy for Kienbock’s disease in 8 hands of 8 patients. The patients consisted of 4 males and 4 females. Their average age was 46.1 years old. The follow up period ranged from 6 to 39 months. The Lichtman classification revealed five Stage3a cases and 3 were 3b. After the shortening wedge osteotomy, the radius was fixed with locking plate in 5 patients (Synthes LCP-T plate;3, Japan Unitec Stellar I plate;2) and dynamic compression plate in 3 patients. The bone union was evaluated using plain X ray film, when bridging callus was confirmed both sides of radial cortex in both A-P view and lateral view. The statistical analysis was performed using non-parametric method (Mann-Whitney U test).

Results
The bone union was confirmed at 5.9 ± 1.9 months after surgery with locking plates, while it was 2.5 ± 0.5 with compression plates.(p<0.05) Four patients treated with locking plates required LIPUS application for promoting bone union, in contrast to no patients requiring additional treatment in compression plate group. We considered that dynamic compression plate was more useful than the ordinary locking plates because of the accelerated bone union and for no LIPUS necessity.

Summary
- Dynamic compression plate (JMM OSR plate) is very useful for the fixation of radius after osteotomy for Kienbock’s disease.
Poster 194: Distal Radius Union Score (DRUS) Improves Interobserver Reliability in Radiographic Assessment of Fracture Healing

Category: Wrist

Evaluation/Diagnosis;Treatment;Prognosis/Outcomes
Level 4 Evidence

Nima Kabirian, MD
Ram Kiran Alluri, MD
Gabriel Bouz, BS
Alidad Ghiassi, MD

Hypothesis
Previous radiographic scoring systems for diaphyseal fractures of the tibia and humerus have shown reproducible results among different observers. The purpose of this study was to assess if a novel scoring system has reproducible reliability in assessing distal radius fracture healing.

Methods
Posteroanterior (PA), oblique and lateral plain radiographs of 32 consecutive operatively treated distal radius fractures stabilized with a radiolucent carbon fiber volar plate (CarboFix Orthopaedics, NC, USA) were retrospectively reviewed.
A score of 1 to 3 was assigned to “Fracture Line”, “Bridging Callus”, and “Metaphyseal Trabecular Disruption.” (Figure 1)
A cumulative score of 9 (no union) to 27 (complete union) was summated from the above 3 scores for each fracture at 2, 6, and 12-weeks postoperatively by two independent observers. Each observer repeated the scoring 2 weeks after initial review. Inter- and intraobserver reliability of the DRUS scores were analyzed. We also assessed for progression of fracture healing by comparing the average summed score across each time point.

Results
The average DRUS score for each variable increased significantly from 2 to 6 weeks and from 6 to 12 week (p < 0.0001). (Table-1)
Pearson’s coefficient showed excellent overall (all variables, all time points) intraobserver (r= + 0.90) and interobserver (r= + 0.84) correlation.

Summary Points
- Our preliminary results demonstrate that the Distal Radius Union Scoring (DRUS) system has excellent inter- and intraobserver reliability.
• DRUS can be used to assess distal radius fracture healing as an adjunct to clinical examination or in future comparative research studies assessing fracture healing.
**Poster 195: Headless Screw Fixation of Metacarpal Neck Fractures: a Biomechanical Comparative Analysis**

*Category: Wrist*

Treatment; Surgical Technique; Basic Science

N/A - not a clinical study

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Eric Padegimas, MD  
Nicole Weikert, MS  
Samuel Greulich, BS  
Asif M. Ilyas, MD  
Sorin Siegler, PhD

**COI**

Other: Medartis provided the implants, cutting jigs, and engineering support for this study

**Hypothesis**

The purpose of this study is to evaluate the mechanical properties of headless compression screw (HCS) fixation of a metacarpal neck fracture compared to K-wire cross-pinning and locking plate fixation. We hypothesize that headless compression screw fixation will demonstrate sufficient stability in a biomechanical model of a metacarpal neck fracture.

**Methods**

A metacarpal neck fracture model was created in 30 fourth generation composite Sawbones by removing a volar-based wedge using a custom jig to simulate a typical apex-dorsal fracture, unstable in flexion. The models were divided into three equal group according to the method of fixation: retrograde cross-pinning with two 1.2mm K-wires (KW), 2.0mm dorsal T-plate with six 2.0mm locking screws (LP), and 3.0mm retrograde HCS. Models were potted at the base and mounted vertically in a materials testing machine, employing a cable tensioned over the metacarpal head to simulate forceful grip. Cyclic loading to 40N (simulating finger active range of motion exercises) and failure testing were performed. Load, displacement, and failure mode were recorded.

**Results**

Average final stiffness of the HCS (7.3±0.7N/m) was significantly greater than the KW (5.8±0.5N/m), but significantly less than the intact bone (9.6±0.8N/m) and LP (9.5±1.9N/m). With cyclic loading to 40N, the LP exhibited significantly less displacement (0.2±1.3mm) compared to the HCS (2.5±2.3mm) and KW (2.8±1.0mm). Load to failure for the HCS...
(215.5±39.0N) was non-significantly lower than the KW (279.7±100.3N) and significantly lower than the LP (267.9±44.1N).

**Summary Points**
The HCS provided comparable mechanical properties to KW against a physiologic cyclic loading simulating an early active range of motion protocol. While the LP construct allowed significantly less displacement and had the highest strength, this benefit should be weighed against the more extensive surgical dissection required.

**Bibliography**

Images
Poster 196: Radiographic Analysis of Proximal Pole Scaphoid Fractures

Category: Wrist

Treatment; Surgical Technique; Anatomy
N/A - not a clinical study

Timothy J. Luchetti, MD
Youssef Hedroug
Bonnie P. Gregory
John J. Fernandez, MD
Mark S. Cohen, MD
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Hypothesis
Proximal pole scaphoid fractures represent a challenging surgical problem for hand specialists. Optimal screw orientation remains unclear with few studies focusing specifically on this aspect of the procedure. Authors have hypothesized that maximizing purchase in the proximal fragment is the key to optimal fixation. The purposes of this study were (1) to describe radiographic parameters of proximal pole scaphoid fracture plane morphology, (2) to describe the ideal starting point of an eccentrically placed screw for antegrade insertion to achieve maximal purchase in the proximal fragment, and (3) to measure the maximum screw length possible for this trajectory.

Methods
All patients treated through our practice for a scaphoid fracture over an eight-year period. All proximal pole scaphoid fractures were included. Computed tomography (CT) imaging was analyzed. A grid system was applied, and fracture morphology was characterized on coronal, sagittal and scaphoid planar views, when available. The ideal starting point, trajectory, and available length for screw placement perpendicular to the fracture line were then established.

Results
The fracture inclination was on average 24.8° +/- 9.9° extended from the long axis of the scaphoid in the sagittal scaphoid view, and 33.0° +/- 9.8° extended from the long axis of the scaphoid in the sagittal view. The screw trajectory should be 9.0° +/- 15.9° radially inclined to the long axis of the scaphoid in the frontal plane (similar to the axis of the forearm). The ideal starting point of a screw is between 9.8mm +/- 1.3mm proximal and volar on the surface of the proximal pole. This allows for a maximum screw length of 21.3mm +/- 2.4mm.
**Summary Points**
Trajectory for screw placement in proximal pole scaphoid fractures should be adjusted by approximately 33.0° ± 9.8° degrees of extension from a line perpendicular to the scaphoid axis on the lateral intraoperative x-ray. The ideal starting point of a screw should be 9.8mm ± 1.3mm proximal to the fracture line when viewed from a dorsal approach to the wrist. These measurements will serve as guidelines for surgeons as they attempt to maximize purchase in the proximal pole of the scaphoid bone to achieve the most stable fixation and to promote fracture healing.

**Bibliography**
Images
Poster 197: Minimal clinically important difference of Patient-rated outcome instruments in distal radial fracture

Category: Wrist

Evaluation/Diagnosis
Level 2 Evidence

Chang-Hun Lee, MD
Kwang-Hyun Lee, MD
Joo-Hak Kim
Sung-Jae Kim, MD
Wan-Sun Choi, MD

Hypothesis
The purpose of this study is to determine the minimal clinically important difference (MCID) of Disability of shoulder, arm, and hand (DASH) and Patient-rated wrist evaluation (PRWE) in the patients with the fracture of distal radius.

Methods
161 patients treated with volar locking plate for the fracture of distal radius were evaluated between August 2014 and August 2016 in our clinic. Among these patients, the one who completed the two patient-rated outcome instrument (DASH, PRWE) and anchor questionnaire at consecutive outpatient visits were enrolled. Anchor questionnaire is indicating the degree of clinical change that patient was perceived since the previous visit. The patients with the fracture of distal radius were asked to visit the outpatient department 1 month, 2 months, 3 months, and 6 months after the operation. The patients were categorized in three groups according to the anchor questionnaire: (1) no change or (2) minimally improved or (3) markedly improved. Difference of the two patient-rated outcome instrument were used for calculating an anchor-based receiver operator characteristic curve. Minimum detectable change was also calculated as distribution based approach. We determined the MCID of DASH and PRWE in reference to the cut-off value from ROC curve and minimum detectable change.

Results
The MCID of the DASH was 9.3 points. The area under the curve was 0.78 (95% CI, 0.6-0.95). The MCID of the PRWE was 17.75 points. The area under the curve was 0.82 (95% CI, 0.68-0.96). Using the cut-off value, the sensitivity of the MCID is 91.3% for DASH and 70% for PRWE. The specificity of these MCID is 61.5% for DASH and 92.3% for PRWE respectively.
Summary Points

• We determined the MCID of the DASH and PRWE for the patients with distal radius fractures using anchor-based and distribution-based approaches.
• These values can be used when evaluating the effects of treatment or calculating sample size on studies of distal radial fractures.

Bibliography


Images
Poster 198: A Comparison of Direct Perioperative Costs in the Treatment of Unstable Distal Radius Fractures: ORIF versus CRPP

Category: Wrist

Treatment; Prognosis/Outcomes
Level 4 Evidence

Grant received from: The Hand Research and Education Endowment Fund

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Hypothesis
With an increased focus on value based healthcare and bundled payments, a better understanding of healthcare costs and resource utilization is paramount. The financial impact of the trend toward open reduction and internal fixation (ORIF) for management of distal radius fractures (DRF) has not been clearly established. We hypothesize that ORIF for closed, displaced, unstable DRF is associated with greater direct perioperative costs than closed reduction percutaneous pinning (CRPP).

Methods
We performed a retrospective review of 37 patients from one institution with closed, displaced, unstable DRF who had previously been randomized to CRPP or ORIF. Study groups were compared based upon patient characteristics, hospital direct costs, post-operative care and therapy costs, and additional procedure costs. All cost data was reported utilizing cost ratios (CR) relative to the CRPP cohort. Statistical analysis was performed with chi-squared analysis and independent sample T tests with a discriminatory alpha level <0.05.

Results
Seventeen patients underwent CRPP and 20 underwent ORIF with volar plating. There were no significant differences in emergency room or preoperative clinic costs between groups. The ORIF cohort incurred greater total perioperative costs than the CRPP cohort (CR 2.7/1.0, p<0.001). The perioperative costs were subcategorized into operating room (OR) fee (CR 1.7/1.0, p<0.001), OR implants, and anesthesia costs (1.8/1.0, p<0.001), which were all significantly greater in the ORIF cohort. However, there were no significant differences with regards to perioperative recovery stay, pharmacy, or radiology costs. Similarly, both study cohorts incurred comparable postoperative occupational rehabilitation and cast technician costs (ORIF 0.88/CRPP 1.0, p=0.69).
The ORIF cohort was associated with lower postoperative clinic costs when compared to the CRPP cohort (0.5/1.0, p=0.004). One ORIF patient and four CRPP patients required a second procedure (CR 0.62/1.0, p=0.14) for pin removal, while one CRPP patient required a third procedure for pin removal. Overall, patients who underwent ORIF incurred greater direct costs (1.6/1.0, p<0.001), with implant costs carrying the greatest contribution.

**Summary Points**
- Patients treated with ORIF for, displaced, unstable DRF’s incurred greater direct costs than those who underwent CRPP.
- The implant costs associated with ORIF provided the greatest cost contribution, even after the consideration of additional procedures in the CRPP cohort.
- As the focus on value based healthcare and optimal health care resource utilization increases, surgeons should be aware of the perioperative direct costs associated with ORIF.
- Indirect costs, such as return to work and daily activities, were not evaluated in this study and merit further analysis.

**Bibliography**

Images
Poster 199: Arthroscopic anatomy variants

*Category: Wrist*

Basic Science; Residents/Fellow/Educator Resources
N/A - not a clinical study

Vera Resende
Artur Neto
Pedro Atilano Carvalho

**Hypothesis**
Arthroscopy is a useful tool for diagnosis and treatment for the orthopaedic surgeon. It is technically demanding and requires a thorough knowledge of normal anatomy and its variants.

**Methods**
Review of normal arthroscopies records.

**Results**
We found numerous variations between individual patients undergoing arthroscopy of the wrist. The possibility of visualizing the interior of a joint, has added significantly to our knowledge of the anatomy and pathological mechanisms. However, arthroscopy and arthroscopic surgery are not compatible with beginners, even with their willingness. To initiate the arthroscopic surgery, it is necessary to have reasonable training in all aspects of arthroscopic surgery. This is a universal truth that those who undertake the arthroscopy perfectly know and respect.

**Summary Points**
- The arthroscopic anatomy is highly variable. Our findings may help to understand why the need for a deep knowledge of normal anatomy and its variants for understanding the joint pathology
Poster 200: Hairline fractures following volar plating of the distal radius: a new hardware-related complication

Category: Wrist

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Hila Otremski
Oleg Dolkart
Tamir Pritsch, MD
Dan Hutt
Yishai Rosenblatt
Franck Atlan

Hypothesis
Intraoperative hairline longitudinal fractures were recently reported in association with distal radius volar plating. Our aim was to further analyze this newly described complication.

Methods
A retrospective radiographic and chart review was performed on 225 patients who underwent distal radius plating between 6/2013 and 6/2015. The Acu-Loc/Acu-Loc2© plating system (Acumed, Hillsboro, OR) was used in 208 cases, and the VariAx© plating system (Stryker, Kalamazoo, MI) was used in 17 cases. Three independent reviewers performed a blind evaluation of all relevant radiographs for the occurrence of longitudinal fractures around the plate, and validity was considered only when there was agreement between all three of them.

Results
Hairline longitudinal fractures were identified in 57 cases (25%), 55 with the Acu-Loc/Acu-Loc2© system and 2 with the VariAx© system. All fractures occurred with volar plating. Fracture occurrence was associated with age over 59 years, female gender, extra-articular fractures, and the use of Hexalobe screws.

Summary Points
- We believe that the source of fracture occurrence lies within the screw design and that better screw design and possibly tapping in cases at risk may reduce the occurrence of intraoperative hairline longitudinal fractures.
- Further clinical and biomechanical research is needed to better understand this newly reported complication.
Bibliography
Images
Poster 201: Readmission Rate After Distal Radius Fracture

Category: Wrist

Prognosis/Outcomes
Level 4 Evidence

Kirsten A. Sumner
Louis C. Grandizio, DO
Joel C. Klena, MD
Max Gehrman
Jove Graham, PhD

Hypothesis
The purpose of this study is to define the incidence of 30-day readmission and unscheduled healthcare contact after distal radius fracture (DRF). In addition, we aim to define risk factors for 30-day readmission and unscheduled healthcare contact (UHC). We hypothesized that readmission rates would be low and that readmissions and UHC may be related to coping skills.

Methods
A retrospective review of all patients 18 years of age and older who sustained a DRF during a two-year period (2013-2014) and who presented to a rural Level 1 trauma center was performed. We recorded baseline demographics, fracture characteristics and treatment for all patients. Any UHC (phone call, email, or clinic visit outside of routine follow-up) or readmission (including ED visits) was documented. Reasons for readmission and UHC were further stratified to determine if contact or readmission was related to the fracture. We utilized a case-control design comparing patients readmitted within 30 days after DRF and those who were not readmitted as well as patients with and without UHC. Chi-square or Fisher’s exact tests, where appropriate, were used to compare percentages between the two groups, and Student-t tests were used to compare means of continuous variables.

Results
353 patients were identified. 23 patients (7%) were readmitted within 30 days, 8 (2%) for reasons related to their fracture. 73 patients (20%) had UHC within 30 days. The most frequent type of UHC was a phone call (47% of patients) and the most frequent reason for contact was issues related to pain medication (38%) followed by cast problems (18%) and swelling (12%). Patients with anxiety or depression were more likely to be readmitted (39% of readmitted patients vs 16% of non-readmitted patients P=0.01) as were patients with open fractures (13% vs 3%, P=0.05). Patients with any UHC within 30 days were younger (54 vs. 60 years, P=0.02), more
likely to have depression or anxiety (29% of patients with UHC vs 15% of those without, P=0.006) and were more likely to have undergone operative treatment (69% vs 52%, P=0.01).

Summary Points
- For patients sustaining DRF, we report a 30-day readmission rate of 7% (2% related to fracture care), with 20% of patients having UHC during this period.
- Patients with depression or anxiety were more likely to be readmitted or to have UHC.
- Identifying risk factors for readmission during initial presentation, including psychiatric comorbidities, may help reduce readmissions.
- Improving pain-control strategies early may aid in decreasing the burden of UHC.

Bibliography
Poster 202: Treatment Trends and Complications of Distal Radius Fractures: Does Age Matter?

Category: Wrist

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

N/A - not a clinical study

William Mosenthal, MD
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Hypothesis
This study sought to elucidate the impact age, fracture type, and patient comorbidities have on the current treatment of DRFs and risk of complications. We hypothesized that comorbidities rather than age would relate to the risk of complications in the treatment of DRFs.

Methods
A retrospective review of data from commercially insured patients was performed using Truven Health Marketscan® Research Databases, a national, de-identified database of approximately 55 million Americans from 2003-2014. The association between patient demographic and comorbidities with complication rates was analyzed using logistic regression models. Variables in our univariate analysis found to have a p<0.05 were included in our multivariate logistic regression analysis.

Results
A total of 155,353 DRFs were identified between 2003-2014. Of the examined age groups, the greatest number (39,718 or 26%) of DRFs occurred in the 50-59 age group with females accounting for a greater proportion of DRFs than their male counterparts in all age groups older than 40 years. Closed treatment predominated in all age groups with the highest percentage of open treatment occurring in the 50-50 age group. Between 2007-2014, an increase in the rate of ORIF of DRFs in all age groups under the age of 90 was observed with the largest increase (11%) occurring in the 70-79 year old age group. Sub analysis of non-closed treatment over the same time period revealed a 12% increase in the rate of open treatment of intraarticular DRF with internal fixation of three or more fragments and a 17% decrease in the rate of percutaneous fixation. A significantly higher complication rate was observed in the open treatment group in all ages less than 90 with a trend towards decreasing complication rates in the open treatment group as age increased. Multivariate logistic regression analysis revealed diabetes, CKD, osteoporosis, obesity, tobacco use, depression, CHF and hypertension to be significant
independent risk factors for development of post-treatment complications. Age of the patient was not a significant independent risk factor for development of post-treatment complications.

Summary Points
• DRFs occur predominantly in the elderly, female population.
• While closed treatment of DRFs is the predominant treatment method among all age groups, they are increasingly being treated with ORIF.
• Emphasis on the patient’s comorbidities rather than chronological age should be considered in the treatment decision-making process of elderly patients with DRFs.

Bibliography

Images
Poster 203: Electrodiagnostic Findings in Asymptomatic Patients After Acute Fixation of Distal Radius Fractures with a Volar Locked Plate

Category: Wrist

Evaluation/Diagnosis; Treatment; Patient Education
Level 2 Evidence

Stephen Y. Liu, MD

Hypothesis
Acute fixation of isolated distal radius fractures with volar locked plating does not result in electrodiagnostic changes of the median or ulnar nerves

Methods
This is a prospective cohort study of fourteen asymptomatic patients who underwent open reduction and internal fixation (ORIF) of an isolated distal radius fracture with a volar locked plate. All patients were operated on within 2-weeks of their injury. On the day of surgery and at their 6-week follow-up, patients were evaluated by history, clinical exam, quickDASH, and nerve conduction studies using a hand-held device - ADVANCED-NCS (NeuroMetrix; Waltham, MA). Data was collected prior to surgery and 6-week post-operatively. The comparison between pre-operative and post-operative nerve function was assessed using a 2-tailed student t-test for each nerve. The latency values were assessed for correlation to the quickDASH using the Pearson coefficient. Significance was set to p < 0.05.

Results
The average patient was 54.1 years of age (range 20-73). The average time from injury until surgery was 9.85 ± 3.9 days. No patient reported changes in sensation pre-operatively and all patients could detect 2-pt discrimination of six to eight mm. Eight of the fourteen (57%) patients had NCS evidence carpal tunnel syndrome (CTS) pre-operatively when using a distal sensory latency cutoff of 3.5ms. No patient met CTS criteria using a distal motor latency cutoff <4.5ms. The nerve conduction velocities are shown in Table 1. QuickDASH was most strongly correlated with relative change in motor latency (r = 0.465).

Summary Points
- Acute open reduction and internal fixation of distal radius fractures may lead to increased distal motor latencies in the median and ulnar nerves, however, it is unclear if these changes are clinically significant
- There were no significant differences in distal sensory latency before and after ORIF
- Patient reported symptoms and clinical exam findings do not correlate strongly with NCS
• QuickDASH correlates poorly with NCS with the exception of change in distal motor latency
Poster 204: Normative data for the Patient-Rated Wrist Evaluation

Category: Wrist

Prognosis/Outcomes
Level 3 Evidence

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Hypothesis
To evaluate whether patients have returned, or at least come closer, to pre-injury ranges of functioning, it is important to know the population-based normative data. Normative data for a few patient reported outcome measures have been determined, however the normative data for the PRWE are unknown. Therefore, the aim of our study was to determine the normative data for the PRWE questionnaire. Secondary, we aimed to determine if there were factors influencing these normative data.

Methods
A cross-sectional prospective study of adult visitors and employees of four hospitals in the Netherlands was performed. Excluded were all participants who were scheduled for surgery or who were currently being treated in treatment or after-treatment of an injury of the wrist or hand within one year after trauma. All participants were asked to complete the PRWE questionnaire and were asked about their age, gender, history of wrist or hand injuries or surgery, daily activities, and type of employment. Furthermore, the socioeconomic status was determined based on the zip code of the participants. Due to the non-parametric distribution, the PRWE score was presented as median and interquartile range [IQR]. Additionally, the mean and standard deviation (SD) were provided to show the variability of the whole population and to allow comparison with other studies.

Results
A total of 1042 participants were included. The median PRWE score was zero [IQR 0 – 8.5] and the mean score 7.7 (SD 15.0), with a range of zero to 97. Women had a significantly higher PRWE scores compared to men (median zero [IQR 1 – 10.5] and mean 8.6 (SD 15.9) versus median zero [IQR 0 – 6.1] and mean 6.5 (SD 13.6); p=0.014). Moreover, the PRWE score increased significantly with age (correlation coefficient 0.084; p=0.007). Participants who had a history of a
wrist or hand fracture or surgery and participants who were unfit for work had a significant higher PRWE score compared to participants who performed other daily activities (both p<0.001). The socioeconomic status was not correlated with the PRWE score.

Summary Points
• The normative value of the PRWE in the general population has a median of zero [IQR 0 – 8.5] and a mean of 7.7 (SD 15.0).
• This normative value increases with age, is higher in women and in individuals who had a history of a fracture or surgery of the wrist or hand, or who are unfit for work.

Bibliography

Images
Hypothesis
The purpose of our study is to analyze patients younger than 65 years old with complete articular distal radius fracture (DRF) treated by internal fixation with volar locked plate with a minimum of six years of follow-up.

Methods
A retrospective review was performed during a 6 years’ period. The inclusion criteria were patients with complete articular DRF (AO type C), between 18-65 years old at the time of treatment treated by internal fixation with a volar locked plate, and with a minimum of 6 years of follow-up. We excluded patients with radio-carpal dislocations or patients that required additional fixation.

Clinical evaluation was performed. Active range of motion of the wrist in flexo-extension, radial and ulnar deviations and pronation and supination were measured. Grip strength was measured with a dynamometer. Both AROM and grip strength were measured bilaterally and compared with the healthy side. Radiographic extra-articular and intra-articular parameters were measured pre and postoperatively. Osteoarthritic changes were analyzed according the Knirk-Jupiter classification. At the last follow-up, the modified Mayo wrist score was recorded. The patient-reported outcomes were also evaluated with the DASH questionnaire, the PRWE score and the visual analogue scale (VAS) pain score. Complications were recorded. Statistical analysis was performed.

Results
Thirty-three patients were included. The mean age was 49 (range 22-61). Twelve fractures were classified as C1, 13 as C2 and 8 as C3. The mean follow-up was 7.6 years (range 6-10). Mean postoperative range of motion compared with the contralateral side was: 87% for flexion, 94%
for extension, 96% for radial deviation and 87% for ulnar deviation, both supination and pronation recovered 95%. The mean grip strength was 82% of the opposite wrist. Articular step-offs were reduced in all patients. Average VAS was 0.6 (range 0-3) and DASH score was 6.8 (0-26). The Mayo score results were excellent in 12, good in 12 and fair in 9 patients. Mean PRWE score was 10.7 (range 0-80). According the Knirk classification, eleven patients were stage 0, twelve stage 1, six stage 2 and one stage 3. None of the three clinical scores showed statistical correlation with the radiographic changes. Four patients required a plate removal.

Summary Points
- At an average of seven years, young adults with complete articular DRF achieved good subjective and objective clinical outcomes after a satisfactory internal fixation.
- Despite an anatomical reduction, at midterm follow-up osteoarthritic changes can be expected. However, do not correlate with the clinical outcomes.

Bibliography
Poster 206: Patient Preferences in the Management of Acute Non-Displaced or Minimally Displaced Scaphoid Fractures: A Conjoint Analysis

Category: Wrist

Evaluation/Diagnosis; Treatment; Patient Education
N/A - not a clinical study

Ronnie L. Shammas
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Hypothesis
We hypothesized that out-of-pocket costs would have a greater influence on patient decision making for operative or non-operative management of a scaphoid fracture when compared to the time spent in a cast or brace, degree of soreness, or the risk of treatment failure.

Methods
Survey participants were recruited using Amazon Mechanical Turk. A conjoint preference experiment derived the relative importance of attributes thought to be influential in the decision to undergo operative or non-operative management of a scaphoid fracture. The attributes described were time in a cast, time in a brace, remaining soreness/stiffness, risk of treatment failure, and cost. Respondents chose among 13 different alternatives that differed in these attributes, an example of which is shown in Figure 1. Survey respondents were then asked to choose between operative or non-operative management (Figure 2).

Results
A total of 250 people participated in this survey. The most important factors in respondent decision-making were cost, followed by time spent in a cast and risk of treatment failure. Time spent in a brace and remaining soreness or stiffness were less important. The relative importance of these attributes was used in conjunction with a 5-point scale that assessed the respondents’ apprehension to undergo surgery. This allowed for a prediction to be made about the type of management the respondent would choose to undergo; and in conjunction with a sensitivity analysis, the proportion of respondents who would choose operative management given different outcomes (i.e. higher cost, higher risk of treatment failure, etc.) was estimated. Overall, 37% of respondents chose operative management. Instead of paying $500, people would rather experience two weeks in a cast, three weeks in a brace, two months of soreness, or
a 2% increase in the risk of treatment failure. A one point decrease in an individual’s apprehension about surgery has the same impact on treatment selection as a $600 reduction in the cost of surgery. Individuals who have undergone surgery in the past, and those with a higher level of education, were less apprehensive about surgery.

Summary Points:
- Cost is an important factor in patient decision making for scaphoid fractures.
- Instead of paying more for treatment, respondents would rather experience greater time in a cast/brace, increased soreness, or an increased risk of treatment failure.
- Apprehension about surgery is important.
- Those who are strongly apprehensive are unwilling to undergo surgery, even if the benefits are substantial, and the procedure is inexpensive.

Bibliography

Images
Poster 207: Outcomes of Conservative Treatment of Ulnar-Sided Wrist Pain

Category: Wrist

Treatment
Level 4 Evidence

Laura Y. Lu
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Hypothesis
Ulnar-sided wrist pain is a common cause of upper limb disability, and management varies from immobilization to surgery. Despite these varied treatments, we hypothesize that most patients presenting with ulnar-sided wrist pain do not require surgery for relief of symptoms.

Methods
We completed a retrospective chart review of patients treated at a tertiary care facility for ulnar-sided wrist pain. After receiving IRB approval, a cohort of patients with ICD-9 codes matching ulnar-sided wrist pain were identified from October 2014 to October 2016. All patients were evaluated and treated by a board-certified, fellowship-trained hand surgeon at a single institution. Patients with wrist fractures or a history of prior wrist surgery were excluded.

Results
Forty wrists with ulnar-sided wrist pain were identified in 39 patients. Of these 40 wrists, thirty-seven (92.5%) were diagnosed with triangular fibrocartilage complex (TFCC) injuries and 3 were ulnocarpal abutment syndromes (7.5%). Half of the wrist pain was a result of non-traumatic causes while 30.0% and 17.5% were due to trauma or overuse, respectively. A period of immobilization by casting, bracing, or both (casting followed by bracing) was the first-line treatment for all patients. The average length of casting was 2.85 ± 2.52 weeks with a range of 0 to 8 weeks. For the 33 patients (82.5%) who returned to clinic after receiving a removable brace or cast, the average length of bracing was 6.12 ± 5.74 weeks with a range of 0 to 22 weeks. Thirty percent of patients received additional treatment with one or more steroid injections and 1 (2.5%) patient received a nerve block to alleviate pain. X-rays were obtained for 82.5% (33) of the cases while 40% (16) of the cases needed further MRI studies. Of the X-rays, 15.2% (5) revealed negative ulnar variance, 27.3% (9) showed positive variance, and 57.6% (19) were neutral. Across all 40 cases, only 7 (17.5%) surgeries were performed, and all but one required arthroscopy and had an ulnar osteotomy instead.
Summary Points
• Most patients (82.5%) presenting with ulnar-sided wrist pain do not require surgery.
• A period of immobilization by casting (2.85 ± 2.52 weeks), bracing (6.12 ± 5.74 weeks), or both is sufficient treatment for the majority of patients with ulnar-sided wrist pain.

Bibliography

Images
Poster 208: Computed Tomography Increases the Rate of Surgery for Distal Radius Fractures

Category: Wrist

Evaluation/Diagnosis; Treatment
Level 3 Evidence

Sezai Ozkan
Claudia Bargon
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Hypothesis
The greater detail provided by computed tomography images may bias surgeons to recommend operative treatment of a distal radius fracture. We tested the null-hypothesis that there is no difference in the rate of surgery between patients with a distal radius fracture managed with and without a CT-scan accounting for other factors.

Methods
We identified 323 patients with a distal radius fracture treated between 2014 and 2015 at two level I trauma centers and one level II trauma center. We manually assessed the charts, operative reports, and radiographs of 323 patients to identify factors associated with 1) obtaining a CT scan and 2) operative treatment. Bivariate analysis was performed to identify factors associated with obtaining a CT scan and operative treatment, and multivariable logistic regression analysis was performed on factors identified in bivariate analysis with \( P < 0.10 \).

Results
Intra-articular fracture, scaphoid fracture, being treated by a hand surgeon, and ulna variance were associated with obtaining a CT scan (Table 1). In multivariable analysis, CT-scan, treatment by a hand surgeon, and a greater pre- to post-reduction difference in the ulnarward inclination on the PA radiograph, were independently associated with operative fracture treatment (Table 2).

Summary Points
- Patients with distal radius fractures that are evaluated with a CT-scan are more likely to receive surgical treatment of their distal radius fracture, even when other factors are taken into account.
Additional research is needed to determine whether CT-scans improve the outcomes and improve the value of distal radius fractures fracture care.

Bibliography
Poster 209: Performance Outcomes After Hook of Hamate Fractures in Major League Baseball Players

Category: Wrist

Treatment; Prognosis/Outcomes; Patient Education
Level 4 Evidence

David P. Taormina, MD
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Hypothesis
Major League Baseball (MLB) players who sustain hook of hamate fractures demonstrate decreased performance upon return to competition when compared with their performance before injury and with that of control-matched peers.

Methods
Data for 18 MLB players with hook of hamate fractures incurred over 26 seasons (1989 to 2014) were obtained from injury reports, press releases, and player profiles (www.mlb.com and www.baseballreference.com). Player age, position, number of years in the league, mechanism of injury and treatment were recorded. Individual season statistics for the two seasons immediately prior to injury and the two seasons after injury for the main performance variable - wins above replacement (WAR) were obtained. Eighteen controls matched by player position, age, and performance statistics were identified. A performance comparison of the cohorts was performed.

Results
Mean age at the time of injury was 25.1 years with a mean of 4.4 seasons of MLB experience prior to injury. All injuries were sustained to their nondominant batting hand. All players underwent operative intervention. There was no significant change in WAR or ISO when pre-injury and post-injury performance was compared. When compared with matched-controls, no significant decline in performance in WAR the first season and second season after injury was found.
Summary Points

• MLB players sustaining hook of hamate fractures can reasonably expect to return to their pre-injury performance levels following operative treatment.
• Players were able to return to play after their injury and perform at a similar level as control-matched peers at two years post-injury.
• This study provides the hand surgeon with information to aid in guiding competitive baseball athlete expectations regarding return to play after hook of hamate fractures.
Poster 210: Interobserver reliability of CT scan in the plane of wrist versus in the long axis of the scaphoid in scaphoid fractures

*Category: Wrist*

Evaluation/Diagnosis; Treatment

N/A - not a clinical study

Stefanie Wieschollek
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Rainer Schmitt, MD
Georgios Christopoulus
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**Hypothesis**
Evaluation and understanding of location, dislocation, humpback deformity and misalignment of scaphoid fractures is essential for the decision of the following treatment. Therefore a CT scan in the long axis of the scaphoid (CTsc) is more significant and reliable than a CT scan in the plane of the wrist (CTw).

**Methods**
We tested the interobserver reliability of those two CT scan methods. 42 patients with scaphoid fractures had a CT scan in the long axis of the scaphoid (CTsc). CT reformations along planes relativ to the wrist (CTw) were made. Those 84 cases were anonymised and put in a random order. They were presented to 4 clinical observers (2 handsurgeons and 2 radiologists) for fracture evaluation regarding: localization, humpback deformity, offset (radial/ulnar and palmar/dorsal) and classification by Herbert. Additionally the surgeons should decide for palmar or dorsal approach and open or percutaneous technique.

Statistical analysis was made between 2 and 4 observers using Cohen’s kappa coefficient, Pearson coefficient, Fleiss’ kappa, interclass correlation coefficient (Shrout and Fleiss) and Spearman-Rho coefficient.

**Results**
see attached table

**Summary Points**
- Regarding evaluation of humpback deformity there was a significantly higher interobserver correlation in CTsc than CTw
Regarding evaluation of localization, offset, Herbert classification, approach and technique there was a slightly higher interobserver correlation in CTsc than CTw. In all evaluated parameters the interobserver reliability was slightly higher in the CT scan in the long axis of the scaphoid.

Conclusion: for evaluation and understanding of scaphoid fractures the CT scan along the long axis of the scaphoid is more significant and reliable than the CT scan in the plane of the wrist and therefore preferable.
Poster 212: Biomechanical study of Monteggia fracture dislocation

Category: Elbow/Forearm/Shoulder

Prognosis/Outcomes; Anatomy; Basic Science
N/A - not a clinical study

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Akio Iida, MD, PhD
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Yasuhito Tanaka, MD, PhD

Hypothesis
In the current biomechanical study, we hypothesized that instability of the proximal radius is correlated with the magnitude of simulated angular deformity of the ulna and the degree of soft tissue sectioning in the proximal forearm.

Methods
We used 6 fresh cadaver upper limbs amputated above the elbow, preserving ligaments around the elbow and the interosseous membranes. The humerus and ulna were solidly fixed on a customized zig, and the radius was allowed to rotate freely. An electromagnetic tracking device was used to measure 3-D coordinate of the proximal radius and the ulna (Figure 1-a). We pulled the biceps tendon with a load of 20N in anterior direction and measured magnitudes of movement of the radius relative to the ulna in 3 forearm rotations as maximum supination and pronation, and neutral rotation in Monteggia fracture model as indicated below. Radial head stabilizers were sequentially sectioned from proximal to distal, including annular and quadrate ligaments, and additional sectioning of proximal portion of the interosseous membrane. Each stage was divided into 6 substages according to the degree of angular deformity of the ulna at the proximal one third (Figure 1-b). Radial head displacement was normalized by its diameter, and the displacement ratios were compared between stage 0 (intact), 1 and stage 2, and among different sub-stages.

Results
Displacement ratio of the radial head increased significantly following sequential soft tissue sectioning, and the ratio increased approximately in proportional to the degree of angular deformity of the ulna in three forearm positions. In stage 1, we found significant displacement (32%) at a minimum of 5 degrees’ ulnar angulation during pronation, while a minimum of 20 degrees’ angulation had significant displacement (40%) during supination. In stage 2, significant
displacement was found (37%) at a minimum of 5 degrees of angular deformity during supination and pronation, while a minimum of 10 degrees’ deformity had significant displacement (39%) in neutral forearm rotation (Figure 2).

**Summary Points**

- Instability of the radial head differed depending on the presence or absence of loss of integrity in proximal portion of the interosseous membrane in simulated Monteggia fracture model.
- Different types of soft tissue injuries may occur associated with Monteggia fracture, and each injury have a specific forearm position for stabilizing the elbow joint.
- Minimum angular deformity of the ulna contributed to significant radial head instability, suggesting that anatomical reduction of the ulna is necessary for stabilizing the radial head.

**Bibliography**


Images
Poster 213: Functional Outcomes and Complications of Radial Head Fractures Treated with Screw-Fixation.

*Category: Elbow/Forearm/Shoulder*

Treatment; Surgical Technique; Prognosis/Outcomes

Level 4 Evidence

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**Hypothesis**

Null Hypothesis: There are no factors related to complications after of radial head fractures with screw fixation

**Methods**

We performed a retrospective analysis of all patients that had a radial head fracture treated with screw fixation from February 2008 to April 2016 at a single institution. Indication for operative treatment was partial articular radial head fracture with displacement >2mm, radial head fracture with greater than one fragment, or if there was restricted supination or pronation. We included 23 patients with a median follow-up of 38 weeks. The fractures were treated with bicortical positioning screws without compression, either through a dorsal or lateral approach. The range of motion was evaluated clinically by the treating physician and we gathered patient reported outcomes using the Quick Disabilities of the Arm, Shoulder and Hand (DASH) score. We performed bivariate analysis to evaluate factors associated with complications.

**Results**

The median QuickDASH score was 6.8 (IQR 4.6-19.3). There were six complications, non-union being the most common (3/23), followed by hardware irritation (2/23) and heterotopic ossification (1/23). There were significantly more complications in patients with more than two fracture fragments (p=0.045). Four patients required reoperation, hardware removal in 3 patients and one patient underwent late radial head resection.

**Summary Points**

- Screw-fixation demonstrates an excellent patient reported outcome in the majority of cases
- There is a higher risk for complications if more than 2 fragments are present.
Bibliography
Images
Poster 214: Efficacy of a forearm band for lateral epicondylitis: A multicenter, randomized, controlled trial

Category: Elbow/Forearm/Shoulder

Treatment
Level 2 Evidence

Takanobu Nishizuka, MD
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Hypothesis
A forearm band is frequently used for lateral epicondylitis worldwide. However, evidence regarding its efficacy has been insufficient. The objective of this prospective, randomized, controlled trial was to analyze the effects of a forearm band for treatment of lateral epicondylitis at 1, 3, 6, and 12 months.

Methods
Patients with lateral epicondylitis were randomly allocated into a band (n = 55) or non-band (n = 55) group. Patients in the band group were instructed to wear a forearm band for more than 6 hours daily for at least 6 months. Patients in both groups were instructed to perform wrist extensor stretching exercises for 30 seconds, 3 times daily, for 6 months. Hand10, pain, and satisfaction scores, and proportions of positive physical examinations, including tenderness assessment, Thomsen test, and middle finger extension test, were evaluated at 1, 3, 6, and 12 months after enrollment.

Results
There were no significant differences between the band and non-band groups with regard to Hand10, pain, or satisfaction scores at 1, 3, 6, and 12 months. Likewise, there was no significant difference in proportions of positive physical examinations between groups at 1, 3, 6, and 12 months.

Summary Points
- This RCT revealed that there was no statistically significant difference in Hand10 score, Pain score, etc at 1,3,6 and 12months between the band and the non-band group.
- A forearm band do not support the use of a forearm band based on its effectiveness.
Poster 216: Complications in Elbow Arthroscopy: A Multi-Surgeon Experience  
Category: Elbow/Forearm/Shoulder

Prognosis/Outcomes  
Level 4 Evidence

Jessica Intravia  
Raffy Mirzayan

Hypothesis
The risks of elbow arthroscopy, have been previously described by Kelly et al (2001) with 473 consecutive elbow arthroscopies from 1980-1998. Since that time, the field of elbow arthroscopy has drastically changed and the complexity of procedures increased. Another report by Nelson et al in 2014, shared the results of 417 consecutive elbow arthroscopy performed over a thirteen year period by three orthopedic surgeons who have completed specialized subspecialty training in shoulder and elbow surgery. While this data set highlights the complication rate of three highly trained surgeons, it may fail to capture the true rate of complications observed with elbow arthroscopy in a community practice. We reviewed the complications of elbow arthroscopy in a community practice with multiple surgeons. Our hypothesis was that there would not be a significant difference in nerve complication rates from previously published literature.

Methods
After institutional IRB approval, the electronic health record of an integrated healthcare system including 13 medical centers with a captured population was reviewed for all elbow arthroscopies that occurred in the eight year period between 2006 and 2014. A complete retrospective chart review was performed on over 563 consecutive elbow arthroscopies in 528 patients performed by 42 board certified orthopedic surgeons. The average length of follow up was 375 days (0-2739 days). Major complications tracked included deep infection, compartment syndrome, vascular injury, re-hospitalization, deep vein thrombosis, and pulmonary embolus. Minor complications include superficial infection, heterotopic ossification and transient nerve palsies.

Results
The average age was 38.6 years (range: 5-88). There were 418 males. The average length of follow up was 376 days (0-2739 days). Overall, heterotopic ossification occurred in 13 of 559 (2.33%) cases, and 20 of 559 (3.5%) cases developed transient nerve palsies (8 ulnar, 8 radial, 1 median, 3 medial antebrachial cutaneous). There were 3 deep infection and 11 superficial
infections (1.96%). There were no vascular injury, compartment syndrome, deep vein thrombosis, or pulmonary embolism. Relative to pediatric patients, there was a higher risk in adults for nerve injury (OR=1.99; P=0.27), infection (OR=3.36; P=0.25), and heterotopic ossification (OR=1.40; P=0.66). There was no difference in re-operation rate (OR=0.92, P=0.8).

**Conclusion**
Elbow arthroscopy remains a safe procedure with very low complication rates. There were higher complications in adults relative to pediatric patients, but they did not reach significance. The major weakness of the study is that the complications were very low and statistical analysis was challenging due to few complications.

**Summary Points**
Poster 217: Clinically Redefining Flexor Zone V. A Prospective Study

Category: Elbow/Forearm/Shoulder

Evaluation/Diagnosis; Prognosis/Outcomes
Level 3 Evidence

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Hypothesis

Flexor zone five of the forearm is proximal to the transverse carpal ligament and distal to the musculotendinous junction. However, the musculotendinous junction is highly variable and difficult to identify clinically. Furthermore, previous studies have demonstrated the physical exam in patients with zone five injuries to be unreliable. The purpose of this study was to identify a clinically relevant zone in the volar forearm at greatest risk of tendon injury following penetrating trauma.

Methods

All patients who presented with an isolated flexor zone five laceration were prospectively evaluated. A physical exam was performed on eligible patients and the length of the forearm and dimensions of the laceration were measured to allow for normalization of the zone of injury relative to forearm length (Figure 1a). Per standard practice at our institution, all patients with zone five lacerations underwent operative exploration. The surgeon subsequently completed a study datasheet, providing detailed documentation of the intraoperative findings. From this information, the critical area of the forearm at greatest risk of tendon injury was determined. Two groups were created: Group 1 consisted of patients with injuries distal to the critical area, and Group 2 consisted of patients with injuries proximal to this area. Chi-square analysis was performed to assess for differences in injuries between the two groups.

Results

A total of 19 patients met inclusion criteria. The distal 50% of the forearm (Group 1) had the greatest probability of tendon injury based on operative findings. Tendon injury was present in 64% of patients in Group 1, and 0% of patients in Group 2 (P=0.0135). Muscle belly injuries occurred in 43% of patients in Group 1, and 100% of patients in Group 2 (P=0.0263). The incidence of tendon injury by integral increase in 20% of relative forearm length is presented in
Figure 1b. There were no differences in artery or nerve injuries between groups (Table 1). The accuracy of the physical exam relative to operative findings was similar between groups (Table 1).

**Summary Points**
- Patients with lacerations in the distal 50% of the forearm were at greatest risk of tendon injury
- No patient with a laceration in the proximal 50% of the forearm without neurosensory deficit had a tendon injury
- Patients with evidence of tendon injury on physical exam in the distal 50% of the forearm should be operatively explored, however, patients with lacerations in the proximal 50% of the forearm without evidence of nerve or arterial injury can likely be observed.

**Bibliography**

Images

*Category: Elbow/Forearm/Shoulder*

Treatment;Surgical Technique;Prognosis/Outcomes

Level 4 Evidence

Avi D. Goodman, MD
Joseph P. Johnson, MD
Justin Kleiner
Joseph A. Gil, MD
Alan H. Daniels

**Hypothesis**

We sought to determine the operative and non-operative trends in treatment of distal humerus fractures from 2002-2012 using the National Inpatient Sample. Our hypothesis was that, over time, the use of total elbow arthroplasty for the treatment of distal humerus fractures has increased; we also sought to evaluate the demographics, complications and costs associated with the treatment of these injuries.

**Methods**

Patients over 50 years old with distal proximal humerus fractures were identified in the National Inpatient Sample between 2002-2012, and demographics and hospital-related information were recorded. Outcomes examined included complications, in-hospital mortality, length of stay, and total hospital charges. Multivariable logistic regression was utilized to determine variables associated with greater proportion of surgical treatment and determine variables associated with increased complication rate, and mortality rate.

**Results**

106,237 patients over age 50 with distal humerus fractures were identified. From 2002-2012, the proportion undergoing operative treatment remained similar over the study period with 53.2% undergoing surgery for their injury. Multivariate regression revealed that patients undergoing surgery were younger (56.9 vs. 66.3 years, P<0.0001), healthier (mean Charlson Comorbidity Index [CCI] 0.65 vs. 1.02, p<0.0001), more likely to be female, and treated in a later year. The proportion of patients surgically treated with arthroplasty rose 2.5-fold from 2.0% in 2002 to 4.9% in 2012 (OR 1.061 per year, p=0.0006). Arthroplasty patients were older than those undergoing ORIF (71.4 vs. 56.2 years, p<0.0001), more likely to be female (81.5% vs. 66.0%, p<0.0001), and less healthy (CCI 0.93 vs. 0.64, p<0.0001), and treated in a later year (p=0.0035). Multivariate analysis demonstrated that compared to ORIF patients, arthroplasty patients had
similar inpatient complication (6.5% vs. 6.3%) and mortality rates (0.60% vs. 0.59%), but an increased length of stay by 0.6 days (p=0.0274) and hospital charges by $13,394 (p<0.0001).

Summary Points
- Distal humerus fractures are challenging to treat due to their intra-articular nature and frequent comminution, and total elbow arthroplasty implants have been used for unreconstructable fractures since their introduction in 2001.
- From 2002-2012, an increasing proportion of patients were treated with arthroplasty, while the rate of treated with ORIF decreased.
- Our data suggests that total elbow arthroplasty has seen expanding indications, including some fractures previously treated with fixation.
- Given the increasing utilization of total elbow arthroplasty for fracture, and higher in-hospital costs and length of stay, ongoing trials examining long-term outcomes of arthroplasty versus fixation are needed.

Bibliography
Poster 219: Histologic Evaluation of the Triceps Brachii Insertion

*Category: Elbow/Forearm/Shoulder*

Anatomy; Basic Science  
N/A - not a clinical study

Robert Harold Ablove, MD

**Hypothesis**
A detailed understanding of the triceps tendon insertion onto the olecranon establishes the basis for proper repair of a rupture and diminishes risk of injury during surgical exposure. The anatomy of the triceps tendon insertion has been previously described, although most prior studies utilize gross observational measurement techniques. There is limited histologic investigation with direct evaluation of the triceps insertion. The purpose of this study is to evaluate and quantify the triceps tendon insertion via direct histologic measurement. We hypothesize the triceps insertion is different in size and structure than previously described.

**Methods**
Seventeen fresh-frozen cadaveric elbow specimens were prepared. After dissection, we isolated and resected the proximal ulna and its soft tissue attachments. Exclusion criteria included any evidence of prior trauma or degeneration, including enthesophyte formation. Specimens were sectioned in either the sagittal or coronal plane. Sections were embedded, processed into slides, and stained. The proximal-to-distal and medial-to-lateral dimensions of the tendon insertion were measured directly. A Student’s t test was used to compare specimens to each other and to previously reported results.

**Results**
The triceps brachii was visualized at a histologic level to insert on the olecranon as a confluent tendon. The mean histologic dimensions of the proximal-to-distal and medial-to-lateral tendon insertion were $11.0 \pm 0.8\text{mm}$ and $21.7 \pm 2.1\text{mm}$ respectively.

**Summary Points**
- The proximal-to-distal dimension of the triceps tendon insertion was less than previously reported.
- The medial to lateral dimension was statistically similar to existing reports.
- This has potential clinical applications in both trauma and reconstructive surgery.
Bibliography
Images
Hypothesis
The annular ligament (AL) of the radius and proximal band (PB) and central band (CB) of the interosseous membrane (IOM) are key stabilizers of the forearm that are often ruptured sequentially due to high impact axial loads to the forearm. Contributions of the IOM and AL to longitudinal stability have been clearly defined. We present results showing contribution of the IOM and AL to 3-dimensional radial head stability through sequential sectioning of these stabilizing structures during pronation and supination activities.

METHODS: Fifteen fresh-frozen cadaveric arms were used. All soft tissue was removed proximal to the wrist leaving the main stabilizing structures of the forearm intact. Elbow was fixed at 90 degrees of flexion. The specimen was loaded along the long axis of the forearm and through the biceps tendon. Mechanical testing: A custom, electronically actuated fixture allowed the forearm to rotate between 45 degrees of supination and 45 degrees of pronation. An 8-camera Optitrack motion capture system tracked the motion of the radius and ulna for several test stages: 1. intact, 2. AL of the radial head sectioned, 3. PB of the IOM sectioned, and 4. CB of the IOM sectioned. With the hand in neutral position we report the position of the radial head at each stage. Translational radial head motion is then reported in three directions: radial-ulnar, volar-dorsal, and proximal-distal, across each stage, at all degrees of pronation and supination. Rotational radial head motion is reported about the long axis (z) and transverse axis (x) of the forearm and about the long axis of the humerus (y).

Results
After AL sectioning the radial head displaces an average of 1.2 mm dorsally, 1.4 mm ulnarly, and 2.1 mm distally. With subsequent sectioning of the PB it displaces an additional 0.4 mm dorsally, returns 0.2 mm radially, and proceeds 0.02 mm distally. With subsequent sectioning of the CB it
returns 0.5 mm volarly, proceeds 0.5 mm radially, and returns 0.3 mm proximally. Typical translation and rotation paths are represented graphically in Figure 2.

**Summary Points**
- The greatest amount of instability to the radial head occurs after sectioning of the AL, with little additional effect due to PB and CB sectioning.
- The translational path of the radial head intact and after AL, PB, and CB sectioning is not significantly different.
- Rotational instability due to AL sectioning is significant about the x-axis in supination and y-axis in pronation.
Poster 221: Outcomes of Displaced Olecranon Fractures Treated With the Olecranon Sled

Category: Elbow/Forearm/Shoulder

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Andrew Lovy, MD
Isaiah Levy
Aakash Keswani
Todd Rubin
Michael Hausman

Hypothesis
Tension band wiring is largely considered the gold standard for fixation of displaced olecranon fractures despite high rates of hardware complications. We hypothesize that fixation of displaced olecranon fractures with the Olecranon Sled™ (TriMed Inc., Santa Clarita, CA) will lead to reduced hardware complications and excellent functional outcomes.

Methods
We retrospectively reviewed 24 consecutive displaced olecranon fractures from 2011-2015 treated with the Olecranon Sled™. Inclusion was limited to functionally independent patients with Mayo type II fractures and 12 month minimum follow up. Clinical outcomes including range of motion, Disabilities of the Arm Shoulder and Hand (DASH) score and Mayo Elbow Performance Score (MEPS) were assessed.

Results
Twenty-two patients with mean 31.8 month follow up were included in the study as two patients declined participation. All patients indicated satisfaction with their outcome. Mean MEPS and DASH scores were 95.5 (range 70-100) and mean DASH score was 3.1 (range 0-18.3). Mean total arc of elbow flexion was 145.2° (range 134-158) and arc of total forearm rotation was 175.2° (range 160-180). There was no difference in range of motion, DASH or MEPS between Mayo type IIA (17/22) or IIB (5/22) fractures. No patient underwent subsequent hardware removal or sustained any hardware related complication. The overall complication rate was 4.5% (1/22) as one patient developed significant heterotopic ossification requiring contracture release.

Summary Points
- Fixation of displaced olecranon fractures with the Olecranon Sled™ results in excellent functional outcomes.
The Olecranon Sled™ is a well-tolerated implant that may obviate the need for subsequent hardware removal.
Poster 222: Lateral Para-olecranon Approach for Distal Humeral Fracture

Category: Elbow/Forearm/Shoulder

Treatment; Surgical Technique
Level 4 Evidence

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Satoshi Oki
Taku Suzuki, MD, PhD
Noboru Matsumura, MD, PhD
Kazuki Sato, MD, PhD

Hypothesis
An olecranon osteotomy approach provides good exposure of the articular surface, enabling accurate articular reduction for intra-articular distal humeral fractures, however, this approach is associated with several complications, including symptomatic hardware prominence, nonunion or delayed union of the olecranon, and loss of osteotomy reduction. The purpose of this study was to assess the outcomes of the lateral para-olecranon triceps-splitting approach for the treatment of distal humeral fracture.

Methods
Ten patients (3 males, 7 females) with a mean age of 59 years were retrospectively reviewed. There were two A2, three C1, and five C2 fractures according to the AO/ASIF classification. Type B3 and C3 fractures were excluded from this study because the olecranon osteotomy approach was indicated to visualize the anterior fragment. The triceps was split at the midline, and the anconeus muscle was incised from the proximal ulna. The lateral half of the triceps along with anconeus was retracted laterally as a single unit. The distal part of the humerus could be visualized from medial and lateral windows by retracting the medial half of the triceps. The articular fragment was anatomically reduced and fixed temporarily with Kirschner wire, and the reconstructed distal articular block was then fixed to the humeral shaft with double locking plates.

Results
Postoperatively, average elbow flexion was 127° (range, 110° to 145°), and extension was −10° (range, −20° to 0°) at the average follow-up time of 12.4 months (range, 8-20 months). Seven patients had normal muscle strength against full resistance (manual muscle testing grade 5), and the other three patients had slightly reduced muscle strength (grade 4). No articular step-offs of more than 1 mm were seen on postoperative radiographs. There were no cases of triceps
insufficiency and nonunion. The average (± standard deviation) Mayo Elbow Score was 93.5 ± 5.8 points at the final follow up.

Summary Points

- The lateral para-olecranon approach is useful for the management of selected fractures of the distal humerus, preserving extension strength and providing satisfactory clinical outcomes, with no risk of olecranon osteotomy-related complications.
- This approach would be indicated for type C1 and C2 fractures, while an olecranon osteotomy would be recommended for type C3 fractures.

Bibliography

Images
Poster 223: Biomechanical properties of a new intramedullary suture anchor fixation compared to tension band wiring in osteoporotic olecranon fractures

Category: Elbow/Forearm/Shoulder

Surgical Technique; Basic Science
N/A - not a clinical study

Arvind von Keudell, MD
Amir Reza Kachooei, MD
Michael Nasr
Amin Mohamadi
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Hypothesis
Olecranon fractures are common in elderly patients. The traditional fixation with tension band fixation represents a reliable repair; however, it is associated with hardware prominence and failure, necessitating reoperation. The aim of the present study is to compare the biomechanical stability of the fixation of transverse olecranon repair in cadaveric osteoporotic bone provided by three different techniques: (1) Suture anchor fixation; (2) Polyester suture fixation and (3) current recommended AO tension band technique with K-wire fixation placed in the anterior cortex.

Methods
We studied 7 human elbow cadavers and assessed the bone mineral density. Only osteoporotic and osteopenic elbows were used. A transverse olecranon fracture was simulated by osteotomy leaving the joint capsule and triceps intact. The fracture was reduced anatomically by using either traditional AO tension band technique or two 4.75mm biocomposite fully threaded suture anchors (Smith and Nephew) or regular polyester suture (5-0 Ethibond). Active elbow range of motion (AROM, 100N) and push up from a chair exercise (500N) was simulated with the use of an Instron load frame (Instron) and cyclic loading. Fracture displacement was measured using videographic analysis. Failure was defined as 2mm displacement.

Results
There were 3 female and 4 male elbows with an average age 76±13 years, average bone mineral density of 0.6±0.1 g/cm2 and an average T score of -2.3±1.0. The biomechanical analysis demonstrated that there was no statistical difference in all three groups in AROM testing (p>0.5 for all cases). The AO tension band technique provided the most stable fixation in push-up
experiment followed by suture anchor and suture fixation (p <0.0001 for all cases). The suture fixation failed after an average of 200 cycles of push-up testing.

Summary Points
- Suture anchor fixation and even regular suture fixation might be a viable surgical treatment option for osteoporotic transverse elbow fractures in low demand patients.
- These techniques may mitigate the necessity of reoperation despite its inferior biomechanical characteristics compared to the traditional AO tension band technique in push-up exercises.

Bibliography

Images
Poster 224: Acute Compartment Syndrome of Forearm from Gunshot Wound

Category: Elbow/Forearm/Shoulder

Prognosis/Outcomes
Level 4 Evidence

Peter D. Gibson, MD
John S. Hwang, MD
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Mark Reilly

Hypothesis
Penetrating injuries causing compartment syndrome have been largely ignored in the current literature, yet are a significant burden within many urban centers. The objective of this study was to determine causes, complications, and clinical outcomes associated with forearm compartment syndrome of the upper extremity resulting from gunshot wounds.

Methods: All patients that underwent forearm fasciotomy with associated gunshot were identified from our orthopedic trauma from 2001-2013. Retrospective chart review was performed recording demographic information, means of diagnosis (pressure monitor vs clinical) associated neurovascular injury, time to fasciotomy, pre- and post-fasciotomy neurovascular status, time to fasciotomy closure, and method of closure.

Results
Twenty-five patients who underwent forearm fasciotomies due to gunshot were identified over a 14-year period. Seventy-two percent (n=18) suffered the gunshot wound to the elbow region. Injury to a named artery occurred in 48%, with the most common injury involving the brachial artery. A clinical diagnosis was made in 14 cases, and made with Stryker monitor alone in 7 cases (5 of these patients were intubated, and 2 patients had an unreliable exam due to nerve injury). Neurologic sensory and motor deficits were noted in 13 and 6 patients respectively prior to fasciotomy, with 38% (n=8) recovering full sensory function and 33% (n=2) recovering full motor function after fasciotomy. A mean of 2.7 operative procedures were performed for wound management (I&D, closure, etc.) (range 0-23, SD-4.4) after fasciotomy, with 12 patients (48%) requiring skin graft or free flap coverage. Only 20% of patients recovered full painless function on most recent follow up, with the remaining 80% suffering from one or more of the following: neurologic deficit (56%), Chronic pain in extremity (28%), decreased range of motion (32%).
Discussion

- Forearm compartment syndrome from a gunshot is a difficult diagnosis due to its association with fractures, soft tissue damage, and neurovascular injury.
- High incidence of vascular injury (52%) with injury to named vessel.
- Compartment syndrome of the forearm has high morbidity with 80% of cohort of long-term disability. Neurologic deficit is seen in up to 56% of patients.
- Diligent and frequent clinical examination should be performed in all individuals with abnormal vascular status. Pressure monitoring should be considered in all intubated patients, and those who have altered sensation.
- Acute compartment syndrome of the forearm has significant morbidity often with permanent neurologic injury and loss of function.

Bibliography


Images
Hypothesis
Using computed tomography (CT) scans of normal elbows, we sought to characterize the articular morphology of the radiocapitellar and ulnohumeral joints. Furthermore, we sought to further test the recent idea that the shape of the radial head falls into a bimodal distribution of circular and elliptical, as well as determine the reliability of these measurements between observers.

Methods
Following Institutional Review Board approval, 68 normal elbow CT scans obtained between January 2012 and October 2015 at our institution were retrospectively examined by three observers using the axial, coronal, and sagittal reconstructions on the Picture Archiving and Communication System (PACS). Various anatomic parameters were measured, including the largest and smallest radial head diameters, the length and depth of the radial head, ulnohumeral articulation, trochlea, and capitellum. The difference between the largest and smallest radial head diameters was calculated, with >1mm difference being considered elliptical. Standard descriptive statistics were used to characterize the measurements. Intraclass correlation (ICC) was calculated to determine interrater reliability.

Results
The mean maximum and minimum radial head diameters were 23.4mm and 22.2mm, respectively (standard deviations [SD]: 2.5mm, 2.5mm) (Table 1). The median difference was 1.2mm, with 39 radial heads (57.4%) considered elliptical. The mean radial head depth was 2.6mm (SD 0.8mm), and length 10.2mm (SD 3.2mm). The ulnohumeral articulation had a mean depth of 11.7mm (2.3mm) and length of 26.2mm (3.9mm). The trochlear width and depth were 26.3mm and 19.0mm, respectively (SD 3.6mm and 3.4mm, respectively). The capitellum width and depth were 18.0mm and 22.1mm, respectively (SD 2.7mm and 3.2mm). Interrater ICC for all values was 0.885, indicating excellent interrater reliability.
Summary Points

- Radial heads follow a bimodal distribution for shape, in which 57% of samples were elliptical and 43% were circular.
- Interrater reliability is excellent for measuring these parameters on CT scans.

Bibliography


Images
Hypothesis
An unlinked Kudo type-5 elbow prosthesis is one of the most commonly used unlinked total elbow prosthesis for rheumatoid arthritis of the elbow(1). The ulnar component of Kudo type-5 can either be all-polyethylene or metal-backed. A prospective randomized study showed that prostheses with a metal-backed ulnar component lasted significantly longer than those with an all-polyethylene ulnar component(2). However, the likelihood of implant failure remains. Soft tissue laxity and initial incongruity of the ulnohumeral articulation is thought to be the cause of articular surface wear and loosening in unlinked total elbow arthroplasty (TEA). However, the mechanisms leading to wear and loosening remain unclear, as there are few articles describing intra-articular findings at the time of revision surgery. This study observed the intra-articular findings during Kudo-type 5 revision surgery and inferred the mechanisms that led to implant failure.

Materials and Methods
We performed primary Kudo type-5 TEA on 60 rheumatoid elbows in 45 patients between 1994 and 2003(3). This study included eight patients and nine elbows that underwent revision surgery due to aseptic loosening. In every patient, the humeral component was implanted without cement and the all-polyethylene ulna component incorporated cement fixation. The patient group contained eight women, with a mean age of 63.6 years (range, 53-77 years). The mean duration between primary TEA and revision surgery was 72.2 months (range, 36-101 months). Preoperative status was assessed radiographically using the method proposed by Souter(4). The intra-articular findings at the time of revision were based on surgery records and photographs.

Results
In all cases, revision surgery was performed due to the failure of the ulnar component. Implant failures were divided into two types; fracture of ulnar component neck ($n = 3$) and loosening of ulnar stem ($n = 6$). There were no cases of metallosis or wear of the articular surface.
Furthermore, six elbows showed valgus tilting on plain radiographs, and a valgus deformity of the retrieved ulnar component was observed in two cases.

Summary Points

- This study speculates on the type of mechanical stress that causes implant failures of unlinked Kudo type-5 TEA with all-polyethylene ulna components, which are relatively prone to implant failure, by reviewing the intra-articular findings.
- Ulnar neck distortion compensated for the uneven loading on the articular surface of the all-polyethylene ulnar component.
- Valgus tilting of the elbow joint contributed to uneven loading on the articular surface.

Bibliography

Images
Hypothesis
Precontoured posterior locking plates (PLPs) are commonly used in the treatment of comminuted olecranon fractures; however, little is known about their strength in fixation of comminuted proximal olecranon fractures involving 25% or less of the articular surface of the ulna. Strong fixation is required to prevent displacement and catastrophic failure of the elbow extensor mechanism.

Methods
Ten matched-pairs of cadaveric upper extremities underwent DEXA scans to evaluate bone mineral density. Cadaveric arms were stripped of all tissue except for the elbow joint capsule, triceps tendon, and radioulnar interosseous membrane. The humerus and forearm were transected with ≥15cm remaining from the tip of the olecranon. Variable-angle proximal olecranon plates (Synthes, West Chester, PA) were fixed to the olecranon with identical configurations of four locking screws proximally and three non-locking screws distal to the fracture. Matched specimens were randomly assigned to groups requiring 5mm-thick osteotomies centered at either 25% or 50% of the length of the articular surface of the ulnohumeral joint measured from the tip of the olecranon (Figure 1). Specimens were secured at the humerus and ulna and the triceps tendon was secured with a running-locked no. 2 Fiberwire (Arthrex, Naples, FL) and clamped to a servohydraulic test machine. Loading of the triceps from 10-150N at 1Hz for 500 cycles and then at 1mm/s until catastrophic failure was performed. Comparison of means was performed using two-tailed t-test.
Results
Specimens were an average of 58 years old (SD ±7.5). None failed during cyclic testing. Nineteen specimens failed by sagittal olecranon bisection fracture (Figure 2). One failed through the suture-triceps interface proximally due to triceps tendon desiccation. There were no failures of the screws, locking mechanisms, or plates. The 9 matched-pairs that completed the cycling and load-to-failure testing with physiologic failure mechanism were analyzed. Specimens in the 25% osteotomy group failed at lower ultimate forces of 808N (SD ±474N) vs. 1058N (SD ±480N) in the 50% osteotomy group (p = 0.044).

Summary Points
• PLPs provide enough fixation strength for small, comminuted proximal olecranon fractures to sustain loads within the range of the non-weight bearing flexion-extension arc of motion of the elbow
• The strength of PLP fixation for fractures at 25% of the distance from the tip of the olecranon is significantly lower than the fixation strength of fractures at 50%
• Failure of fixation occurs through bisection of the proximal fragment bone-screw interface
• Additional fixation may be indicated for fractures proximal to the center of the trochlear notch

Bibliography
Poster 228: Morphological Changes in the Elbow with Chronic Monteggia Fracture

Category: Elbow/Forearm/Shoulder

Evaluation/Diagnosis
Level 4 Evidence

Naoto Inaba, MD
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Hiroo Kimura, MD
Satoshi Oki
Taku Suzuki, MD, PhD
Takuji Iwamoto, MD, PhD

Hypothesis
Open reduction of chronic Monteggia fractures often results in poor clinical outcomes, especially in cases with a long-standing untreated dislocation. This is presumably due to morphological abnormalities of the elbow joint. We hypothesized that a longer untreated period might cause morphological changes to the elbow joint with chronic Monteggia fracture.

Methods
We surveyed 22 cases with untreated, chronic Monteggia fracture who visited our hospital between 2000 and 2016. We determined the duration of untreated dislocation, and assessed radiographic indexes, including total length of radius and ulna, diameter of radial head and neck, morphology of radial head, transverse diameter of ulnohumeral joint, degree of radial head dislocation, deformity of capitellum, and carrying angle in both the affected and intact limbs. Two-sided paired t-test was utilized to compare the affected and intact sides. The untreated period was divided in two groups, within 2 years (group A, n = 7) and more than 2 years (group B, n = 15), and the relationship between morphological changes and untreated period was also analyzed.

Results
The total ulna length was shorter in the affected side than the intact side (p = 0.006), and the radial head-neck ratio, carrying angle, and transverse diameter of ulnohumeral joint were greater in the affected side. There were no significant differences in the radius length, or the diameters of the radial head and radial neck between the two sides. The ulnohumeral joint diameter (ratio to intact side) was greater (p = 0.024) in group B than group A, while there were no significant differences in the total length of radius and ulna, the diameter of radial head, the degree of radial head dislocation, and the carrying angle between the two groups. Hypertrophic
deformity of the capitellum and a dome-shaped radial head were found in 6 of 15 cases and 12 of 15 cases, respectively, in group B. On the other hand, no significant morphological changes were found in group A.

Summary Points

- Our study demonstrated that there were greater morphological changes, including hypertrophic capitellum, a dome-shaped radial head, and increased ulnohumeral joint diameter, in the cases of chronic Monteggia fracture with more than 2 years’ untreated period.
- These results might suggest that careful consideration is needed for joint congruity during open reduction of chronic Monteggia fracture with more than 2 years’ untreated period.
Hypothesis
Elbow stiffness, posttraumatic or degenerative, is a difficult and challenging problem. Several surgical techniques have been suggested for the treatment of elbow contracture, however, the optimal approach has not been well described. The purpose of this study was to report the outcomes of a lateral column approach combined with a minimal posterior triceps splitting approach for elbow contracture release.

Methods
Forty-three elbow contractures were included in the study, twenty-six were posttraumatic and seventeen were degenerative. There were nine women and thirty-four men with a mean age of 38 years (range, 19-58 years) at the time of the surgery. All elbow releases were performed through a lateral column approach combined with a minimal posterior approach. Through a limited Kocher approach the anterior capsule was released and any coronoid osteophyte and loose bodies were removed. Then through a separate mini posterior triceps splitting incision the posterior capsule was released and any posterior olecranon osteophyte and loose bodies were removed. After anterior and posterior capsular releases had been completed, a gentle elbow manipulation using a short level arm was used to maximize motion. At the end of the procedure, a well-padded, long-arm posterior splint was applied with the forearm in neutral and the elbow in 20° of flexion. The splint was removed 1 week later, physical therapy was initiated for active range of motion and a removable hinged elbow splint was used which provides passive stretching in flexion and extension.

Results
Mean follow-up was 41 months (range 24-58 months). There was a significant improvement in mean pain levels from 7.7 preoperatively to 0.4 postoperatively. The total arc of elbow motion increased significantly from 51° preoperatively to 110° postoperatively with an improvement of 59°. The patients maintained 94% of the motion that was achieved intraoperatively at the final follow-up. No patient lost motion. Persistent pain with extreme extension was observed in two patients. The remaining patients were symptom free. The Mayo Elbow Performance score
improved significantly from 43 preoperatively to 91 postoperatively. No patient suffered triceps weakness or instability of the elbow.

Summary Points
- Open elbow contracture release using a combined lateral and mini open posterior triceps splitting approach:
  - is a safe and effective alternative technique for the treatment of elbow contractures
  - properly visualize and address pathology in both the anterior and posterior compartments of the elbow joint

Bibliography

Images
Poster 231: New pathologic entity of tennis elbow: Lateral elbow impingement syndrome (LEIS)

Category: Elbow/Forearm/Shoulder

Evaluation/Diagnosis; Treatment; Surgical Technique
Level 4 Evidence

Osamu Soejima, MD
Kunihide Muraoka
Kosuke Yamamoto

Hypothesis
The pathologic entity of recalcitrant tennis elbow (lateral epicondylitis of the elbow: LEC) would be the impingement syndrome of the lateral elbow related to the radial head abutment during supino-pronation as the impingement syndrome of the shoulder. We hypothesize that the radial head of patients with LEC has poorer mobility. Thus, it is critical to release the tension of the radial head, therefore both the capsule and a part of the annular ligament must be resected during the surgery.

Methods
71 elbows in 68 recalcitrant LEC patients (26 males and 42 females) who underwent mini-open modified Boyd’s procedure were evaluated clinically, ultrasonographically, MRI findings, and histologically. Average follow-up period was 14.2 months.

Results
JOA-JES score was improved from 33.9 to 92.2. From the ultrasonographic analysis, the severe LEC group had poorer radial head mobility than the mild LEC group. From the MRI and histological evaluations, degree of the MRI signal changes and histological character were correlated but the histological changes (e.g. fibrosis or angiogenesis) were randomize.

Summary Points
• The abutment of the radial head to the ECRB origin during the supino-pronation were confirmed, and the decrease of the elasticity in the ECRB origin and the inhibition of the normal radial head motion were observed in the ultrasonographic evaluations (Fig. 1).
• Degree of the MRI signal changes and histological character were correlated but the histological changes (e.g. fibrosis or angiogenesis) were randomize.
• Recalcitrant LEC has a progress cycle (micro tear -> angiogenesis -> remodeling -> fibrosis). As this cycle progresses, the decrease of the elasticity in the ECRB origin and the inhibition of the
normal radial head motion would occur (Fig. 2) like as the impingement syndrome of the shoulder (Latera elbow impingement syndrome: LEIS).

• Thus, the key-point of the surgical concept for the recalcitrant tennis elbow is not only the debridement of the degenerative tissue at the ECRB origin but also the decompression of the peri radial head at the lateral elbow (Peri radial-head decompression: PRD).

Bibliography
1: Soejima O, Iwamoto R, Matsunaga A: Surgical treatment of lateral epicondylitis: Results of arthroscopic versus open procedures. FESSH, 2014

Images
Hypothesis
Distal humerus fractures in the elderly with osteoporosis and complication pose a considerable challenge to even the most experienced surgeon. The purpose of this study is to report on the results of internal fixation of distal humerus fractures in elderly patients and to identify the problems of the treatment of fractures in the elderly patients involving osteoporosis and complication.

Methods
Between 2010 and 2015, 18 patients with distal humerus fractures were treated by open reduction and internal fixation. The study included patients who were aged 65 years or older. According to AO/ASIF classification, there were 10 cases of type A2, 1 cases of type A3, 1 case of type B1, 1 case of type B2, 3 case of type B3, 1 cases of type C1. Each of double plating method using anatomical locking plate (Locking compression distal humerus plate (LC-DHP); Depuy Synthes) and tension band wiring was performed in 5 cases for AO type A2. For all AO type B3, headless compression screw fixation (DTJ screws; MEIRA) was performed. For the other AO types, LC-DHP was performed. Patient outcomes were assessed with radiographic and CT examination, range-of-motion measurements, ulnar nerve palsy and their past history.

Results
In case of AO type A2, there was no significance between LC-DHP and tension band wiring in the mean flexion (123° vs 123°) and extension (-13° vs -24°). In one case of tension band wiring for type A2, the varus deformity progresses and the final varus angle was 18°. In the past history, there were 2 cases of hemodialysis, 3 cases of cerebral infarction, 1 case of Alzheimer disease and 1 case of osteoarthritis. A mean arc (110° vs 85°, p<0.05) and a mean flexion (129° vs 115°, p<0.05) were significantly improved for the patients without past history compared to the patients with past history. One patient treated with DTJ screw of the type B3 had non-union. Two patients had ulnar nerve palsy, but they recovered gradually after surgery.
Summary Points

- Treatment of fractures of the distal humerus in the elderly patients involves osteoporosis and complication.
- LC-DHP is a useful implant providing stable-enough fixation early rehabilitation. On the other hand, LC-DHP has several problems such as invasive procedure, ulnar palsy, necrosis and skin trouble. The usefulness of tension band wiring is still reported.
- It must be carefully analyzed to determine operative procedure considering the background of the elderly patients including complication, past history and their demand level.
Poster 235: Variation Among Surgeons When Treating Medial Epicondyle Fractures

Category: Elbow/Forearm/Shoulder

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Level 5 Evidence

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Hypothesis
Medial epicondyle fractures account for 11-20% of elbow fractures in children and adolescents. The indications for surgical intervention are currently evolving. This purpose of this study was to determine the current variability among surgeons when treating pediatric and adolescent medial epicondyle fractures and identify factors that lead to operative intervention.

Methods
A discrete choice experiment was conducted to determine which patient and injury attributes influence the management of medial epicondyle fractures. An orthogonal and balanced fractional factorial design combined patient attributes and levels based on a Bayesian D-Optimal design. A convenience sample of 13 surgeons reviewed 60 case vignettes of medial epicondyle fractures that included anteroposterior and lateral elbow radiographs and patient/injury characteristics (gender, mechanism of injury, type of sport participation, and presence of concurrent elbow dislocation). Displacement was incorporated into the study model as a fixed effect. Surgeons were queried if they would treat the injury with immobilization alone or open reduction and internal fixation (ORIF). Statistical analysis was performed using a mixed effect regression model. Surgeons also filled out a demographic questionnaire (age, gender, years in practice after fellowship, subspecialty, and frequency of being on-call) and a risk assessment (Jackson Personality Inventory Risk-taking Likert Subscale) to determine if these factors affected clinical decision-making.

Results
Elbow dislocation and fracture displacement were the only attributes that significantly influenced surgeons to perform an operation (p < 0.05). The presence of an elbow dislocation had the largest impact on surgeons when choosing operative care (β = -0.14; p = 0.02). For every 1 mm increase in displacement, surgeons tended to favor ORIF by a factor of 0.09 (p < 0.01).
Surgeons unanimously began favoring ORIF at 8.16 mm of displacement (95% CI: 2.05 – 14.1). Gender, mechanism of injury, and sport participation did not influence decision-making. 54% of the surgeons favored ORIF. Based on the personality Likert-scale, participants were neither high-risk takers nor extremely risk adverse with an average risk score of 2.24. Participant demographics did not influence clinical decision-making.

Summary Points

- There is substantial variation amongst surgeons when treating medial epicondyle fractures. The decision to operate is significantly based on fracture displacement and if there is a concomitant elbow dislocation.
- There is currently no standardization regarding how to treat medial epicondyle fractures in the pediatric and adolescent population. Treatment algorithms are needed in order to provide optimal patient outcomes.
Poster 237: Arthroscopic resection and debridement arthroplasty for the treatment of osteoarthritis of the elbow: investigation of prognostic factors

Category: Elbow/Forearm/Shoulder

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
We hypothesis arthroscopic resection and debridement arthroplasty is effective for the patients of osteoarthritis of the elbow and to investigate prognostic factors of the outcome after the procedure is valuable not for the patients but also for the physicians.

Methods
From 2007 to 2015, we conducted a retrospective study which included 23 patients (7 females; 16 males); 21 primary osteoarthritis of the elbow and two post elbow fractures were diagnosed. Mean age at the time of the procedure was 55 years (range, 27-84). Mean postoperative follow up period was 27 months (range, 6-96). All patients presented disability of upper arm extremities because of both elbow pain and limitation of range of motion (ROM). All patients underwent arthroscopic resection and debridement arthroplasty after synovectomy and loose bodies removal through six or seven portals around the elbow. Osteophytectomy and partial resection were performed to coronoid, olecranon, radial head and each fossa using abrader without impingement to opposite side (Figure 1 and 2). In the 12 cases of cubital tunnel syndrome (CuTS) association, we added both open ulnar nerve neurolysis and release for posterior oblique portion of medial collateral ligament through small medial skin incision. Investigated factors were age, gender, association of CuTS, pre and postoperative pain, ROM, grip strength and Quick DASH score. We defined that postoperative Mayo Elbow Performance Score (MEPS) was higher than 85 points, was the superior group, on the other hands, the other was the inferior group.

Results
There were no complications such as compartment syndrome and transient neuritis. Regarding the ROM, the preoperative average extension of -18 and flexion of 112 degrees significantly improved to postoperative average extension of -12 (P=0.01) and flexion of 123 degrees (P<0.01). Average gain of motion was 17 degrees after the procedure. Regarding the MEPS, the
preoperative average of 70 points (range, 40-90) significantly improved to postoperative average of 95 (range, 80-100) (P<0.01). Regarding the Quick DASH score, the preoperative average of 25 points (range, 6.8-54.5) significantly improved to postoperative average of 6 (range, 0-22.7) (P<0.01).

In comparison with the superior and inferior groups, postoperative pain (P<0.001) and ROM of the extension (P=0.043) were the factors with significance.

Summary Points

• This procedure provided pain relief, improvement of approximately 20 degrees ROM and both objective and subjective excellent outcomes.
• For achievement of good results without complication, this less invasive arthroscopic treatment is highly recommended for patients who have pain and limitation of motion of the elbow as

Category: Elbow/Forearm/Shoulder

Treatment; Surgical Technique
Level 4 Evidence

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Hypothesis
The anatomy of the posterior aspect of the elbow makes the area prone to soft tissue defects. Several types of fasciocutaneous flaps and free tissue transfers have been used to reconstruct these defects. The posterior interosseous artery (PIA) flap has been described as versatile, technically easy, and with low complication rates to cover soft tissue defects on the dorsum of the hand. This flap has consistent perforators at the distal third of the forearm, and therefore can safely be used to cover defects at the posterior aspect of the elbow using the dorsal skin of the donor area.

Methods
Between 2008 and 2016, a clinical study in 4 patients that presented with soft tissues defects around the elbow, treated with an antegrade PIA flap we. Additionally, an anatomical study was performed on 6 cadaveric specimens to assess the number of perforators of the PIA at the distal third of the forearm, along with the distance of the perforators from the ulnar styloid. The pedicle distance from the pivot point to the lateral epicondyle was recorded. All the specimens were dissected after the injection of colored silicone rubber.

Results
The mean age of the patients was 68 (range 61-75) years old. One was one male and three females. The mean number of previous surgeries was 2.5 (range, 2-3). The mean follow-up was 6 months (range 0.5-9). The mean size of the flap was 5.25x4 cm (range 8x3). All patients had survival to the flap, with full coverage of the defect and without necrosis or venous congestion. In the cadaveric study, a mean of 3 perforators was found (range 2-4). The first perforator was found at 3.5 cm from the ulnar styloid (range 1.6-6), the second perforator was found at 5.3 (range 2.8-7.2), the third perforator was found in five specimens, mean length 7.82 (4.5-9). The pedicle distance from the pivot point to the lateral epicondyle was 9.6 cm (range 8-11). The end point for rotation was the posterior interosseous nerve at the proximal forearm.
Summary Points

- The present technique presents a suitable regional flap that covers elbow defects on patients with exposed hardware or chronic wounds without the need of microsurgical anastomosis.
- The antegrade PIA flap shown to be a reliable and effective alternative for the treatment of soft tissue defects at the elbow.
- The cadaveric study showed the presence of at least two fasciocutaneous perforators at the distal third of the forearm.

Bibliography


Images
Poster 239: The Epidemiology of Lateral and Medial Epicondylitis and Its Surgical Treatment  
*Category: Elbow/Forearm/Shoulder*

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Level 4 Evidence

Neil Gregory Harness, MD  
Justin Haghverdian

**Hypothesis**
The incidence and prevalence of lateral and medial epicondylitis in an adult population and the percentage of patients that undergo surgery is uncertain. The first purpose of this study was to calculate the incidence and prevalence of lateral and medial epicondylitis in a large, adult patient population and the second purpose was to estimate the number of epicondylitis cases that are treated surgically within five years of the diagnosis.

**Methods**
Using International Classification of Diseases and Related Health Problems (ICD-9) codes, the [Institution removed for blinding] database was queried to identify the number of patients 18 years of age and older who were either newly diagnosed or already carried the diagnosis of lateral or medial epicondylitis between January 1st, 2008 and December 31st, 2008. A search was conducted using Current Procedural Terminology (CPT) codes to identify the number of individuals who underwent surgery for a diagnosis of lateral or medial epicondylitis between January 1st, 2008 and December 31st, 2009. With this information we were able to calculate the incidence and prevalence of lateral and medial epicondylitis as well as the percentage of cases that required surgical intervention during a five year period after the diagnosis. Incidence rates were calculated as case per person-year. Confidence intervals for incidence rates were determined. Statistical comparison of sex distribution was obtained using a two-sample proportion test.

**Results**
2,389,111 adult patients were enrolled in [Institution removed for blinding] in 2008. The incidences of lateral and medial epicondylitis were found to be 7.0 per 1000 person-years and 1.7 per 1000 person-years, respectively. The incidence of a simultaneous diagnosis of medial and lateral epicondylitis was 0.4 per 1000 person-years. The prevalence during that year was noted to be 16,839 (0.70%) for lateral epicondylitis and 3,980 (0.17%) for medial epicondylitis. The prevalence of simultaneous medial and lateral epicondylitis was 879 (0.04%). 279 (1.7%) individuals with lateral epicondylitis underwent surgery within 5 years of diagnosis while 94
(2.4%) patients with medial epicondylitis had surgical intervention within the same time frame. Both conditions were significantly more common in the 40-60 year old age group and no more common in men than women.

Summary Points
- Incidence and prevalence was found to be lower than previous reports.
- Approximately one third of those diagnosed were younger than 40 or older than 60.
- Only 1.7% of those with lateral and 2.4% with medial epicondylitis will need surgery within five years of the date of diagnosis.
Poster 240: Posterior Medial Ulnar Collateral Ligament Reconstruction as Treatment for Coronoid Fracture Induced Posteromedial Rotatory Instability

Category: Elbow/Forearm/Shoulder

Evaluation/Diagnosis; Surgical Technique; Basic Science
N/A - not a clinical study

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Hypothesis
We hypothesized a transverse type II coronoid fracture in the presence of a transected posterior medial ulnar collateral ligament (pMUCL) would result in posteromedial rotatory instability (PMRI). Secondly, we assessed whether our method of pMUCL tendon graft reconstruction would sufficiently recover elbow stability without the need to repair the coronoid fracture.

Methods
Eight (N=8) cadaveric elbows were used in this study. Soft tissue was dissected, leaving the capsule and medial and lateral collateral ligaments intact. A radial osteotomy was performed to ensure rotation was not limited by a fixed radius. PMRI was simulated by applying a 10 N axial load, followed by a varus bend of up to 5 degrees to a maximum varus moment of 4.5 N-m. Internal rotation was then induced to a maximum of 2.5 N-m. 4 infrared markers fashioned to Kirshner-wires were mounted to the specimen (Fig. 1). A Vicon three-dimensional motion capture system (Vicon, Denver, CO) was used to measure joint displacement to assess elbow stability. Mechanical testing was conducted at four conditions: intact (intact coronoid and MUCL complex), cut coronoid + cut pMUCL (type II coronoid fracture and transected pMUCL), pMUCL reconstruction (tendon graft reconstruction of the pMUCL), pMUCL reconstruction + cut aMUCL (transected aMUCL in the presence of the pMUCL reconstruction). Testing of each condition was performed at 30, 60, and 90 degrees of elbow flexion.

Results
Compared to the intact condition, proximal joint gapping increased at all flexion angles in the cut coronoid + cut pMUCL condition based on independent T-tests. Gapping significantly increased at 60 and 90 degrees by an average of 1.6mm (p=0.005) and 2.15 mm (p=0.007), respectively.
There was an increase in joint gapping at 30 degrees, however this increase was not significant. Following the pMUCL reconstruction, elbow stability was recovered at 60 and 90 degrees of flexion; joint gapping was reduced by an average of 1.034 mm (p=0.049) and 2.433 mm (p=0.0025), respectively. After transection of the aMUCL, there was no significant increase in joint gapping when compared to the reconstructed condition. Furthermore, joint gapping was significantly different from the intact condition at 30 and 60 degrees. Comparisons between multiple conditions were made via traditional one-way ANOVA (Fig. 2).

Summary Points
- PMRI can result from a type II coronoid fracture in the presence of a damaged pMUCL
- pMUCL reconstruction can recover elbow stability without the need for coronoid fracture repair
- aMUCL and the pMUCL are most functionally active at 30 and 90 degrees respectively
Poster 241: Proximal Radio-Ulnar Joint Anatomy as a Marker for Radial Head Arthroplasty

Category: Elbow/Forearm/Shoulder
Evaluation/Diagnosis; Surgical Technique; Anatomy
N/A - not a clinical study

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Hypothesis
The proximal radio-ulnar joint (PRUJ) has reproducible radiographic anatomy that can be used for reference when templating radial head implant positioning. If x-rays can provide reproducible measurements for this purpose, the extra cost and radiation associated with CT imaging of contralateral elbows can be avoided.

Methods
Patients above the age of 18 who had radiographs of their elbows performed in the last year were eligible for study. Patients who had trauma anywhere from the humeral shaft to the distal radius were excluded from study. Radiographs were deemed acceptable if proper radiographic technique had been used and the elbow had been imaged at full extension and full supination. Upon chart review, the indication for radiography, age, sex, height, weight, and BMI were abstracted. Two fellowship trained orthopaedic hand surgery attendings, one senior resident and one junior resident assessed the radiographs for two measures of PRUJ variance: 1) AP coronoid to radial head height defined as the distance from the center of the radial head to the top of the coronoid projection, 2) AP coronoid to radial head angle defined as the angle between a line connecting the most proximal projections of the radial head and a line from the lateral radial head to the most proximal point of the coronoid. Data was analyzed for average PRUJ variance and inter-observer reliability.

Results
Fifty elbow radiographs were randomly selected from the inclusion group for radiographic study. There were 13 females and 37 males in the study group with an average age of 40 +/- 16 years. The average coronoid-radial head distance was 2.1 +/- 1.5mm and the average coronoid to radial head angle was 3.7 +/- 2.6 degrees. Interobserver reliability was 0.95 for both measurements.
**Summary Points**

- The PRUJ has a consistent radiographic relationship with the coronoid on average 2.1 mm proximal to the radial head
- The PRUJ relationship can be used as a marker for appropriate placement and sizing of radial head prostheses
- The radiographic outcomes of this study show it is similar to CT in reliability and avoids the cost and radiation exposure of CT.

**Bibliography**

1: Doornberg J, Linzel D, Zurakowski D, Ring D "Reference points for radial head prosthesis size" JHS 31A: 53-57. 2006

Images
Poster 242: The AO/OTA Classification – A Useful Means of Predicting Compartment Syndrome in Both Bone Forearm Fractures.

Category: Elbow/Forearm/Shoulder

Evaluation/Diagnosis; Prognosis/Outcomes; Basic Science

Level 4 Evidence

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Mark Adams

Hypothesis
The purpose of this study is to evaluate the efficacy of using the AO/OTA classification for predicting the incidence of forearm compartment syndrome.

Methods
A retrospective chart review was conducted at a level 1 academic trauma center for upper extremity fractures between 2001 and 2016 for fractures of the forearm. Inclusion criteria for this study included patients who were 18 years and older who sustained both bone fractures of the forearm. On radiological review, patients were only included if a minimum of 2 preoperative views could be analyzed for fracture classification. Gunshot wounds were excluded from analysis. 151 patients met inclusion criteria.

Data was collected regarding patient age, sex, location of the fracture, open vs. closed status, mechanism of injury, and whether or not surgical fasciotomy was conducted. Radiographic studies for both bone fractures were then reviewed and graded based on the AO/OTA fracture classification system. Statistical analysis was conducted using chi square tests to analyze which fracture classifications were more likely to be associated with fasciotomies.

Results
Of 151 total both bone forearm fractures, 23 patients developed compartment syndrome and underwent fasciotomies, and 128 did not require fasciotomies. 56 were open fractures and 95 were closed. 8 fractures were in the proximal third, 70 were in the middle third, and 42 were in the distal third. The remaining 31 fractures were “mixed” and had segmental components, with each fracture line in a different third of the forearm.

Of 151 total both bone forearm fractures, 6 of 80 (7.5%) grouped 22-A3, 8 of 44 (18%) grouped 22-B3, and 9 of 27 (33%) grouped 22-C required fasciotomies for compartment syndrome (p =
The relative risks of developing compartment syndrome for group 22-B3 versus 22-A3 was 2.42 (p = 0.08), 22-C versus 22-B3 was 1.83 (p = 0.15), and 22-C versus 22-A3 was 4.44 (p = 0.002).

Summary Points

• There is a significant difference in the incidence of compartment syndrome when comparing the three AO/OTA classifications, with group C fractures representing the highest risk.
• Fracture location, open vs closed status, and mechanism of injury were not shown to predict compartment syndrome with statistical significance.
• Clinicians can use this information to have a higher index of suspicion for compartment syndrome based on AO/OTA classification to help minimize the risk of a missed diagnosis.
Hypothesis
Despite the prevalence of lateral epicondylitis, there is a lack of consensus on best treatment practices for this condition. The purpose of this study is to investigate current management for lateral epicondylitis by fellowship-trained upper extremity surgeons.

Methods
A 17-question survey about treatment and outcomes related to lateral epicondylitis were sent to over 3000 surgeons using the American Society for Surgery of the Hand (ASSH) and American Shoulder and Elbow Surgeons (ASES) member databases. The data was analyzed using pivot tables and multivariate analysis.

Results
612 upper extremity surgeons completed the survey. The five most frequently prescribed non-operative treatments for lateral epicondylitis included home exercise program/stretching (81%), NSAIDs (75%), steroid injection (71%), counterforce bracing (68%), formal physical therapy (65%), and wrist brace (48%). Less commonly performed non-operative treatment measures included platelet-rich plasma (16%), Tenex (6%), and iontophoresis (2%). Of those who offer a steroid injection, 86% will give no more than three. Duration of non-operative treatment varies from 3 months (12%), 6 months (47%), and 12 months (39%). 59% of surgeons perform 3 or fewer surgeries per year, 29% perform 4 to 10, and 12% of surgeons will perform more than 10 per year. Before surgery, 42% of surgeons obtain an x-ray, and 33% obtain an MRI. Of the 95% of surgeons who offer surgery as a treatment, 56% perform open debridement with side-to-side repair, 21% perform open debridement with reattachment of the extensor mass to the lateral epicondyle, 16% who openly debride without side-to-side repair, 12% who arthroscopically debride, and only 4% who percutaneously release the extensor origin. Immobilization after surgery was very variable ranging from long arm splint for 2 weeks (22%), short arm splint for 2 weeks (17%), and the majority who do not immobilize post-operatively at all (34%). Surgeon
perception of 90% patient improvement after surgery occurred on average 3 months post-operatively, with higher volume surgeons (>3 cases/year) believing it occurs at 3 months versus lower volume surgeons (=3 cases/year) believing it occurs at 6 months (p = 0.004).

**Summary Points**
This study provides insight into current trends in treatment of lateral epicondylitis amongst fellowship-trained upper extremity surgeons. There is a lack of consensus in the literature in management of lateral epicondylitis and therefore clear guidelines for treatment do not exist. Future research may include prospective randomized control studies to help clarify best practice for this common diagnosis.
Hypothesis
Distal humerus fractures (DHF) have been increasing in incidence over the last few decades.\(^1,2\) Elbow fractures account for roughly 7% of all adult fractures; DHF making up roughly 30% of those.\(^3,4\) We hypothesize that the 30-day complication rate after operative fixation of DHF is similar regardless of patient comorbidities.

Methods
All instances of operative fixation of DHF from 2005 to 2015 in the prospective, American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database were identified using 7 CPT codes. Bivariate analysis and logistic regression were performed to determine which patient demographics, surgical factors and medical comorbidities were predictors for complications. Complications examined included wound complications, systemic complications, return to operating room (OR) and readmission. We also analyzed a subset of patients with wound complications, returned to the OR for surgical management of their injury or were readmitted for surgical complications.

Results
We included 1015 patients who underwent operative fixation of their DHF. Of them, 121 patients (11.9%) experienced at least one complication including wound complication (2.28%), return to OR (2.36%), readmission (4.63%), need for blood transfusion (4.24%) and death (0.69%). (Table 1) Under univariate analysis, age over 65, female sex, functional status, American Society of Anesthesiologist (ASA) Class, diabetes, hypertension, COPD, renal dialysis, increased surgical time, inpatient surgery and increased length of stay were significant risk factors for complications \((p<0.05)\). We further isolated patients with surgery-related complications – open fracture, ASA class, COPD, renal dialysis and longer length of stay were significant risk factors. (Table 2) Multivariate logistic regression identified age \((p<0.05)\), operative time \((p<0.001)\) and increased length of stay \((p<0.02)\) as independent risk factors for all complications; for surgical
complications only, open fractures (p<0.01) and ASA class were noted to be independent predictors.

Summary Points

- DHF had a complication rate of 11.9%, surgical complication rate of 5.62% and wound complication rate of 2.28%
- Open fracture, ASA Class, COPD and renal dialysis were significant risk factors for surgical complications in univariate analysis
- Multiple logistic regression identified open fractures and ASA as class independent predictors for surgical complications

Bibliography


Images
Poster 247: Radial head replacement with a bipolar system: an average 10-year follow-up

Category: Elbow/Forearm/Shoulder

Treatment; Surgical Technique; Prognosis/Outcomes

Level 4 Evidence

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Hypothesis
We report the long-term results of a cohort of patients undergoing radial head replacement utilizing a bipolar radial head prosthesis with a smooth, unfixed, telescoping stem after a mean follow-up of over 10 years.

Methods
Sixteen of seventeen possible patients from a previous 3-year follow-up study were available for review. Patients were assessed using clinical and radiographic examination, as well as with standardized outcome measures. Elbow range or motion, elbow stability, and radiographic measures evaluating implant loosening and joint degeneration were assessed. Comparisons were performed using two-tailed T-test.

Results
The average follow-up was 10.4 years (range, 8.6-11.9 years). The median VAS was 1.0 (range 0-5), MEPI was 92.5 (range 70-100), and DASH score was 7.5 (range 0-52.5). Arcs of motion were decreased on the operative side compared to the nonoperative side for flexion/extension (p = 0.005), pronation (p = 0.015) and supination (p = 0.015), as was grip strength (p = 0.045). No patients were found to have elbow instability. Two patients developed significant arthritic changes at the ulnohumeral joint. The average cantilever quotient was 0.42 (range, 0.31-0.50). Osteolysis in zones 1-7 was found in all but 2 patients. The mean stem radiolucency was 0.55 mm (range 0.22 – 0.88 mm). As reported in our previous series there were 3 patients who underwent reoperation within 1 year for stiffness and 1 patient whose implant was revised at 14 days for ulnohumeral joint instability, but no re-operations in any patients since the previous report. Overall survivorship at greater than 10 years in this cohort was 96.67%.
Summary
At 10 years, bipolar radial head prostheses with smooth stems and telescoping necks effectively restore elbow stability and function following comminuted radial head fractures with or without concomitant elbow instability. Our study demonstrates excellent long-term survivorship. To date, this is the largest long-term reported outcome analysis of a smooth-stemmed uncemented bipolar radial head replacement in the literature.

Bibliography
Poster 248: Medial Collateral Ligaments as the Initial Site of Rupture in Simple and Complex Elbow Dislocations

Category: Elbow/Forearm/Shoulder

Evaluation/Diagnosis;Anatomy
N/A - not a clinical study

Grant Received from: American Foundation for Surgery of the Hand: Resident and Fellow Fast Track Grant

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Hypothesis
Using data from our previously published in vivo observational and imaging studies, we aimed to biomechanically recreate elbow dislocations in the most common previously identified position of dislocation (shoulder abduction, elbow extension, forearm pronation), and to evaluate the type of soft tissue and osseous injury that occur.(1,2) We hypothesized that most dislocations would involve initial failure of the medial collateral ligaments.

Methods
Eleven fresh frozen cadaveric elbows were thawed and dissected leaving all medial ligaments, lateral ligaments, and the anterior and posterior capsule intact. Specimens were mounted in a servo-hydraulic load frame in the most common position of elbow dislocation observed during an in vivo study (30° forward flexion, 30° shoulder abduction, Figure 1). Humerus and forearm axial rotation and elbow flexion were fixed while elbow varus/valgus motion was unconstrained. Each specimen was ramped to failure at 10mm/sec. Fluoroscopic and manual examination was performed to determine presence of fracture and/or soft tissue injury. Dislocation status and modes of injury were noted for all specimens.

Results
Seven of the eleven specimens (64%) dislocated when loaded, three failed through fracture alone, and one reached the machine’s load limit before failure. In all seven dislocated elbows (100%), at least one band of the medial collateral ligament (MCL) was functionally compromised. The lateral ligamentous complex (LCL) was disrupted in only 2/7 (29%) of the dislocations (Figure
2). There were two simple and five complex dislocations; 4 were “terrible triad” injuries and the other was a trans-olecranon fracture dislocation with a radial head and neck fracture. The three specimens that sustained fracture alone included two isolated radial head fracture and one specimen with a radial head, coronoid and capitellum fracture.

**Summary Points**

- This biomechanical study, along with our previous in vivo and imaging studies, support our hypothesis that the MCL is frequently the initial site of disruption in the most common position of elbow dislocation.\(^{(1,2,4)}\)
- Previous studies proposing the lateral ulnar collateral ligament (LUCL) as the initial site of failure in elbow dislocations were performed with the elbow in flexion.\(^{(3)}\) The current study successfully dislocated elbows in the more common dislocation position of elbow extension, shoulder abduction, and forearm pronation as seen in our previous in vivo studies.\(^{(1)}\)
- Falling on an outstretched arm with elbow extension, shoulder abduction and forearm pronation is also likely a mechanism for terrible triad injuries and radial head fractures.\(^{(5)}\)

**Bibliography**


Images
Poster 249: Are follow-up elbow radiographs indicated to detect interval displacement of isolated intra-articular radial head fractures?

Category: Elbow/Forearm/Shoulder

Evaluation/Diagnosis
Level 3 Evidence

Grant Received from: National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health under award number U01AR067138

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Hypothesis
The current peer-reviewed literature suggests that, in the absence of a mechanical block to motion, the majority of isolated radial head fractures with small amounts of displacement can be treated non-operatively with good functional outcomes. It is unknown, however, what percentage of these fractures initially treated non-operatively subsequently displace. Our null hypotheses are that 1) isolated intra-articular radial head fractures do not displace further in the early post-injury period (as defined as or =18 years) evaluated at a single tertiary academic center between 11/1997 – 9/2016 with a diagnosis of radial head fracture were identified based upon ICD-9/10 codes. Exclusion criteria included non-isolated upper extremity injury including concomitant dislocation, lack of follow-up ipsilateral elbow radiograph series within 3-8 weeks from injury, and initial operative management. Radiographs and clinical charts were retrospectively reviewed in a random and blinded fashion to measure radial head articular gap and step-off and to determine fracture management. Basic descriptive statistics were calculated, and a one-sided one-sample equivalence test was utilized to determine whether interval displacement was within 1mm. The study was powered to detect a 5% rate of displacement to > or =5mm on follow-up radiographs with a 95% confidence interval (CI, 1.2-13.0%).

Results
The 73 included patients had a mean age of 44 years and 51% were male. Fractures were classified as Mason I (74%), II (25%), and III (1%). The average duration between radiographs was 33.6 (± 8.9) days. The majority of follow-up radiographs demonstrated a change of 5mm of
step-off was not observed, and follow-up radiographs did not prompt surgical treatment for any patient in the cohort.

Summary Points?

• Routinely obtaining follow-up radiographs following initial injury films in the management of isolated intra-articular radial head fractures utilizes resources without clear benefit.

Bibliography


Poster 251: A Microeconomic Evaluation of Treatment Methods for Diaphyseal Forearm Fractures

*Category: Elbow/Forearm/Shoulder*

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**Hypothesis**
We hypothesized that a microeconomic evaluation of treating diaphyseal forearm fractures will indicate plate fixation over intramedullary nailing leading to improved economic and health outcomes for the adolescent patient.

**BACKGROUND**
There is currently a lack of consensus as to the optimal treatment of diaphyseal forearm fractures in adolescent patients. While many studies have highlighted the benefits and pitfalls of intramedullary nailing (IMN) and plate fixation (ORIF) methods, few studies performed cost-analysis and examined the economic impact on patients. Clinicians should consider costs in treatment decisions as rising healthcare costs have a significant impact on both patients and the healthcare system in general with the overall share of the U.S. economy devoted to health care spending at 17.8% in 2015 (1).

**Methods**
A retrospective review was performed on all adolescent patients at a children’s hospital between ages 10-16 years old and treated with intramedullary fixation or plate fixation for diaphyseal both bone forearm fractures between 2005 and 2014. We attained the charges billed to patients which included cost of hardware, OR time, and anesthesia. The impact of complications and hardware removal on cost was also collected. Health outcomes were measured using time to radiographic union.

**Results**
102 patients met the inclusion criteria. Generally, IMN hardware costs less to implant than plate hardware. Cost ratio of the primary surgery was 1.57:1 when comparing ORIF versus IMN, respectively. However, we identified a reoperation rate of 91% for IMN within our study. When standardizing the costs of anesthesia and OR time in the primary surgery and the subsequent reoperation, we found a cost savings of 12% to patients for single operation ORIF when
compared to the primary surgery combined with reoperation in IMN. Time to radiographic union was 10 days longer for intramedullary fixation (P=0.03).

Summary Points
- Plate fixation has a higher initial cost, but led to shorter time to radiographic union and overall lower economic impact to patients when considering the high reoperation rate in IMN.
- A reoperation leads to additional costs to patients, both direct and indirect
- Clinicians can lower the cost burden to patients and maintain excellent clinical outcomes in treating diaphyseal both bone forearm fractures in adolescent patients by considering ORIF for these patients rather than IMN.

Bibliography
Poster 252: Long-term Outcomes of Arthroscopic Elbow Contracture Release

Category: Elbow/Forearm/Shoulder

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Christina M. Beck, PhD
Matthew J. Gluck, BA
Wayne Reizner, MD, MBA
Todd Rubin, MD
Michael Hausman, MD

Hypothesis
Arthroscopic contracture release of the elbow results in excellent long-term functional outcomes.

Methods
This is a retrospective review of 22 patients who underwent arthroscopic contracture release for either primary osteoarthritis or traumatic injury by one surgeon at a single institution from 2003-2014. At a minimum of one year follow-up, patients were evaluated for elbow range of motion during an office visit or via digital pictures (Meislin et al), and completed the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire. Furthermore, any complications or further procedures were documented.

Results
The average patient age was 48 years (range 13-70). Indications included elbow contracture secondary to osteoarthritis (N=9) or trauma (N=13). 21 patients completed the DASH questionnaire with an average follow up of 4.8 years (range 1.5-13 years). The average score was 24±26. Average post-operative flexion/extension elbow arc of motion was 19-129 degrees with a range of 0-147. Average supination was 82 degrees (range 58-120) and pronation 81 degrees (range 53-98). Four patients underwent reoperation, one for hematoma and three for subsequent contracture release to further improve range of motion.

Summary Points
- Arthroscopic contracture release is a technically challenging procedure, though offers similar results compared to open approaches.
- This study demonstrates good to excellent subjective and objective outcomes at long-term follow up.
• Despite the challenge associated with this procedure, we demonstrate a low complication rate.

Bibliography

Images
Hypothesis
Network meta-analysis (NMA) of randomized controlled trials (RCTs) was performed to compare the adverse events, reoperation rates and functional outcomes associated with non-surgical treatment (NST), open reduction internal fixation (ORIF), hemiarthroplasty (HA), and reverse total shoulder arthroplasty (rTSA) for the treatment of 3 and 4-part proximal humerus fractures (PHFs) in the elderly.

Methods
We searched four electronic databases for RCTs comparing 3 and 4-part PHF treatments in the elderly. Eight RCTs with a total of 364 participants (mean age = 73.4 years) were ultimately included. Quality of the included studies was evaluated using the Cochrane Collaboration’s tool for risk of bias.(1) The pooled Standardized Mean Difference (SMD) was calculated and presented with 95% confidence interval (CI). Pooled risk ratio (RR) was used to compare adverse event and additional surgery rates.

Results
rTSA resulted in significantly better Combined Constant/DASH score than HA at the furthest available follow-up time (SMD = 0.89; CI = 0.36 - 1.41; p < 0.01). There were no significant differences between ORIF versus NST, HA versus NST, and HA versus ORIF (Figure 1). rTSA was associated with a lower adverse event rate than HA (RR = 0.57; 95% CI = 0.36 - 0.90; p = 0.02) while ORIF was associated with a higher rate than NST (RR = 1.45; CI = 1.10 - 1.91; p < 0.01). There were no significant differences between HA versus NST and HA versus ORIF (Figure 2).
ORIF was associated with an increased rate of additional surgery compared to NST (RR = 8.13; CI = 2.10 - 31.60; p < 0.01). There were no significant differences between rTSA versus HA, HA versus NST, and HA versus ORIF.

Summary Points
- A 2015 Cochrane Review revealed no consensus regarding the superiority of any one surgical strategy. (2)
- This NMA found that NST should be the preferred treatment strategy when indicated, as it had similar (and in some cases better) outcomes than surgical interventions. NST is the cheaper option and has a higher probability of being cost-effective compared to surgical treatment. (3)
- In cases where surgical treatment is deemed necessary, rTSA should be preferred over HA as it produces better outcomes, lower adverse event rate, and no significant difference in additional surgery rate.

Bibliography
Images
Poster 254: Does the transcondylar screw of posterolateral plate contribute to the stabilization of orthogonal plating?

Category: Elbow/Forearm/Shoulder

Treatment; Surgical Technique; Basic Science
N/A - not a clinical study

Akira Hara, MD, PhD
Satoshi Ichihara, MD, PhD
Toshiya Kudo, MD
Hideaki Iwase
Kouichi Kusunose, MD, PhD
Yuichiro Maruyama, MD, PhD

Hypothesis
Transcondylar screw of the posterolateral plate in Synthes LCP-distal humerus plate (LCP-DHP, Synthes GmbH, Solothum, Switzerland) makes stiffer or more rigid on the stabilization of orthogonal plating in the distal humeral intraarticular AO type C fractures.

Methods
We used artificial bone to make an AO type 13-C2.3 intraarticular fracture model with a 1cm gap at the supracondylar level.
We used double plates as orthogonal plate, with the medial plate and the posterolateral plate without support (n=3, group A) or the posterolateral plate with support inserted one 2.7-mm LCP locking screw through the support hole from lateral to medial direction (n=3, group B).
An axial load was applied to the radial or ulnar column respectively from 0N to 200N. We calculated the stiffness of the radial or ulnar column during 50-150N and 100-200N axial load, and the anterior displacement of condylar fragment as angular movement of this fragment in the lateral view. Data was analyzed using the unpaired student t test.

Results
There were no significant differences regarding of the radial column or ulnar column stiffness between two groups. The ulnar column stiffness was superior to the radial column in both groups, but there were no significant differences between ulnar column and radial column during 50-150N axial load in both groups and 100-200N axial load in group B. There were significant differences between radial column stiffness (96.2±8.6 N/mm) and ulnar column stiffness (126.9±12.8 N/mm) during 100-200N axial load in group A (p=0.0132) (Fig.1).
The angular displacement of capitellum was 5.2 ±1.2 degree in group A and 5.4±0.9 degree in group B (no significant differences between both groups). On the other hand the angular
displacement of trochlea was 2.8±1.0 degree in group A and 2.1±0.8 degree in group B (no significant differences between both groups). The capitellum moved anterior more than trochlea during axial compression in both groups. There were significant differences in group B (P=0.0145) (Fig.2).

**Summary Points**
- In the LCP-DHP the posterolateral plate tended to be bent on axial compression.
- The transcondylar screw of the support hole in group B did not contribute both to the stability on the medial or lateral compression force and to the bending motion on the lateral view.
- We used only one transcondylar screw in group B. We need further investigation whether the two transcondylar screws make any effect on the stability of the distal humerus fracture in orthogonal plating.

**Bibliography**
Hypothesis
Geriatric comminuted, intra articular distal humerus fractures have sufficient long-term outcomes with ORIF.

Methods
This is a retrospective case series of 9 patients >65 years treated with ORIF for distal humerus fracture by 2 surgeons at a single institution from 2001-2016. All of these injuries were treated in the acute setting. Baseline characteristics of patients were documented and patients were asked to complete the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and the Mayo Elbow Performance Score (MEPS) at most recent follow-up in the office or over the phone. Furthermore, any complications or need for further surgery were collected and documented.

Results
9 patients with average follow up of 7 years (6mo – 64mo) completed the questionnaires. The MEPS average score was 90±10 and the DASH average score was 12±11. There were no complications in this series. No patients required further surgery for contracture release or hardware removal.

Summary Points
• Surgical treatment for distal humerus fractures in the elderly (>65 years) includes open reduction internal fixation (ORIF) and total elbow arthroplasty (TEA).
• The number of geriatric distal humerus fractures being treated with TEA in the United States has increased dramatically.
• TEA postoperative instructions require patients to comply with lifetime weightbearing restrictions of five lbs on the affected extremity.
• This is problematic because as we age, we become quadrupeds due to the need for assistive devices such as walkers and canes. Furthermore, dementia in the elderly is increasingly common and causes inability to comply with restrictions.
• As such, we believe that elderly patients are unable to comply with weightbearing restrictions, and the complications associated with TEAs including loosening and failure can be devastating.
• In our series, patient outcomes were good to excellent.
• We suggest ORIF as a safe long-term treatment for elderly patients with distal humerus fractures.

Bibliography
Poster 256: Treatment of Traumatic Elbow Instability with an Internal Joint Stabilizer

*Category: Elbow/Forearm/Shoulder*

Treatment; Surgical Technique; Prognosis/Outcomes

Level 4 Evidence

Kristen M. Meier, MD
Steven Koehler, MD
Steven Andelman
Michael Hausman

**Hypothesis**
The recent development of an 'internal joint stabilizer', acting as an internal "external fixator" allows for early ulnohumeral range of motion while maintaining a stable and congruent reduction of the ulnohumeral and radiocapitellar joints.

**Methods**
This retrospective study reviewed ten patients who underwent placement of a modified internal joint stabilizer for persistent elbow instability after severe elbow fracture-dislocations. Final post-operative range of motion and complication rates were monitored for all patients and five patients completed outcome-scoring questionnaires.

**Results**
Ten patients who underwent placement of an internal joint stabilizer for persistent elbow instability after fracture-dislocation were reviewed. The final post-operative flexion-extension arc was 113° ±24.2°. When controlling for two uniquely complex patients, the final post-operative arc of motion improved to 124.3° ±11.0°. The average Mayo Elbow Performance Score improved from 10 ±11.2 to 64 ± 21.4 while the average Disabilities of Arm, Shoulder, and Hand score improved from 97.8 ± 2.5 to 40.5 ± 34.7.

**Summary Points**
- Current options for treating persistent elbow instability associated with complex elbow fracture-dislocations
- Include splint or cast immobilization, transarticular cross-pinning, temporary bridge plating.
- And hinged or rigid external fixation.
• Use of an internal joint stabilizer allows for early, congruent, and stable ulnohumeral and radiocapitellar
• Range of motion in instances of persistent elbow instability after elbow fracture-dislocation.
Poster 257: Anatomical Axis of the Distal Humerus Articular Surface

Category: Elbow/Forearm/Shoulder

Treatment;Anatomy;Basic Science
N/A - not a clinical study

Harry Hoyen

Hypothesis
3D modeling of the entire distal humerus surface will allow an accurate determination of the articular segment anatomic axis.

Methods
10 human cadaver specimens were used to acquire CT scan DICOM images, in 1 mm thickness. These images were converted into STL files using the Volnigna® software, and then subsequently into a Mesh file for analysis with Solidworks® software. The radius and ulna were removed in specific steps for each program. A coordinate system was created as a reference based on the humerus intramedullary axis and highly conserved flat section of the posterior humeral cortex. The ridges of the lateral and medial columns coalesced to form this flat section, thus defining the x axis of the coordinate system. The Z axis was parallel to the intramedullary canal. The Y axis was perpendicular to x axis at an intersection point between the X and Z axes. The articular surface "spool" was then represented by best fit spheres shapes. Using the 3D modeling program, a portion of three spheres was used to represent the trochlea and one for the capitellum. Two spheres were used to define the intramedullary axis. The articular axis was defined by a best fit line through the center of the four trochlear and capitellar spheres (figure 1). The articular axis was then described in relation to the different axes.

Results
The best fit line for the sphere centers (articular axis) was highly conserved with r² of 0.99 (figure 2). The average articular axis of the XY axis (rotational plane) was 10.86 degrees (6.14 to 16.78). The average XZ articular axis (varus/valgus) was 5.70 degrees (1.07 to 12.73.) The YZ axis (anterior/posterior) was 60.3 degrees (42.44 to 80.14 degrees). The capitellar sphere diameter was 22.94 +/- 5.23 mm. The most medial trochlear ridge (red) diameter was 27.65 +/- 2.67 mm. The center trochlear segment was 17.83 +/- 1.32 mm. The most medial trochlear ridge was 20.67 +/- 2.22 mm.
Summary Points

- This investigation describes a novel 3D modeling method to accurately defining the native distal humeral articular axis.
- The position of this articular axis is variable among the specimens and thus may be very patient specific.
- This has an important clinical relevance for placement of a humeral articular component in elbow arthroplasty.
- The restoration of the articular alignment using this method would reference the humerus IM axis and readily identifiable posterior distal humeral cortex.

Bibliography

2: Sabo MT, Athwal GS, King GJ. Landmarks for rotational alignment of the humeral component during elbow arthroplasty. JBJS. 2012;94:1794-800.

Images
Poster 258: Season-Ending Shoulder Injuries in the National Collegiate Athletic Association, 2009-2014

Category: Elbow/Forearm/Shoulder

Treatment; Prognosis/Outcomes; Patient Education
Level 2 Evidence

Avi D. Goodman, MD
Steven F. Defroda, MD
Joseph A. Gil, MD
Neill Li, MD
Brett D. Owens, MD

Hypothesis
The epidemiology of season-ending upper extremity collegiate sports injuries has not been described. We sought to examine the National Collegiate Athletic Association (NCAA) Injury Surveillance System database and characterize the severity of the upper extremity injuries, determine the injuries with the highest rate of ending an athlete’s season, and in which sports they occur in a population of varsity college athletes.

Methods
After IRB approval, the NCAA Injury Surveillance System database was reviewed for shoulder and elbow injuries from 2009-2010 to 2013-2014. Injuries were stratified by amount of time lost (season-ending versus non-season-ending), characterized using descriptive statistics, and comparisons made between groups via a chi-square test; statistical significance was set to p<0.05 a priori.

Results
2,867 injuries in 23 NCAA sports were identified between 2009 and 2014, of which 119 were season-ending (Figure 1). Clavicle fractures (n=33) and scapular fractures (n=9) had a 33.3% rate of being season-ending. Shoulder dislocations (n=117) had a 19.7% rate of being season-ending. There was no difference between the rate of posterior (n=10) and anterior (n=107) dislocations that were season-ending (20.0% and 19.6% rates, respectively [p=0.98]). Additionally, 22.0% of glenoid labrum tears (both SLAP and non-SLAP lesions, n=136) were season-ending. Other season-ending injuries included axillary nerve injury (20.0%), shoulder subluxation (5.4%), and multidirectional instability (4.8%). No other shoulder injury resulted in a loss of the season. Football accounted for the majority (54.6% [n=65]) of the season-ending shoulder injuries, while men’s soccer had the highest overall proportion of injuries that ended the season (14.3%).
Summary points

- Dislocations, labrum tears, and fractures were the most common season-ending shoulder injuries for NCAA athletes.
- Athletes sustaining these injuries, along with their coaches and medical providers, may benefit from this return-to-play data to best manage expectations and outcomes, with regards to injury duration and prognosis.
- Future directions include multivariate analysis to determine independent risk factors for time lost to injury.

Bibliography


Images
Poster 259: Symptomatic Cubitus Varus in Adolescents - Not Just A Cosmetic Problem!

Category: Elbow/Forearm/Shoulder

Treatment;Prognosis/Outcomes
Level 4 Evidence

Christine A. Ho, MD
Philip Wilson, MD

Hypothesis
Cubitus varus has been considered a primarily cosmetic problem in the pediatric population, despite adult reports of symptomatic cubitus varus. This is a report of a cohort of adolescents treated surgically for symptomatic cubitus varus with distal humeral osteotomy.

Methods
This is a retrospective review of all patients from 2001-2016 with the CPT code of 24400 (humerus osteotomy), diagnosis of symptomatic cubitus varus, and age greater than 10 years.

Results
Five patients (4 males, 1 female) were identified. Mean age at initial injury was 6.6 years old (range, 3.8-11.7 years); 3 sustained a supracondylar humerus fracture (all treated with CRPP), 1 a TRASH elbow with a medial condyle fracture (cast), and 1 elbow dislocation with medial epicondyle fracture (cast). Mean time to onset of symptoms after injury was 7.3 years (range, 4.4-12.8 years). All patients presented with posterolateral pain, 4 with mechanical symptoms, and 2 with physical exam signs of posterolateral rotatory instability. 1 patient had radiographic trochlear avascular necrosis. Mean cubitus varus was 10deg (range, 5-15deg) with contralateral cubitus valgus of 8deg (range, 5-20deg). Four patients had MRIs performed with findings ranging from normal to osteocartilaginous flaps and loose bodies. Distal humeral osteotomy was performed at a mean age of 15 years (range, 13.5-16.7 years). Three patients had lateral wedge closing osteotomy with posterolateral locked plate fixation, and two patients had dome osteotomies with bicolumnar nonlocked plating. Two patients had antecedent arthroscopy that did not relieve symptoms, and two patients had arthroscopy concurrent with distal humeral osteotomy. Complications included one transient lateral antebrachial cutaneous neuropaxia, one hardware removal, and one elbow stiffness that improved with therapy. Mean length of follow-up after osteotomy was 1.1 years (range 0.2-2.86 years). At final follow-up, mechanical symptoms and pain had resolved in all patients. Two patients complained of mild, occasional, nonfocal pain in their arm. One patient reported
painless elbow popping when extending his elbow playing trumpet. Mean valgus carrying angle at final follow up was 5deg (range, 0-12deg).

Summary Points
- Post-traumatic pediatric cubitus varus is not necessarily just a cosmetic deformity.
- Similar to adults, adolescents may develop posterolateral pain, mechanical symptoms, and posterolateral rotatory instability if the anatomic mechanical axis of the upper limb is not corrected.
- This is the first reported cohort on the existence and treatment of symptomatic posttraumatic cubitus varus in adolescents.
- Families of children with cubitus varus should be counseled about possible future symptoms when discussing corrective osteotomy.
Poster 260: Masquelet Reconstruction for Post-Traumatic Segmental Bone Defects in the Forearm  
Category: Elbow/Forearm/Shoulder  

Level 4 Evidence

Matthew Walker, MD  
Behnam Sharareh, MD  
Scott Mitchell, MD

Hypothesis

The Masquelet technique is an increasingly utilized procedure for addressing segmental bone defects in lower extremity trauma and nonunion. The technique involves bone debridement with temporary spacer placement to induce membrane formation followed by delayed bone grafting. To our knowledge, no study has reported on the Masquelet technique exclusively in the upper limb. We hypothesize that this technique may be used to reconstruct segmental bone loss in the forearm with encouraging results.

Methods

We reviewed all cases in which the Masquelet technique was used to reconstruct segmental bone defects in the forearm resulting from open fracture or non-union, with or without infection, between September 2014 and Jan 2017 at a level 1 trauma center. Injury mechanism, concomitant injuries and comorbidities, prior surgeries, size of bone defect, and demographic data were collected. Time to clinical and radiographic union was assessed along with any treatment related complications or reoperations.

Results

We identified 9 patients with segmental bony defects in the forearm treated with the Masquelet technique. Of this cohort, 5 patients presented with acute trauma, 1 presented with atrophic non-union and 3 with infected non-union with history of prior surgery. All 9 patients had initially sustained open fractures. The mechanism of injury included 3 gunshot wounds, 2 motor vehicle collisions, 2 motorcycle accidents, and 2 falls. Seven patients were treated for radius defects and 2 were for ulnar defects. The mean bony defect was 3.7 cm (SD 1.35, range 2.3–6.3 cm) prior to grafting. Second stage grafting was performed with Reamer Irrigator Aspirator (RIA) graft from the femur in 8 patients and iliac crest cancellous graft (ICBG) in 1 patient. There were 2 unplanned reoperations. In one patient, there was concern for persistent infection identified at the time of spacer removal, necessitating antibiotic spacer exchange followed by subsequent delayed grafting. Another patient sustained plate fracture prior to union and required revision.
open reduction internal fixation with ICBG. All cases went on to successful union. The average time to radiographic union was 14 weeks.

**Summary Points**

- The Masquelet technique effectively reconstructed bone defects in the forearm secondary to trauma or infection.
- Our results suggest that defects up to 6.3 cm may be reliably treated.
- Further studies are required to determine optimal graft type and defect size amenable to this procedure.

**Bibliography**

1. Giannoudis PV, Harwood PJ, Tosounidis T, Kanakaris NK; Restoration of Long Bone Defects Treated with the Induced Membrane Technique: protocol and outcomes; Injury. 2016, Dec; 47 Suppl 6: S53-S61
Hypothesis
Recently graduated fellowship trained hand surgeons are performing an increasing amount of shoulder and elbow surgery, relative to their peers, in their first two years of practice.

Methods
Cases submitted by board-eligible orthopaedic surgeons, taking Part 2 of their board exam, to the American Board of Orthopaedic Surgery (ABOS) between 2004 and 2013 were queried for all shoulder and elbow procedures. The resulting records were subdivided into six groups based on fellowship training: hand surgery, sports medicine, shoulder and elbow, trauma, other, and no fellowship. The percentage of shoulder and elbow cases performed by each group was compared to the total of all groups combined. Additionally, the trend for fellowship trained hand surgeons was compared to the trend for non-fellowship trained surgeons.

Results
Over the ten-year period studied, the average number of shoulder cases submitted by the six groups was 9,230, while the average number of elbow cases was 4,127. The proportion of shoulder cases performed by fellowship trained hand surgeons increased from 7.8% of the total in 2004 to 10.0% in 2013, while the proportion of elbow cases increased from 20.5% to 25.8%. The percentage of shoulder cases performed by non-fellowship trained surgeons decreased from 24.7% to 11.4%, while elbow cases decreased from 22.1% to 5.4%.

Summary Points
- Orthopaedic Hand Fellowship trained surgeons are performing an increasing amount of the shoulder and elbow cases submitted to the ABOS by surgeons taking Part 2 of the boards.
- Non-fellowship trained surgeons are performing a decreasing amount of the shoulder and elbow cases submitted.
• Between 2004 and 2013, fellowship trained hand surgeons are increasingly including care of shoulder and elbow pathology into their operative practice.

Bibliography

Images
Hypothesis
Proximal humerus fractures have long posed a difficult treatment challenge for orthopedic surgeons. Historically, a high rate of complications was seen with fixation of these fractures, though newer implants have improved these results over the past 15 years. The use of hemiarthroplasty (HA) and reverse total shoulder arthroplasty (TSA) have also been advocated as treatment options for these fractures, though indications for their use remain poorly defined. We seek to determine the rates of operative and non-operative interventions for closed proximal humerus fractures on a population level, as well as analyze complication rates and charges for these interventions.

Methods
Patients with closed proximal humerus fractures were identified in the National Inpatient Sample, and demographics and hospital-related information were recorded. Outcomes queried included in-hospital complications (a composite of serious complications, including cardiac, infection, and others), in-hospital mortality, length of stay, transfusion status, and total hospital charges. Multivariable logistic regression was used to determine variables associated with greater proportion of surgical treatment and determine variables associated with increased rates of complications, transfusions, and mortality, as well as in-hospital charges.

Results
For the 468,922 patients over age 50, the proportion of patients undergoing operative interventions increased over time, from 24.3% in 2002 to 30.0% in 2012 (p <0.0001). This increase was primarily driven by patients undergoing internal fixation (ORIF). After controlling for demographics, location, year, and comorbidities, patients treated with ORIF had a shorter length
of stay (6.1 days vs. 6.5 days, p<0.0001) and a lower rate of complications (7.1% vs. 8.5%, p<0.0001) than those treated with arthroplasty. Patients who underwent ORIF had significantly fewer complications than patients who had either total shoulder arthroplasty (TSA, including reverse, 8.8%) or hemiarthroplasty (HA, 8.6%, p=0.0003). Charges were significantly lower in the nonoperative group ($29,102), and ORIF was significantly less costly ($55,096) than HA ($60,976) and TSA ($75,490).

Summary Points

- From 2002-2012, both fixation and reverse total shoulder arthroplasty for proximal humerus fractures has become significantly more common, while the incidence of hemiarthroplasty decreased.
- Despite lower in-hospital charges and clinically similar demographics, patients undergoing fixation were less likely to have serious complications than patients undergoing arthroplasty.
- Further study is needed to determine clinically optimal and cost-effective treatment for proximal humerus fractures.

Bibliography


Images
Poster 264: Biomechanical performance of PH Cage vs PHILOS plate for fixation of proximal humeral fractures

Category: Elbow/Forearm/Shoulder

Basic Science
N/A - not a clinical study

Andrew H. Schmidt, MD
John M. Whatley
Jill Martin
Sam Johnson

COI
Ownership Interest: Equity

Hypothesis
The biomechanical performance of a PH Cage is equivalent or better when compared to PHILOS locking plates for fixation of proximal humeral fractures.

Methods
Thirty sets of Sawbone models were used for biomechanical testing using three different fracture fixation methods (90 test samples). A 5mm surgical neck osteotomy was used as the fracture model, and fixed using one of three methods - a PH Cage, a PH Cage with an optional plate, and a PHILOS plate. Testing for each construct was tested at physiological axial and torsional loads. Quasi static testing was conducted to determine construct stiffness and failure loads. Fatigue testing was conducted between 50N to 400N for axial loading, and 0Nm to 2.5Nm for torsional loading to a minimum of 16000 cycles. These loads represent physiological loading along with a factor of safety, and the cycle times represent conservative rehabilitation protocols (4 months) where the implant is expected to bear all loads prior to healing.

Results
Axial stiffness for the three constructs is 388.8, 606.0, and 366.9 N/mm for the PH Cage, PH Cage and optional plate, and PHILOS plate respectively. The stiffness of the PH Cage is not significantly different from PHILOS plate, but they are both significantly lower than the PH Cage with plate. Varus collapse of the fracture occurred at 1200N for the PHILOS plate whereas the PH Cage plus optional plate construct did not have a failure to 1900N, at which point the testing was stopped due to equipment limitations. For torsional loading, there were no significant difference in stiffness amongst the three constructs. During fatigue testing, the hysteresis loop during loading and unloading of a PHILOS plate has a higher alternating displacement when compared to the PH
Cage with or without plate. This suggests a higher degree of micro-motion at the site of the fracture when fixed using a PHILOS plate as compared to the PH Cage constructs.

Summary Points

- The PH Cage addresses PH fractures by providing intramedullary support to the articular surface to potentially address complications noted with existing fracture fixation methods.
- Biomechanical testing demonstrates that a PH Cage with plate construct has preferentially higher axial stiffness when compared to PHILOS plate, and less micro-motion during fracture healing.
- From a biomechanical perspective, the PH Cage may offer a better alternative to locking plates for PH fracture fixation.

Bibliography


Images
Multiple studies in the hip and knee arthroplasty literature have failed to identify a benefit with closed drainage systems in post-operative range of motion, wound infection, hematoma, or reoperation rates.[1-4] Although a single study examined closed drainage in all shoulder surgeries (including rotator cuff repair, anterior reconstruction for instability, and arthroplasty),[5] no study to date has investigated the effectiveness of closed wound drainage solely in total shoulder or reverse shoulder arthroplasty in preventing post-operative complications. Our purpose is to determine clinical differences exist between closed drainage usage in shoulder arthroplasty and postoperative complications.

Methods
Retrospective review was performed of all primary total shoulder and reverse shoulder arthroplasty procedures at our institution over a 2-year period. Patients were included with a minimum follow up of 12 months. Medical risk factors (bleeding disorders, anticoagulation therapy, diabetes, autoimmune conditions or use of immune suppression medication) and postoperative complications (wound dehiscence, hematoma, seroma, infection or re-operation) were recorded. We employed Fisher’s exact test to determine if significant association existed between drain usage in shoulder arthroplasty surgeries, risk factors, and post-operative complications.

Results
During a 2 year period 378/636 shoulder arthroplasty patients met inclusion criteria. Drains were used in 111 included patients (Figure 1). Complications were reported in 11 (1 drain / 10 no drain) of the 378 patients with deep infection (5), superficial infection (4), and hematoma
formation (2) as the complications identified. With the data available, we did not identify a significant relationship between drain usage (Figure 1) and post-operative complications (p=0.186). When complications were stratified just by the presence or absence of risk factors, irrespective of whether a drain was used, no significant relationship was identified (Figure 2) (4.1% vs. 1.3%, p=0.340)

**Summary Points**
- This study does not support the routine use of closed drainage systems in primary shoulder arthroplasty, including patients with risk factors for potentially developing postoperative complications.

**Bibliography**
Poster 266: Return to Play and Performance after Glenohumeral Dislocation in National Hockey League Athletes

Category: Elbow/Forearm/Shoulder

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Level 4 Evidence

David P. Taormina, MD
John P. Begly
Michael S. Guss, MD
Brian Capogna
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Michael Alaia, MD

Hypothesis
National Hockey League (NHL) players who have sustained glenohumeral dislocations demonstrate impaired return-to-play or decreased performance when compared with pre-injury performance metrics and the performance of control-matched peers.

Methods
Fifty-three NHL players with 57 dislocation events were identified from over 26 seasons (1989 to 2015) by mining injury databases, injury reports, press releases, and player profiles. Demographic data, including laterality of injury, dominant hand and treatment were recorded. Individual season statistics for the season immediately prior to injury and the season after return from injury were recorded. Thirty-four players (including 25 forwards and 9 defensemen) met inclusion criteria for statistical analysis. Thirty-four control players were matched by demographics, position, and career performance.

Results
There were no demographic differences between the study and control groups. Seventy-three percent of injuries were to dominant shoulders, 73% of injuries also underwent operative repair. Players in the control group trended towards modest improvements across all matrices in adjacent seasons. During that same span, the 34 injured athletes returned to play a similar mean number of games (63.7±17.8 versus 64.4±15.8 games; p=0.85) and similar average ice time (15.6±6.5 versus 15.8±7.4 minutes; p=0.85), though they had significant decreases in Corsi% (p=0.02), goals scored (p=0.02) and trends of diminished performance in assists, shooting percentage, and number of hits thrown per game.

Summary Points
• Compared with previous performance, high performance hockey athletes may experience a small decline in statistical measures during their first season returning from injury.
• Nonetheless, these players who sustain glenohumeral dislocations should expect to return to a high level of competitive play.
• Such data might be valued by not only the injured professional ice hockey athlete seeking to return to play, but also the treating physician with regards to patient counseling, team trainers, sports agents representing players with such injuries, teams and owners invested/investing in players with injury, and the avid fan (especially during a modern era of increasing online “fantasy sports” competition).

Bibliography

Images
Poster 267: Risk Factors for Loss of Midline Function in Patients with Brachial Plexus Birth Palsy

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Level 4 Evidence

Arianna Trionfo, MD
Dustin Greenhill, MD
Dan A. Zlotolow, MD

Hypothesis
To quantify the rate of loss of midline function (LOM) in patients with brachial plexus birth palsy (BPBP) who previously underwent surgery about the shoulder, as well as to identify variables associated with postoperative LOM. We hypothesize that patients with global palsy are more likely to develop LOM as compared to patients with upper trunk palsy.

Methods
Records of patients with BPBP who were treated with surgery about the shoulder during a 10-year period were retrospectively reviewed. Levels of palsy, serial physical examinations, and all upper extremity procedures were recorded. LOM was defined as modified Mallet (MMS) or Active Movement Scale (AMS) internal rotation score less than 3. Exclusion criteria were as follows: <1-year follow-up after most recent procedure, insufficient documentation, or preexisting loss of midline function. Odd ratios were computed to identify variables associated with the development of LOM.

Results
Thirty-four (20.9%) of 162 included patients developed LOM. Predictive variables associated with LOM included: global palsy, microsurgical nerve grafting, MMS abduction <4, AMS wrist flexion<5, AMS wrist extension<5, and AMS finger flexion<5. Among these, patients with global palsy were most likely to lose midline function. Age, closed shoulder reduction with casting in external rotation, shoulder tendon transfers, surgical glenohumeral reduction, and humeral osteotomies were not predictive of LOM.

Summary Points
- Approximately one in every five patients with BPBP will develop LOM after undergoing treatment aimed to improve shoulder abduction and external rotation.
• Patients with global palsy, a history of microsurgery, or a physical exam consistent with persistent upper and middle trunk involvement are at the highest risk for developing subsequent LOM.

Bibliography

Images
Poster 268: Hand Syndactyly Patterns in Timothy Syndrome

Category: Pediatrics/Congenital/Nerve

Level 4 Evidence

Jennifer M. Ty, MD
Katherine W. Timothy
Douglas T. Hutchinson, MD

Hypothesis
Timothy syndrome type 1 (TS1) is a rare condition associated with a prolonged QT interval and syndactyly of the fingers and toes. Patients with undiagnosed TS1 are at risk of developing life threatening cardiac arrhythmias during syndactyly reconstruction surgery due to physiologic stress and exposure to anesthetic agents. Previous studies have suggested routine preoperative EKG screening prior to surgical treatment for all children with syndactyly; however this recommendation has recently been challenged due to the low yield and relatively high cost. Timothy syndrome is associated with atypical patterns of syndactyly that may suggest increased operative risk.

Methods
A retrospective review of an established database of 38 patients with clinically diagnosed Timothy syndrome was performed to identify the hand and foot syndactyly patterns. Thirty-one of these patients were genotype positive for TS1; the remainder were deceased prior to the development of genetic testing for Timothy syndrome. Twenty-four were males, and 14 were females.

Results
We identified 38 patients with TS1 that had described syndactyly of their fingers. The most common syndactyly pattern was bilateral 3-5 (45%) with the second most common being bilateral 2-5 (16%). Thirty-four (89%) patients with Timothy syndrome had syndactyly that involved the pinky finger. Twenty-eight (74%) patients have at least 1 hand with either a 3-5 or a 2-5 phenotype. Eight-seven percent of patients have bilateral hand involvement; in 74% of patients this involvement is bilaterally symmetric.

In contrast to patients without syndromic syndactyly in which middle-ring syndactyly is the most common pattern, only 4 patients had bilateral 3-4 syndactyly (11%). Of note, these 4 patients all also had bilateral toe 2-3 syndactyly.

Of the 26 patients for which information about their toes was available, 92% had associated toe syndactyly. Bilateral 2-3 (77%) was the most common pattern.
Summary Points

- Timothy syndrome is a rare condition that is associated with risk of fatal cardiac arrhythmias during syndactyly reconstruction surgery. Despite the importance of preoperative identification of these patients, previous studies have found routine EKG screening of all syndactyly patients to be of no benefit.
- Patterns of syndactyly in Timothy syndrome are atypical when compared to idiopathic syndactyly.
- 89% of patients with Timothy syndrome have syndactyly that involves the pinky finger.
- 74% of patients have at least 1 hand with a 2-5 or 3-5 syndactyly.
- Patients with these atypical patterns of syndactyly should have preoperative EKGs to screen for Timothy syndrome.

Bibliography


Images
Poster 269: Carpal Bone Morphology in Ulnar Ray Deficiency

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis;Anatomy
N/A - not a clinical study

Scott Riley
Janet Walker
Max Shrout

Hypothesis
hand anomalies in ulnar ray deficiencies are associated with preservation of the ulnar carpal bones

Methods
An IRB-approved, retrospective study of 60 patients/81 limbs with ulnar deficiency was performed. 58 limbs had 1-3 missing “ulnar” rays of which, 46 had ossified carpal bones on existing radiographs. These were reviewed for carpal bone identification and coalitions.

RESULTS: Because of anatomy, imaging or extensive carpal coalition, 4 wrists had carpal bones that could not be identified. The remaining 42 wrists all had a capitate. Not all were skeletally mature but 25 wrists had sufficient maturity to have 3 or more carpal bones present. Regarding the ulnar carpal bones, all but 2 wrists of the 25 had a hamate (22) and/or triquetrum (19). Twenty-one scaphoids, 21 trapeziums, 11 lunates, 10 trapezoids, and 12 pisiforms had sufficient ossification to be present on radiographs. Carpal coalitions were found in 21 wrists (50%). They involved 8 capitates, 12 hamates, 10 triquetrums, 3 lunates, 6 scaphoids, 5 trapeziums, 1 trapezoid, and 3 indeterminate.

Summary Points
• As in fibular ray deficiency, “ulnar” ray deficiency generally has preservation of the ulnar carpal bones
• This is in contrast to radial deficiency where radial carpal bones are frequently absent
• Presence of the capitate was universal in ulnar deficiency
• Coalitions of the ulnar carpal bones were common

Bibliography
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Images
Poster 270: Outcomes of web plasty for improvement of pinch and grip in congenital anomaly hand

Category: Pediatrics/Congenital/Nerve

Prognosis/Outcomes
Level 4 Evidence

Hikaru Hayakawa
Kousuke Iba, MD
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Hypothesis
The aim of this study is to investigate outcomes of web plasty for improvement of pinch and grip in congenital anomaly hand.

Methods
The cases included 17 patients (20 hands) who underwent web plasty in our hospitals from 2005 to 2016. There were 11 male and 6 female, and average age at the surgery was 30 months (8 - 132 months). The average postoperative follow up period was 53 months (5 - 125 months). There were 6 hands in cleft hands (bilateral, 2 cases), 4 hands in symbrachydactyly, 3 hands in hypoplastic thumb, 2 hands in arthrogryposis (bilateral case), 2 hands in adduction contracture of thumb, 2 hands in congenital constriction band syndrome and 1 hand in clasped thumb.
Regarding surgical procedures, opposed double Z plasty was performed on 8 hands, Spinner flap on 4 hands, Snow-Littler procedure on 2 hands, and other procedures on 6 hands. Opponensplasty was performed on 5 hands.
We evaluated postoperative complications, secondary operations, pinch and grip functions, and satisfactions of patients’ parents. To assess pinch and grip functions, we use functional dexterity test (FDT), and tape measure test (Iba et al 2011).

Results
There was a post-operative complication at first web contracture after Snow-Littler procedure, which was improved by surgical treatment with spinner flap. The scores of post-operative FDT and tape measure test were improved in comparison with pre-operative those. According to the parents’ satisfaction was excellent or good.

Summary Points
We performed various procedures of web plasty to improve pinch and grip function in congenital anomaly hand, of which, post-operative outcomes were mostly good.
Poster 271: The Constriction Ring of Amniotic Band Syndrome Reveals Idiosyncrasies of Fetal Wound Repair

Category: Pediatrics/Congenital/Nerve

Basic Science
N/A - not a clinical study

Surjya Bhattacharyya
Isaac Iliaishov
Cynthia Loomis
Alice Chu, MD

Hypothesis
In the extrinsic theory of Amniotic Band Syndrome (ABS), presumed mechanical injury from fibrous bands results in the formation of constriction rings in the extremities. This results in dermal thinning, subcutaneous tissue atrophy, and scarring that often lead to vascular and lymphatic changes. We hypothesized that the constriction rings seen in ABS are the sequelae of localized mechanical injury by testing for a typical scarring pattern in the form of collagen and elastin distribution, and in the ratio of collagen I to collagen III (CI:CIII).

Methods
ABS tissue was obtained from our IRB approved Pediatric Musculoskeletal Tissue Bank. Two samples were tested from constriction rings excised from patients at 5 and 7 months after birth. A skin sample from an extra finger of a 20 month old was used as control tissue. Basic morphology was determined via H&E staining, elastin was stained using Weigart’s Resorcin/Fuchsin. Collagen I & III were stained using picro-sirius red. H&E and elastin stained sections were recorded digitally using an Aperio Epathology imager and Imagescope software in the two ABS samples. Collagen stained sections were photo documented using a Leica DMLM microscope under polarized light. Image analysis software Fiji was used to quantify CI:CIII ratios.

Results
In the ABS specimens, sub-epidermal structures were intact and present throughout, and collagen I exhibited a normal basket-weave pattern. Using a t-test for related samples, the mean CI:CIII ratios were not statistically significantly different between groups away vs. below the constriction, (p=.167 and p=.816). At the site of constriction in both ABS samples, reticular dermis elastin fibers were fragmented and papillary dermis elastin fibers were absent. In the control tissue, the reticular dermis contained relatively thick, branching fibers of elastin and papillary dermis elastin was present (figures 1 and 2).
Summary Points

- The normal pattern and deposition of collagen and the presence of sub-epidermal structures favor a non-scarring phenotype.
- However, elastin fragmentation in the reticular dermis and the absence of elastin in the papillary dermis at the constriction ring indicates localized disruption in elastin formation and localized scarring.
- ABS demonstrates a skewed scarring phenotype, with collagen and elastin remodeling differently in response to injury. It seems the scarless nature of fetal healing does not apply to elastin remodeling.

Bibliography

2: Morovic et al. Plast Reconstr Surg (2004); 113:1556
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Images
Poster 272: Long-term Outcomes of Exploration and Microsurgical Reconstruction in Brachial Plexus Birth Palsy

Category: Pediatrics/Congenital/Nerve

Treatment; Prognosis/Outcomes

Level 4 Evidence

Mary Claire Manske, MD
Vincent Hentz, MD
Michelle A. James, MD

Hypothesis

Infants with brachial plexus birth palsy (BPBP) who have not recovered anti-gravity elbow flexion by 6 months of age are often indicated for brachial plexus (BP) exploration and microsurgical reconstruction, although surgical outcomes, specifically the recovery of shoulder, elbow, and wrist function, are not well described. We present the outcomes of microsurgery for BPBP.

Methods

We retrospectively reviewed the charts of infants who underwent microsurgery for BPBP between 1992 and 2014 with at least 2 years follow-up, and used Active Movement Scale (AMS) scores to determine the percentage of infants who gained anti-gravity shoulder abduction and external rotation; elbow flexion; and wrist extension, and the duration of time until anti-gravity strength was observed. We also identified the number and type of secondary surgical procedures in this cohort.

Results

43 infants (26 male) underwent microsurgery at a mean age of 7 ± 2 months, and were followed for a mean of 8 ± 5 years. Patients were classified by Narakas type and intra-operative findings. Patients reliably recovered anti-gravity shoulder abduction and elbow flexion, but recovery of anti-gravity shoulder external rotation and wrist extension was less predictable (See Table 1). 32 children underwent a mean 2 ± 1.2 additional procedures, including botulinum toxin injection (78%), tendon transfer for shoulder external rotation (66%), biceps re-routing (28%), and wrist extension tendon transfer (28%). Infants who underwent microsurgical reconstruction before 7 months of age (24/43) were more likely to regain anti-gravity strength compared those undergoing surgery over age 7 months (19/43) but there was no difference between these groups in the time to observed anti-gravity strength or number of secondary reconstructive procedures.
Summary Points

- Microsurgical reconstruction for BPBP reliably results in recovery of shoulder abduction and elbow flexion, but recovery of shoulder external rotation and wrist extension is less predictable.
- Infants younger than 7 months of age are more likely to recover anti-gravity motor function, but recovery of anti-gravity strength may take more than a year.
- Secondary procedures to optimize motor function are common, and microsurgical reconstruction may enable recovery of expendable donors for tendon transfers.

Bibliography


Images
Complications following surgery for brachial plexus birth injuries (BPBI) are preventable.

Methods
Brachial plexus birth injuries (BPBI) are rare, with treatment and follow-up often required from infancy until skeletal maturity. Here we review complications that may occur related to primary nerve surgery or secondary musculoskeletal procedures, and discuss how these may be avoided and treated. We review our experience of over 450 patients who had nerve surgery for BPBI, and also our experience with secondary surgery in the shoulder and elbow.

Results
Complications related to nerve surgery included phrenic nerve injury and possible iatrogenic downgrade of function, in particular elbow flexion. Careful identification of the phrenic nerve by intraoperative direct stimulation at the initial phase of surgery will prevent the first problem, while “bypass grafting” with end to side repairs rather than resecting all damaged nerve will prevent the second problem. Other authors have reported accidental extubation and fluid overload, but we did not encounter these in our series. Complications from shoulder surgery included injuring the neurovascular pedicles to the latissimus dorsi and/or teres major muscles during mobilization or contracture release, as well as improper insertion of the transferred muscles. Inadequate or excessive rotation of the humerus can be encountered with an osteotomy, which should be done proximal to the deltoid tubercle.

Summary Points
• BPBI is rare, but complications can occur at every stage of surgery from infancy to skeletal maturity.
• Patients should only be treated at dedicated pediatric centers using a team approach to optimize surgical and anesthesia outcomes.
Bibliography
Images
Poster 274: Hospital Variation in Open Reduction Rates for Pediatric Supracondylar Humerus Fractures

Category: Pediatrics/Congenital/Nerve

Level 4 Evidence

Brendan Striano
Divya Talwar
Apurva S. Shah

Hypothesis
Displaced pediatric supracondylar humerus fractures are typically managed with closed reduction and percutaneous pinning. Open reduction may be required following a failed attempt at closed reduction or when fractures are associated with neurovascular compromise. Variation in open reduction rates across hospitals may suggest differences in the technical proficiency of surgeons and could impact cost of surgical care. We hypothesize that significant variation in open reduction rates exists across children’s hospitals.

Methods
The Pediatric Health Information System (PHIS) is a comparative pediatric database that includes clinical and resource utilization data for > 45 children’s hospitals in the United States. The database was queried for isolated, closed supracondylar humerus fractures in children 1 to 18 years of age from 2010-2014. Fractures were identified using ICD-9 diagnosis codes. Open reduction and internal fixation (ORIF) was distinguished from closed reduction and percutaneous pinning (CRPP) using both ICD-9 procedure codes as well as Current Procedural Terminology (CPT) codes. An open reduction rate was calculated for each participating hospital.

Results
During the study period, 32,538 patients underwent surgical treatment for closed, supracondylar humerus fractures at 47 children’s hospitals. The patient population was 51.5% male, with an average age of 5.3 years (standard deviation 2.52). On average, each hospital treated 692 patients (range 35-2,078). Across hospitals, 30,788 patients were treated with CRPP while 1,750 patients were treated with ORIF. The mean open reduction rate was 5.8% (standard deviation 2.8%). The open reduction rate varied significantly across hospitals (p<0.001, ranging from 1.5% to 11.9%). The cost of surgical care also varied significantly across hospitals (p<0.001). On average, open reduction increased the cost of surgical care by $3505 (p<0.001).

Summary Points
• There is significant variation across hospitals in the rate of open reduction for pediatric supracondylar humerus fractures
• Variation in open reduction rates increases the cost of surgical care and may increase patient morbidity
Poster 275: Outcomes in Early Versus Late Presentation of Focal Fibrocartilaginous Dysplasia Affecting the Upper Extremity: Review of Four Cases

*Category: Pediatrics/Congenital/Nerve*

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Level 4 Evidence

Grigory Gershkovich, MD
David M. Kahan, MD
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Dan A. Zlotolow, MD

**Hypothesis**
Focal fibrocartilaginous dysplasia (FFCD) is a rare disorder of the upper and lower extremities. In the distal ulna, a ligamentous tether emerging from the metaphysis crosses the physis and restricts growth, leading to deformity. Release of this tether prior to radiocapitellar subluxation has been shown to restore growth and allow remodeling. Patients that present after radiocapitellar subluxation have limited surgical options. A Salvage procedure may be the only remaining choice for a stable and pain-free extremity.

**Methods**
This investigation was a retrospective chart review of 4 patients diagnosed with FFCD of the distal ulna from 2007 – 2015. We reviewed our patients’ radiographic and functional outcomes. This study was approved by our Institutional Review Board

**Results**
Four patients (3 boys and 1 girl) presented at an average of 37.5 months (range 22 months – 48 months) with FFCD and radiocapitellar joint incongruity. Diagnostic criteria for FFCD were based on radiographic findings: a radiolucent lesion, a cortical break, a rim of surrounding sclerosis, and a resultant bow of the radius and ulna. Our first patient had progressive radiocapitellar dislocation with the forearm fixed in supination, increased pain, and forearm bowing. The second patient presented to our institution after an initial diagnosis of ulnar FFCD and lesion excision at an outside hospital. Despite this, forearm deformity progressed with subsequent radial head dislocation, likely due to incomplete excision. These patients required salvage procedure due to the chronic radiocapitellar dislocation, pain, and/or limited motion. They underwent radial and ulnar osteotomies and creation of a one bone forearm to create a stable forearm unit at the expense of motion. Patient three had frank dislocation of the radiocapitellar joint yet was able to maintain functional elbow flexion and extension and forearm supination.
and pronation were 50 degrees and 80 degrees, respectively. As a result, the patient elected for continued observation. Patient four had a 50% subluxation of the radiocapitellar joint and underwent tether excision, ulnar osteotomy, and ulnar lengthening through an external fixator. This restored radiocapitellar congruity and improved the forearm bow. The patient achieved full supination and pronation with elbow flexion from 0-125 degrees.

Summary Points
- Distal ulnar FFCD can be treated prior to radiocapitellar subluxation by tether release.
- Late diagnosis may require salvage procedures such as osteotomy and creation of the one-bone forearm.

Bibliography
Images
Poster 276: Does Age Contribute to Outcomes for Elbow Release in Arthrogryposis?

Category: Pediatrics/Congenital/Nerve

Treatment; Prognosis/Outcomes
Level 4 Evidence

Christopher Richards
Rey Ramirez, MD
Scott H. Kozin, MD
Dan A. Zlotolow, MD

Hypothesis
Children with arthrogryposis undergoing posterior elbow release after the age of 2 will have improved long-term range of motion compared to children who underwent posterior elbow release prior to 2 years of age.

Methods
This study is a retrospective chart review of consecutive patients with arthrogryposis who underwent a posterior elbow release for an elbow extension contracture between 2007 and 2014 at one institution. Out of 62 procedures in 44 patients, 20 procedures in 14 patients had a minimum follow-up longer than 2 years and were included in the study. Of the six patients who had bilateral posterior elbow releases, all of them were done within 8 months of each other and within the same year of life. Patients were divided into 3 groups based on their age at the time of surgery: 3 years old. T-tests were used to compare the pre- and post-operative passive arcs of motion.

Results
The average pre-operative arc of motion was 16° (0°-30°) for the children younger than 2, 33.5° (5°-60°) for the children 2-3 and 45° (25°-80°) for the children older than 3. These differences were not statistically significant between cohorts. Children >3 years old also developed on average a 6.7° flexion contracture, shifting their pre-operative arc of motion into more flexion. The average post-operative arc of motion was 88.2° (70°-103°) for the children younger than 2, 60° (15°-85°) for the children 2-3 and 54.33° (23°-70°) for the children older than 3. There was a statistically significant difference in the post-operative arc of motion between the children less than 2 years old and both the children 2-3 years old and older than 3 years old. The difference between the 2-3 and >3 year old cohorts were not significant.
Summary Points

- Children who underwent posterior elbow release prior to the age of 2 had a statistically significant increase in their post-operative passive arc of elbow motion compared to older children at long-term follow-up and these results were better and more predictable.
- Restoring passive elbow flexion should therefore be an early priority of the treatment plan for children with arthrogryposis.
Hypothesis
The location of capitellar osteochondritis dissecans (OCD) lesions in the sagittal plane guides the surgical approach. Prior studies have reported that the majority of lesions occur between 4:00 – 4:30 o’clock (120 to 135 degrees anterior to the humeral shaft) in the sagittal plane. We hypothesized that the range of lesion locations in the sagittal plane is larger than previously reported. We further hypothesized that lesion location would differ between lesions requiring operative management and those managed nonoperatively.

Methods
Magnetic resonance images (MRIs) of elbows depicting a nontraumatic capitellar OCD lesion in patients < 20 years old seen at our institution from 2000-2016 were identified, resulting in a cohort of 101 patients (104 elbows). Data was collected on patient demographics and subsequent surgical intervention. In the sagittal plane, the margins of each lesion were recorded as degrees on the capitellum and then converted into time on a clock, where 0° corresponds to 12 o’clock. The 0° axis (12 o’clock axis) was defined as the line parallel to the anterior humeral line where it intersects the capitellum center. Lesion height was obtained on the sagittal cut with the greatest size. In the coronal plane, the following measurements were recorded: lesion width, capitellar width, and distance between the capitellar radial border and the lateral edge of the lesion. Measurements were taken by two independent observers.

Results
In the sagittal plane, average lesion location was 94 to 156 degrees (3:00 to 5:15 on the clock-face), and encompassed a range from 38 to 224 degrees (1:15 to 7:30 on the clock-face). Ninety five percent of lesions were located between 52 to 215 degrees (1:45 to 7:10 on the clock-face). Average lesion width was 10.6mm (range, 3.4-19.9) and average lesion depth was 5.0mm (range,
Lesions requiring operative intervention were more likely to involve the lateral 1mm of the capitellum (p=0.022) and were more likely to extend further anteriorly (p=0.0007). Interobserver reliability was excellent (R2 = 0.94; p<0.0001).

Summary Points
- We identified a larger range of capitellar OCD lesion locations in the sagittal plane than previously reported.
- Furthermore, lesions which went on to require operative intervention in our series were found to be more anterior and more likely to involve the lateral margin of the capitellum as compared to lesions which were managed nonoperatively.
- This has important implications for surgical management, as different anatomic approaches may allow variable access to the capitellum for treatment.

Bibliography
Poster 278: Manipulation of soft-tissue window on CT for pediatric ulnar coronoid fractures.

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Treatment; Surgical Technique
Level 4 Evidence

Jiro Namba, MD, PhD

Hypothesis
We reviewed whether the treatment using effect of bone and soft-tissue contrast manipulation on MDCT as preoperative imaging examination was practicable in 7 young patients with ulnar coronoid fractures.

Methods
All 7 patients were boy with the average age of 12 years old (7-17). Injury mechanisms were 5 falls and 2 sports related accidents. The associated injuries were 3 simultaneous humeral lateral epicondyle fractures, 2 olecranon fracture and 2 radial neck fracture. Raentogen and CT examination was taken for all cases. According to Regan’s classification, there were 3 Type1, 1 Type2, 1 Type3 and 2 undefined. When classifying into O’Driscoll’s criteria, we set the window-function of axial reconstructed CT as WW/WL (100:45) on CT application (Aquarius Net Viewer, Fuji-film, Japan) to visualize the chondral portion of the fragment. Next, according to its information, the height (%) of the fragment was measured in Type1-2 on the sagittal image of the preset CT. The surgical indication was determined following the updated consensus in adults, ie, Type2-3 anteromedial facet fragment (AMF) and Type3 (fragment height :>50%) with no other instability. Whether the reconstructed CT can allocate the osteocartilageous fracture to O’Driscoll’s criteria was examined. Clinical outcome was also reviewed including ROM, radiographs and Mayo score.

Results
The allocation was practicable in all cases, though one 7 year old case was examined by the additional MRI. There were one Type1-1, 2 Type1-2, 2 Type2-3 and one Type3. In 2 cases of Type 1-2, the height (%) of the fragment was measured on the sagittal image of the preset CT. The fragment height % of 2 O’Driscoll Type 1-2 were 39 and 44%. 4 ORIF for coronoid fragment, combination of leaving unexplored and resection of the incarcerated fragment in 1, and only unexplored in 2 were performed for coronoid fractures. While, against lateral epicondyle fracture, ORIF in 3 due to PLRI and unexplored in 1 were performed. At the average 1 year follow up, bone union was recognized besides 7 year old case. The average ROM was 138/plus 6(flexion/extension). Mayo was 100. There were no elbow instability.
Summary Points

- It is radiographically difficult to diagnose or evaluate morphologic condition of the fragment due to invisivility of a chondral lesion.
- Window function processed CT enabled us to visualize the chondral portion of the fragment in all patients.
- Further study with increasing number of the cases is necessary to elucidate the benefit of CT planning.

Bibliography


Images
Hypothesis
There is a paucity of information regarding indications and utilization of arthroscopy in pediatric elbow conditions. A review of previously reported literature identified only two studies with a pooled cohort of 97 arthroscopies in children and adolescents. The purpose of this study was to use population-level data in a statewide administrative discharge database to evaluate trends, indications and demographics of pediatric elbow arthroscopy.

Methods
New York State Statewide Planning and Research Cooperative System (SPARCS) data was used to identify elbow arthroscopy procedures performed in children and adolescents (age under 21 years) from 2003 to 2014 using ICD-9-CM and CPT-4 procedure codes. SPARCS is an all-payer data reporting system collecting information on discharges from non-federal healthcare facilities in New York State. Data analysis was primarily descriptive. Age groups were defined based on anticipated ranges for sport competition: less than 11 years, 11-17 years, and older than 17 years. ICD-9-CM diagnosis codes were used to classify indications for surgery.

Results
We identified 697 pediatric elbow arthroscopies performed between 2003 and 2014. The median age at elbow arthroscopy was 16 years. Most patients were male (78.3%) and 69.4% of arthroscopies were performed on the right elbow. Overall, the most common indications for arthroscopy were: osteochondral injuries (30.1%), loose bodies (20.4%), synovitis/bursitis (14.8%), trauma (8.6%) and stiffness/joint contracture (5.7%). The indication for surgery varied based on age: stiffness/joint contracture was most common in patients younger than 10, osteochondritis dissecans in patients 11-17 years-old, and loose bodies was the most frequent in patients over 17 (figure 1). The number of procedures doubled from 2003-2014, however, the
majority of the growth was driven by a 3-fold increase in elbow arthroscopy in patients aged 11-17 (11-32 per million) during the study period. Due to this rapid growth, elbow arthroscopy is now most commonly performed in children aged 11-17 compared to those under 11 years and over 17 years (figure 2).

Summary Points
- There has been increasing utilization of elbow arthroscopy in children and adolescents.
- The growth rate in utilization is highest in children age 11-17. These findings may represent a statewide injury profile with increased frequency of adolescent participation in throwing sports.(3,4)
- Elbow arthroscopy is most commonly used in children to address osteochondral injuries, although indications do appear to vary with age group; osteochondritis dissecans is the most common in those 11-17 years while elbow joint contracture is most common in the very young.

Bibliography

Images
Hypothesis
A 20-year-old male has presented with mild numbness and tingling sensation at 4,5th finger of his left hand. He has not received any other operation or procedure with his left upper extremity and there was no trauma history recalled by the patient and family. Simple radiograph and MRI images revealed bony mass at medial joint space of ulno-humeral joint. Electromyographic exam (EMG) was done for differential diagnosis, reporting tardy ulnar nerve palsy feature with irritation sign of ulnar nerve around elbow level.

Methods
Patient received operational procedure to remove bony mass and decompress ulnar nerve around elbow level. After surgical exploration, we found that there were two cause of ulnar nerve irritation symptom. Fixed ulnar nerve position at anterior aspect to medial condyle with deficiency of nerve gliding was one cause, and friction irritation around bony mass was another. After releasing the sheath-like structure along the anterior border of ulnar nerve, we confirmed that the ulnar nerve was completely free (Fig. 1). A 2.0 cm-width flap of the dissected sheath-like structure of the medial epicondyle was sutured with subcutaneous fat tissue at anterior skin of incision to make sling structure to prevent further subluxation and dislocation.

Results
In this case, the ulnar nerve may be penetrated while forming an anterior medial portal around elbow joint. It is rarely reported that ulnar nerve consistently travels to the anterior side of the medial condyle of the elbow, and there are no cases involving skeletal variation. In addition, the MRI of the uninvolved side (rt. elbow) of the same patient indicates that the ulnar nerve is not located in the cubital groove in the serial axial image, although the elbow is
fully extended (Fig. 2). This suggests the possibility that the ulnar nerve lesion was dislocated from the cubital groove of the left elbow without the formation of osteoid mass.

Summary Points

- We report a case of ulnar nerve irritation syndrome caused by fixed anterior course and position of ulnar nerve around medial epicondyle and unmovable bony mass between two head of flexor carpi ulnaris muscle origin.
- It is important to know the path of the ulnar nerves very carefully through imaging and physical examination when there is a bony variant in the elbow joint.
- We diagnosed bilateral fixed anterior position of ulnar nerve around elbow with the patient of our case.

Bibliography


Images
Hypothesis
Processed nerve allografts (PNA) have been shown to be safe and effective option to repair nerve gap injuries in a growing number of clinical studies. The RANGER registry is an active database designed to collect outcomes data for processed nerve allografts (Avance® Nerve Graft, AxoGen). The registry has continued to collect long term follow-up and has also expanded to include data from additional centers. Based on scientific evidence and historical controls, we hypothesized that the cumulative registry would continue to demonstrate meaningful recovery for injuries spanning 65mm; and that observable long term follow up outcomes for PNA at higher thresholds of recovery would be similar to nerve autograft and significantly better than hollow tube conduit.

Methods
The RANGER database was queried for nerve repairs in the upper extremity using PNA that reported sufficient quantitative outcome data. Reported sensory and/or motor assessments included 2-point discrimination, Semmes-Weinstein Monofilament (SWMF) testing, range of motion, strength test. Reported outcome data were incorporated into the MRCC scale for sensory and motor function. Meaningful recovery was defined as = S3/M3 on the MRCC scale. Higher thresholds of recovery, defined as S3+/M4 or greater, were evaluated in repairs reporting a minimum of 15 months of follow-up.
Results
The current RANGER® registry has sufficient quantitative outcomes data on 233 repairs (204 sensory and 29 mixed nerve injuries). Mean age of the cohort was 42 ± 16 (18 – 81) years. Mean gap length was 21 ± 12 (3 – 65) mm with an average follow up time of 11 months. Meaningful recovery was observed in 85% of all repairs. Further analysis by nerve type observed meaningful recovery in 85% of sensory and 79% of mixed nerve repairs. Among repairs reporting longer term follow-up, mean 669 ± 221 (460 – 1249) days, 79% reported higher thresholds with S3+/M4 or greater. No adverse events were reported.

Summary
• Processed nerve allografts continue to be a safe and reliable off-the-shelf alternative for the reconstruction of nerve deficits.
• Quantitative data demonstrate meaningful recovery in 85% of all repairs.
• Repairs with longer term follow-up demonstrated higher levels of recovery at 79%.
• These results compare favorably to historical outcomes for autografts and exceed those for conduits.
• The registry remains ongoing and will continue to expand to further collect outcomes data on processed nerve allografts.

Bibliography
Poster 282: Is metacarpal osteotomy necessary for the patients with Wassel type IV thumb duplication?

Category: Pediatrics/Congenital/Nerve

Treatment; Surgical Technique
Level 4 Evidence

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Hypothesis
In the surgical management of Wassel type IV thumb duplication, correction of the angulation deformity in the thumb metacarpophalangeal (MCP) joint is one of the most important procedures in order to prevent recurrence of the deformity and instability in the joint. Although the anatomical musculoligamentous procedures such as reinsertion of the capsule and radial thenar musculature and plication of the collateral ligament can correct the deformity of the MCP joint, the degree of the correction is limited compared to the metacarpal osteotomy. The purposes of this study are to evaluate the degree of the angulation correction in the thumb MCP joint through the soft tissue procedures and to suggest indications for the metacarpal osteotomy in patients with Wassel type IV thumb duplication.

Methods
We retrospectively reviewed 32 patients with Wassel type IV thumb duplication who underwent surgical treatments and were followed up for more than 2 years. Of them, 18 patients underwent only soft tissue procedures and 14 patients underwent both soft tissue procedures and metacarpal osteotomy for the reconstruction of the thumb MCP joint. We measured the angle between the anatomical axis of the 1st metacarpal and that of the proximal phalanx of the thumb on thumb posteroanterior (PA) radiographs at initial visit. We repeated the measurement on thumb PA radiographs two years after surgery.

Results
In 18 patients who had only soft tissue procedures for the reconstruction of the thumb MCP joint, the angulation deformities of the thumb MCP joint significantly improved from 17.7° to 11.4°. The mean correction of the angulation deformity was 6.3° and the maximal correction was
14.5°. On the other hand, the angulation deformities significantly improved from 24.7° to 7.9° in 14 patients who had both soft tissue procedures and metacarpal osteotomy.

**Summary Points**

- Soft tissue procedures can provide on average 6.3 degrees of angular correction of the thumb MCP joint in patients with Wassel type IV thumb duplication.
- Considering that the acceptable remnant angulation deformity is less than 5°, we can suggest metacarpal osteotomy in patients with Wassel type IV thumb duplication who have more than 10° of angulation deformity of the thumb MCP joint.
- Metacarpal osteotomy is a very useful procedure to correct the angulation deformity of the thumb MCP joint effectively in patients with Wassel type IV thumb duplication.

**Bibliography**

Poster 283: Incidence of Encountering the Palmar Cutaneous Branch of the Median Nerve During the Flexor Carpi Radialis Approach to the Distal Radius

Category: Pediatrics/Congenital/Nerve

Anatomy
Level 4 Evidence

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Hypothesis
The purpose of this study was to document prospectively the incidence of encountering the PCBMN during a standard FCR approach to the distal radius. We hypothesize that the incidence of encountering the PCBMN in the sheath of the flexor carpi radialis will be significant (5-10%).

Methods
Skeletally mature patients who presented with a distal radius fracture requiring plate fixation through a volar approach were invited to be included in the study. Exclusion criteria included open fractures or previous surgery or trauma to the distal forearm. Information collected included patient age, date of injury, mechanism of injury, and handedness. All surgeries were performed by one of three fellowship trained hand surgeons. The surgery was done through a standard FCR approach. The PCBMN was identified. If it was not within the sheath, the dissection was carried out medial to the FCR tendon. Once found, the PCBMN was dissected proximally and distally. The branch point from the median nerve, the relationship to the FCR sheath, and the course of the PCBMN were recorded. Simple statistical methods were used to calculate averages and percentages.

Results
82 patients of average age 59.4 (range 18-87) were evaluated between 2013 and 2017. The PCBMN was encountered in 78 of the 82 patients. Of these, 73.1% (57) were in the normal anatomic position, parallel and adjacent to the sheath; 26.9% were in variant positions. 6 were superficial to the sheath, 4 were within the sheath, 8 were deep to the sheath, and two had not yet branched by the palmar wrist crease. The palmaris longus was present in 89% of patients. The average point of take off of the PCBMN was 5.3cm (range 3.3-9.0 cm) from the palmar wrist crease.
Summary Points

- The PCBMN had variant anatomy in 26.9% of our population, putting it at risk during the FCR approach.
- 23.1% were either superficial to, within, or directly deep to the FCR tendon sheath.
- Those anomalous nerves that are superficial, within, and deep to the FCR sheath are at risk for injury during exposure of a distal radius fracture through the FCR approach. This should heighten the surgeon's vigilance and require identification and protection of the PCBMN when exposing a distal radius fracture.

Bibliography

Images
Poster 284: Clinical and Electrical Recovery Following Neurolysis in Recalcitrant Parsonage-Turner Syndrome

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Level 4 Evidence

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COI
Royalty: Elsevier; Extremity Medical
Consulting Fee: Coventus, Trimed

Hypothesis
It is unknown why some Parsonage-Turner syndrome (PTS) patients recover spontaneously while up to 60% may have residual pain and/or permanent motor deficit. High-resolution magnetic resonance imaging (MRI) and ultrasound (US) can identify focal “hourglass” constrictions (HGCs) in patients who present with PTS with spontaneous motor palsy. We hypothesized that patients would have clinical and electrical recovery following neurolysis for recalcitrant PTS.

Methods
We studied 7 consecutive PTS patients (4 M, 3 F) who presented to our center with chronic complete motor palsy of one or more upper extremity nerves and HGCs identified on 3.0 T MRI and/or high resolution US. Mean age was 46 yrs. (range, 21-61). Average time from symptom onset to surgery was 12.4 ± 6.9 months. Electrodiaagnostic (EDX) testing confirmed denervation in affected muscles with absent or isolated motor units. HGCs were defined using 3.0 T MR proton density and T2-weighted fat suppression sequences in multiple planes. 2-D grayscale and power Doppler US was performed of the affected limb, with contralateral imaging for anatomic comparison. HGCs were precisely localized in relation to osseous landmarks for surgical identification. Recovery was demonstrated clinically and with EDX by the same examiners.

Results
Twenty-three muscles innervated by ten nerves were involved, including the radial, anterior interosseous fascicle of the median (AIN), pronator teres fascicle of the median, suprascapular,
and axillary. Twenty-three HGCs were confirmed intraoperatively. Average clinical and EDX follow-up was 7 months (range, 4-12). Postop EMG data was available on 20 muscles. Muscle recruitment improved from none to decreased in 1 muscle, none to discrete in 7, discrete to decreased in 4, and remained unchanged in 8. Configuration pattern improved from none to di/triphasics in 4 muscles, none to nascent in 4, increased polyphasics to di/triphasics in 2, and remained unchanged in 10. At last follow-up, clinical recovery of function was demonstrated in 22 of 23 muscles. Both patients who underwent neurolysis for isolated axillary or suprascapular nerve palsy had improvements in active abduction of 43 degrees (85 and 0 degrees).

**Summary Points**

Patients who underwent microsurgical epi- and peri-neurolysis had clinical improvement in all 11 nerves, at an average of 4 mos. following surgical intervention. In this small, single cohort series, surgical release of MRI and/or US-identified constrictions was clinically beneficial.

**Bibliography**


Images
Hypothesis
In late presentation of brachial plexus trauma, the question arises as to whether donor nerves should be devoted to nerve reconstruction or reserved for free functional muscle transfer (FFMT). The purpose of this study was to systematically review recovery of elbow flexion after nerve reconstruction versus FFMT for late, traumatic brachial plexus palsy.

Methods
A systematic review was performed using the PUBMED, SCOPUS, and Cochrane databases to identify all cases of traumatic brachial plexus palsy in patients 18 years or older. Patients who underwent late (>=12 months) nerve reconstruction or FFMT for elbow flexion were included. Demographics were recorded, including age, time to operation, and level of brachial plexus injury. British MRC strength and range of motion were evaluated for elbow flexion.

Results
Thirty-three studies met criteria (Figure 1) for a total of 103 patients (53 delayed nerve reconstruction, 50 FFMT). Surgical age and preoperative elbow flexion were no different across the groups, whereas time to surgery and follow-up time were significantly longer in the FFMT group (Table 1). For upper trunk injuries, 53% of nerve reconstruction patients versus 100% of FFMT patients achieved M3 or greater strength (p<0.01) and 43% of nerve reconstruction patients versus 70% of FFMT patients achieved M4 or greater strength (p=0.17). In total brachial plexus injuries, 37% of nerve reconstruction patients versus 78% of FFMT patients achieved M3 or greater strength (p<0.01) and 16% of nerve reconstruction patients versus 46% of FFMT patients achieved M4 or greater strength (p<0.04).

Summary Points
- In late presentation of traumatic brachial plexus injuries, donor nerves should be reserved for free functional muscle transfer to restore elbow flexion.
Bibliography


Images
Poster 286: Ulnar neuropathy at the elbow in 413 Japanese patients: an assessment of pathological elbow lesions and neurological severity

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Patient Education; Anatomy
Level 4 Evidence

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Hypothesis
A variety of pathological elbow lesions are associated with ulnar neuropathy at the elbow (UNE). The incidence and characteristics of these lesions may be different between Caucasians and the Japanese.

Methods
The medical records of 413 Japanese patients with UNE who were surgically treated among six hospitals were retrospectively examined by certified hand surgeons. Eligible patients had UNE diagnosed by physical findings and nerve conduction studies according to the criteria of the American Association of Electrodiagnostic Medicine. The mean age of the predominantly male (69%) cohort was 63 years (range: 15-87 years). The association of pathological elbow lesions with UNE was investigated based on medical history, plain radiographs, and operative records. The main criterion for elbow osteoarthritis (EOA) was a Kellgren-Lawrence grade of 2-4 as scored on anteroposterior and lateral plain radiographs of the medial humeroulnar joint. We analyzed the subjects with regard to age, gender, occupation, pathology at the elbow, and nerve palsy severity, and comparisons were made between UNE cases with EOA and those without pathological elbow lesions.

Results
Of 413 elbows, 310 elbows (75.1%) had 1 or more elbow lesions: 231 elbows (55.9%) had a single lesion and 79 elbows (19.2%) had 2 or more lesions. The most common lesion was primary EOA (54.5% of cases), followed next by medial elbow ganglion (8.5% of cases) and cubitus valgus deformity (6.5% of cases). Most elbows with medial elbow ganglion or cubitus valgus deformity were associated with EOA (Table 1). A total of 103 elbows (22.8%) had no apparent lesion in the elbow region, among which the ulnar nerve had most frequently become entrapped by the
cubital tunnel retinaculum (94 elbows). The incidence of a McGowan grade III lesion was 47.5% in patients with EOA. There were significant differences in age, prevalence of manual laborers, duration of symptoms, and prevalence of severe ulnar nerve palsy between patients with primary or secondary EOA and those with no elbow lesion, although the incidence of male gender was comparable (Table 2). A review of the literature and result of the present study reveals the incidence of EOA in Asian UNE patients is notable high compared than that in Caucasian UNE patients.

Summary Points
• Japanese patients with UNE often have various isolated or combined elbow lesions.
• Primary or secondary EOA is noted in 62.2% patients.
• We speculate that the characteristics of Japanese UNE patients are different from those of Caucasians.

Bibliography
Poster 287: Ultrasound Guided Carpal Tunnel Release: A Systematic Review

Category: Pediatrics/Congenital/Nerve

Treatment;Surgical Technique;Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
Ultrasound guided carpal tunnel release (USCTR) is a safe and effective option to treat patients with carpal tunnel syndrome.

Methods
PubMed and Ovid Medline databases were systematically searched using “carpal tunnel” OR “carpal tunnel release” OR “carpal tunnel surgery” AND “ultrasound” OR “sonography” through January 2017. A total of 18 articles were identified for complete review based on reporting clinical or cadaveric data pertaining to USCTR.

Results
Seven articles described USCTR in a total of 185 cadaveric specimens, whereas 11 articles reported the results of USCTR in 462 wrists, including one randomized trial comparing USCTR to mini-open CTR, 7 prospective studies, 1 retrospective study, and 2 case series. Among the 7 cadaveric studies, the rate of complete transverse carpal ligament (TCL) release was 96.2% (178/185) and no neurovascular injuries occurred. The 11 clinical publications reported on 462 wrists from 431 patients (102 male, 329 female) with a mean age of 59.9 years at surgery. Procedures were performed by hand surgeons, interventional radiologists, rheumatologists, and sports fellowship trained family physicians in either an operating room (N= 294) or outpatient procedural room (N=168) using 6 different cutting devices - hook knife, textured thread, rounded knife, sawtooth blade, needle, and basket punch. Among the 462 USCTR cases, there were no documented incomplete TCL releases or neurovascular injuries and no conversions to open or endoscopic CTR. At a mean follow-up of 12.2 months, the overall clinical success rate was >95%. One wrist (0.2%) experienced recurrent pain 2 years post-operatively without recurrent sensory disturbances. The 4 clinical studies providing comparative data suggested that patients treated with USCTR may have higher satisfaction in the early post-operative period, a more aesthetically pleasing scar, faster recovery, and reduced post-operative pain compared to those treated with traditional open CTR procedures.
Summary Points
The literature supports the hypothesis that USCTR appears to be a safe and effective treatment for selected patients with carpal tunnel syndrome requiring surgical intervention and may reduce post-operative morbidity compared to traditional CTR techniques. Further clinical experience and research is warranted to define the role of UGCTR in the management of patients with refractory symptoms.

Bibliography
3: Sample references listed above, full references provided in e-poster and upon request.

Images
Hypothesis
Recessive dystrophic epidermolysis bullosa (RDEB), a genetic disorder caused by mutations in the COL7A1 gene encoding type VII collagen, causes progressive hand contractures that vary unpredictably in severity, speed of progression, and risk of recurrence after surgical release. We hypothesized that specific types of COL7A1 mutations can predict hand contracture phenotype severity.

Methods
A national RDEB registry was queried for genotype and phenotype data collected by a single coordinating center. COL7A1 mutations were identified using a custom next generation sequencing panel specific for EB-causing genes. The putative protein consequences of each patient’s mutations were determined by the cDNA position and nonsense mediated decay, and categorized as no protein (NP – no protein generated by either allele) or abnormal protein (AP – protein generated by at least one allele, but truncated or with amino acid substitutions). Hand contracture phenotypes were assessed by the presence and age at onset of pseudosyndactyly and cocoon hand deformities. These progressive contracture stages were plotted as a function of age for each patient, with logarithmic best-fit curves created for each plot. The constants (slopes) of the logarithmic curves were used to rank the patients by hand contracture phenotype severity. The Mann-Whitney U test compared genotype with this ordinal representation of phenotype severity; Fisher exact tests compared genotypes and phenotypes categorically.

RESULTS: Complete genotype and phenotype data were available for 38 patients, in whom 11 different COL7A1 mutations combined to form 15 distinct genotypes (10 AP, 5 NP). The 27 patients with NP genotypes had significantly worse hand deformity progression than the 11 patients with AP genotypes (p=0.0002). Five patients without contractures all had AP genotypes, including one 75-year-old patient uniquely homozygous for AP alleles. Two outliers had severe phenotypes with AP genotypes, one that severely reduces collagen expression and the other that
accelerates collagen degradation. Overall, NP genotypes conferred a 100% risk of hand deformities and a 44% risk of a cocoon hand, compared to 44% and 0% respective risks with AP genotypes, excluding the 2 AP outliers (p<0.001, p=0.014, respectively).

Summary Points

• Hand contracture progression in RDEB correlates with genotype, with a protective effect conferred by the presence of at least one allele generating even abnormal collagen VII protein.
• Different forms of abnormal protein can lead to different contracture phenotypes, so further mutation analysis may help to elucidate the role of collagen VII in contracture pathogenesis.
• Genotyping provides prognostic utility to guide management of hand deformities in RDEB.
Poster 289: Postoperative change of an area and the form of median nerve in the carpal tunnel syndrome: evaluation by ultrasonography

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis
Level 4 Evidence

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Hypothesis
In a diagnosis of the carpal tunnel syndrome, the cross section evaluation of the median nerve by ultrasonography is useful.

The purpose of this study was to evaluate change over time in the form of the median nerve after carpal tunnel release by ultrasonography.

Methods
This was a single institution prospective cohort study.
Thirty-one patients with carpal tunnel syndrome treated with endoscopic carpal tunnel release were investigated by ultrasonography preoperative 6.12.24 weeks after surgery.
Ultrasonography measurements were performed considering cross section (cm2) of the median nerve in the minor axis image of proximal (distal radioulnar joint) and distal (capitate bone hook and tubercle of scaphoid bone).
By ultrasonography, we also measured minor axis (mm) and major axis (mm) of the median nerve and calculated nerve flattening (minor axis / major axis).

Results
There were no significant differences in the proximal and distal cross section during preoperative, 6, 12 and 24 weeks after surgery.
There were no significant differences in the proximal flattening during preoperative, 6, 12 and 24 weeks after surgery.
The mean distal flattening was significantly higher at 6 weeks postoperatively (P = .002) at preoperative: 30.8 (standard deviation (SD) 1.04), 6 weeks: 36.5 (SD 1.77), 12 weeks: 32.8 (SD 1.51), 24 weeks: 32.8 (SD 2.21).
Summary Points

- The cross section of the median nerve did not change until 24 weeks after surgery.
- The flattened median nerve was improved temporarily in six weeks after surgery, but became same as preoperation again subsequently.
- The ultrasonography of the early postoperative period seemed to be useful as a decompression evaluation by the surgery.
Poster 290: Incidence and Characteristics of Carpal Tunnel Release Following Open Reduction and Internal Fixation of Distal Radius Fractures: A 12-Year Review

Category: Pediatrics/Congenital/Nerve

Treatment; Surgical Technique
Level 4 Evidence

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Hypothesis
This study sought to elucidate any patient-specific factors common amongst those requiring Carpal Tunnel Release (CTR) during or following Open Reduction and Internal Fixation (ORIF) for Distal Radius Fracture (DRF) that could help guide surgeons in surgical decision-making. Our hypothesis is that patients with pre-existing CTS and/or more complex fracture patterns would have a higher probability of needing a surgery for acute CTR.

Methods
Utilizing billing data collected for all patient encounters at a single institution from 1/1/05 – 12/31/16, potential patients were identified using CPT codes to define surgical treatment of DRFs (Table 1) in addition to CPT codes for surgical treatment of CTS (Table 2) within a twelve-month period. A chart review was then performed to identify basic patient demographics, pre-surgical reduction attempt, type of surgery, pre-existing ipsilateral CTS, and time between surgery and carpal tunnel release. Radiographs were reviewed to identify fracture pattern. Incidence of CTR after ORIF was calculated as well as a proportional analysis of the various patient and injury-specific factors.

Results
Over the defined 12-year period, 579 separate ORIFs for DRFs were performed at a single institution by six surgeons. 32 patients (5.5%) were identified who had both ORIF of DRF and subsequent CTR within one year. Three were excluded because the ORIF encounter was revision surgery, and two excluded because they were under 18 years of age at the time of index procedure. 27 patients (4.7%) underwent open CTR within one year of primary ORIF (Table 2). The average age of these patients was 56.7 years. 21 (77.8%) were female. The average time to surgery from date of injury was 9.6 days (Range 1-29). All patients were symptomatic at the time of surgical intervention for CTS; no CTR was performed prophylactically. 25 (95.6%) of these CTRs
were performed at the time of ORIF and two (7.4%) performed at a later date (Range 1-78 days). Three (11.1%) patients who underwent both procedures had a diagnosis of pre-existing CTS prior to injury. 20 (74.1%) underwent closed reduction and immobilization prior to ORIF. Based on radiographic review, the most common fracture pattern was closed intra-articular DRF (70.4%).

Summary Points
- 5.5% of patients with DRFs developed concomitant CTS warranting CTR.
- Closed reduction prior to surgical intervention and higher grade fracture patterns had an increased incidence of acute CTS.
- Patients with pre-existing CTS are not more likely to present with acute CTS after DRF.

Bibliography
Poster 291: Influence of Endoscopic Blade Case Geometry on Carpal Canal and Median Nerve Pressures and on Anatomy During Endoscopic Carpal Tunnel Release Surgery in a Cadaver Model

*Category: Pediatrics/Congenital/Nerve*

Prognosis/Outcomes; Anatomy; Basic Science

N/A - not a clinical study

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**HYPOTHESIS**

1) Carpal canal and median nerve pressures increase as cross-sectional areas of endoscopic carpal tunnel release blade cases increase.
2) Median nerve shape is increasingly distorted with larger cross-sections of endoscopic blade cases.
3) Cross-sectional area of endoscopic blade cases may be the more influential indicator of transient neurapraxia than carpal canal size of the patient.

**Methods**

An incision was made in the proximal wrist crease of 8 cadaveric arms and under ultrasonic guidance, 3.5F pressure transducers were placed in the carpal canal and epineurium of the median nerve at the level of the hook of hamate. Five simulated endoscopic blade cases of various cross-sections were randomly inserted into the carpal canal while measuring peak pressures and anatomic changes via ultrasound. Four of the five blade cases had rectangular cross-sections while one was a “V” shape.

**Results**

Peak carpal canal pressures and median nerve pressures linearly correlated (p<.05) with larger blade case cross-sections (Figure 1).

Neither percentage change in pressure nor median nerve shape correlated with wrist size (Figure 2).

Median nerve shape, expectedly, trended towards becoming more circular upon blade case insertion and this effect was more pronounced with increasing blade case cross-section than with wrist size.

No other statistical significant differences were observed.
To determine the factor that was most influential in carpal canal and median nerve pressures (blade case area, blade case height, and carpal canal area), a design of experiments sum of squares analysis was conducted. The blade case area was significantly \(p<.05\) most impactful for carpal canal pressure. There was no statistical significance between factors for median nerve pressure.

**Summary Points**

- Carpal tunnel (canal and median nerve) pressures and median nerve distortion increase with the insertion of larger endoscopic blade cases. Increased pressures from larger blade cases may be a contributing cause of median nerve neurapraxia that is observed in approximately 1% of the postoperative endoscopic carpal tunnel release patients.
- Increasing the size of endoscopic blade cases predictably leads to increased carpal tunnel pressures, independent of patient wrist size.

**Bibliography**


Images
Poster 292: Regional Variations in the Incidence of Hospital-Diagnosed Carpal Tunnel Syndrome and Carpal Tunnel Release Surgery in Sweden: A Population-Based Study

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Treatment
Level 4 Evidence

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Hypothesis
The incidence of carpal tunnel syndrome (CTS) and of carpal tunnel release (CTR) surgery varies across regions.

Methods
From the nationwide patient registry we identified all individuals aged >17 years who had consulted a doctor at any hospital in Sweden 2001-2009 and received CTS diagnosis (ICD-10 code G560). We also identified all individuals who had CTR surgery in conjunction with the diagnosis. The incidence of CTS and CTR was calculated according to sex, age and county (21 counties in Sweden). Each individual was included only once (first-time diagnosis and first-time surgery). All incidence rates shown are per 100,000 person-years with 95% confidence intervals (CI).

Results
During the 9-year study period, 108,699 persons (75,799 women and 32,900 men) were diagnosed with CTS at hospitals in Sweden. The incidence in women was 232 (CI 230-233) and in men 104 (CI 103-105). The incidence peaked at 50-59 years in women and 70-79 years in men. The incidence in women increased from 216 (CI 211-221) in 2001 to 243 (238-248) in 2009, and in men from 95 (CI 92-98) to 119 (CI 115-122). Across the 21 counties the 9-year incidence varied from 172 to 364 in women, and from 71 to 175 in men. Of the 108,699 persons with hospital-diagnosed CTS, 70,120 (65%) had CTR surgery (49,440 women [65%] and 20,680 men [63%]). The incidence of CTR in women was 151 (CI 150-152) and in men 65 (CI 64-66), peaking at 50-59 years in women and 70-79 years in men. The incidence of CTR in women increased from 117 (CI 114-121) in 2001 to 168 (CI 164-173) in 2009, and in men from 52 (CI 49-54) to 78 (CI 75-81). Across the 21 counties the 9-year incidence varied from 106 to 251 in women and from 40
to 117 in men. The proportion of individuals treated with CTR was lowest in the ages 18-29 years (women 52%, men 52%) and highest in the age >79 years (women 69%, men 73%). Across the 21 counties the proportion varied from 53% to 81% in women and from 51% to 77% in men.

Summary Points

- The incidence of hospital-diagnosed CTS and of CTR surgery in Sweden 2001-2009 increased significantly over time in both women and men.
- There were large regional variations in the incidence of CTS and CTR and in the proportion of CTS-diagnosed individuals treated with surgery, a finding that should raise concern about health care equity.
Hypothesis
Post-operative scar formation, adhesion development, and inflammation are inherent following traumatic injury or surgical intervention. These complications can impact adherent tissues and lead to recurrent pain, altered range of motion, and neuritis. Excessive scarring around peripheral nerves can lead to poor outcomes and make access difficult in the event of additional procedures.

Amniotic membrane is an extracellular matrix and has been shown to modulate inflammation, reduce scarring and soft tissue attachments. These membranes have been used as wound dressings and coverings for years, but have lacked the qualities ideal for surgical application. Avive™ Soft Tissue Membrane (AxoGen Inc, Alachua FL) is processed amniotic membrane from human umbilical cord (UCM) intended for use as a soft tissue covering. This material, designed to overcome specific shortcomings of amniotic sac based membranes, is suturable and remains intact during the critical time of scar formation and maturation. We hypothesize that UCM can act as an interposition barrier for exposed peripheral nerves when post-operative scar formation, adhesion development, and inflammation are a concern.

Methods
Early evaluation of the utilization and handling characteristics of UCM was conducted. Following relevant consents, data was collected in cases where UCM was used during a surgical procedure on an exposed nerve. Information on the injury, purpose, and placement were collected on standardized report forms. Data was reviewed to evaluate clinical application and outcomes after use in peripheral nerve surgery.
Results
This case series included 12 patients (8 female/4 male) undergoing surgical procedures where a nerve was exposed but found intact. The average age was 50 (26-62) years. Use of UCM included traumatic, decompression, and planned reconstructive procedures. A majority of these nerves were in the upper extremity. See Table 1. Pre-operative preparation, injury site dissection, and surgical procedures were based on institution’s standard of care. After exposure and neurolysis, UCM was hydrated and placed in as a covering over the nerve. In eight cases, sutures (6-0/8-0) were used to secure in place. All surgeons reported UCM conformed well, easily positioned, secure, and remained intact. There were no reported complications and patients are recovering as expected. Additional follow-up is on-going.

Summary Points
- UCM can be used during nerve surgery to keep potentially adherent surfaces apart.
- Utilization included injuries when the potential of post-operative scar formation, adhesion development, and inflammation were a concern
- Placement was successful in all cases and patients are progressing as expected
- There were no reported complications

Bibliography

Images
Poster 294: Targeting an Epigenetic Regulator of Neural Development: Validation of Nuclear Translocation of a Therapeutic Peptide Toward the Possibility for Peripheral Nerve Regeneration

Category: Pediatrics/Congenital/Nerve

Basic Science
N/A - not a clinical study

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HYPOTHESIS BACKGROUND:
Peripheral nerve injury remains a challenging clinical problem. We have previously found trauma-induced mesenchymal progenitor cells (MPCs) at these injury sites, and demonstrated their ability to secrete neurotrophic factors.

The repressor element-1 silencing transcription factor (REST) is a nuclear factor that acts as a master regulator of neurogenesis by repressing terminal neuronal differentiation. Previous reports have found that REST was decreased following central nervous system insult, but the role that REST plays in peripheral nerve injury and the associated pathways are not well described.

C-terminal domain small phosphatase-1 (CTDSP-1) phosphorylates and stabilizes REST. Using a novel peptidomimetic decoy to bind CTDSP-1 limits its phosphorylation ability. Without the CTDSP-1 blockade on REST, neurogenic gene expression can facilitate neuron axonal growth after nerve injury. It is not known if this peptidomimetic is able to access CTDSP-1 at its site of action, the nucleus.

Hypothesis
We believe that we will be able to visualize the intracellular localization of the CTDSP-1 binding peptidomimetic, and demonstrate a decrease in REST levels after peptide treatment

Methods
MPCs were seeded onto coverslips on a 24-well plate and treated with the CTDSP-1-binding peptidomimetic, containing a FLAG-tag. Cells were harvested at 1 day after treatment, and fixed for immunocytochemistry with FLAG antibody for the peptidomimetic and Hoechst for the nucleus. Secondary antibodies were used for fluorescent visualization. Images were taken using confocal microscopy.

REST expression after peptide treatment was analyzed by Western blot, using a wild-type / mutant construct.
**Results**

The fluorescent tag for the CTDSP-1-binding peptidomimetic was collocated with fluorescent stain that binds DNA. That is, the peptidomimetic gained access to the nucleus in trauma-induced mesenchymal progenitor cells. In Figure 1, panel B demonstrates the FLAG antibody, associated with the peptide. Panel C shows the Hoechst staining of the nucleus, and panel D demonstrates the colocalization. Western blot analysis demonstrated a 35% decrease seen for the wild-type REST expression after peptide treatment.

**Summary Points**

- REST is a regulator of neural differentiation, and it is controlled by CTDSP-1.
- The peptidomimetic, with affinity for CTDSP-1, can translocate to the nucleus, which strengthens the feasibility of modulating the epigenetic control of REST.
- The peptide also lowers the levels of REST, which may allow for increased transcription of downstream neuronal genes.

**Bibliography**

Hypothesis
We hypothesize that second harmonic generation (SHG) microscopy can be used to visualize rat median nerve damage in vivo. Furthermore, we postulate that the use of intra-operative nerve stimulation can serve as a valid assessment of nerve damage.

Methods
With IACUC approval, six Sprague-Dawley rats (n=6) were anesthetized and prepared for surgery. Under sterile conditions, an anterior incision was made on the right and left upper limbs, continuing into the fascia. The flexor carpi radialis and flexor digitorum superficialis were separated in order to identify the underlying median nerve. In both upper limbs, median nerves were carefully dissected from surrounding tissue and vasculature. The nerves were probed using the Checkpoint Nerve Stimulator (Cleveland, Ohio) and the lowest amount of stimulation required to induce the slightest detectable amount of finger movement (flicker) was recorded. Using a custom made stretch applicator, a stretch of 30% was induced and held for 5 minutes in the right median nerve. The left median nerve served as a sham control, being clamped for 5 minutes in the applicator, with no stretch applied. Both nerves were probed again, and stimulation required for a flicker of finger movement was recorded. The subjects' nerves were then imaged using an Olympus FV1000MPE Fluoview (Tokyo, Japan) multiphoton laser scanning microscope. All images were obtained using an Olympus XLPlanN 25x/1.05 numerical aperture water immersion multiphoton lens (Tokyo, Japan).

Results
Intact nerve stimulation for both right and left median nerves exhibited flicker movement at 0.5mA with 50µs of pulse duration (the lowest setting on the stimulator). After applying a stretch, the amount of stimulation required to induce a flicker was increased to 2.0mA at 100µs for all subjects. In the Sham nerves, only one specimen required an increase in stimulation; pulse duration increased from 50µs to 100µs (at .0.5mA), however, there were no changes in the
amount of current required. In vivo nerve images obtained using SHG microscopy showed characteristics indicative of nerve damage in the stretched median nerves only, while sham median nerves appeared normal. Images obtained from stretched nerves showed crossing fibers, undulating fibers, and splits/tears in collagenous tissue (Fig. 1). In the sham control nerves, fibers were noticeably more linear, with a lack of crossing and splitting fibers (Fig. 2).

Summary Points
- Intra-operative nerve stimulation can distinguish between intact and damaged nerve function following an acute stretch injury
- SHG microscopy can be used in vivo to image median nerve damage
Poster 296: Hand Surgeon Perspectives on Ulnar Nerve Instability at the Elbow: Pre- and Intra-operative Decision Making Considerations for Anterior Transposition of the Ulnar Nerve

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis;Treatment;Prognosis/Outcomes
Level 5 Evidence

Brent R. DeGeorge, Jr., MD, PhD
Sanjeev Kakar, MD, MBA

Hypothesis
We postulated that a survey of American Society for Surgery of the Hand (ASSH) members would provide insight into the practice patterns among hand surgeons treating cubital tunnel syndrome and demonstrate the extent to which pre and intra-operative patient factors regarding ulnar nerve instability at the elbow influences practice behavior.

Methods
After approval by our IRB and ASSH research committee, a multiple-choice questionnaire was sent to all ASSH members. The survey examined practice variables, cubital tunnel practice patterns, pre-operative imaging and electrodiagnostic evaluation, and a series of standardized intra-operative photographs of ulnar nerve instability at the elbow.

Results
Surveys were sent to 3685 eligible ASSH members, and 558 (16%) completed the survey and partial responses were collected from 132 (18.3%). For patients with primary cubital tunnel syndrome, with and without muscle weakness, respondents most commonly reported performing in situ decompression (55.2% and 42.3%, respectively) and anterior transposition of the ulnar nerve (17.5% and 28.5%, respectively). Despite the subjectivity involved, most members (approximately 85%) relied on history and physical examination to determine ulnar nerve instability. Only 6.1% indicated they routinely obtained pre-operative dynamic ultrasound. Factors influencing anterior transposition of the ulnar nerve are shown in Table 1. On review of clinical photographs, respondents identified a “normal” ulnar nerve as not “dislocated” (91.3%) and not “subluxated” (76.4%), and a majority of respondents recommended against anterior transposition. However, with any degree of ulnar nerve instability simulated with anterior translocation of the ulnar nerve in flexion, the respondents demonstrated decreased concordance on the terms “subluxated” and “dislocated” and the majority of respondents recommended for anterior transposition with any degree of simulated “subluxation” or “dislocation” (Figure 1).
Summary Points

- Despite its subjectivity, most ASSH members routinely evaluate for ulnar nerve instability with history and clinical examination without uniform use of pre-operative adjuncts, including ultrasound.
- The decision to transpose the ulnar nerve is made intra-operatively in about 50% of cases.
- Definitions for the degree of ulnar nerve instability at the elbow are not uniformly agreed upon, and further development of a classification system may be warranted to standardize treatment.
Hypothesis
Brachial plexus birth palsy (BPBP) can lead to glenohumeral dysplasia and shoulder internal rotation contractures. Arthroscopic capsular release (ACR) and glenohumeral reduction is commonly performed to improve shoulder function, and is currently indicated for patients =4 years. The hypothesis of this study was that patients =4 years with BPBP internal rotation contractures would gain external rotation following ACR and glenohumeral reduction.

Methods
A retrospective review of all BPBP patients =4 years that underwent ACR and glenohumeral reduction over a 5 year period at 2 institutions was performed. Outcomes measured were shoulder range of motion (ROM) and function, as measured by the Modified Mallet (MM) scale. Pre and post-operative measurements were compared between all patients.

Results
10 patients =4 years underwent ACR and glenohumeral reduction over the 5 year time period. 7 patients had complete records of MM scores and 6 patients had complete records of ROM measurements. The mean age at surgery was 8.56 (4.2 to 17.2) years in the MM group, and 7.12 (4.2 to 14.3) years in the ROM group. All patients were male. Mean follow up time was 13.87 (5.12 to 41.65) months in the MM group, and 22.36 (5.82 to 40.67) months in the ROM group. Mean active external rotation improved pre to post-operatively from -6.67 to 21.67 degrees (p=0.08). Mean MM scores improved from 1.86 to 3.29 (p=4 years showed an average gain of 28.34 degrees of external rotation.

• ACR and glenohumeral reduction in patients >=4 years showed an average MM score gain of 1.43 in MM external rotation
•ACR and glenohumeral reduction can be considered in patients ≥4 years of age with BPBP shoulder internal rotation contractures, particularly if there is a MM abduction score ≥4

Bibliography
Images
Poster 298: Reoperation Rate and Factors Associated with Reoperation After Neurolysis, Direct Nerve Repair or Nerve Grafting in Traumatic Brachial Plexus Injury

Category: Pediatrics/Congenital/Nerve

Treatment; Prognosis; Outcomes
Level 4 Evidence

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Kyle Eberlin

Hypothesis
Neurolysis, direct nerve repair and nerve grafting are traditional options for treatment of traumatic brachial plexus injuries. Secondary surgery may be interpreted as an index of success that provides a different perspective than traditional outcome measures. We examined the rate of and factors associated with secondary surgery in traumatic brachial plexus injured following these procedures.

Methods
In this retrospective study spanning two Level I medical centers in a single metropolitan area, 48 patients were identified who underwent neurolysis, direct nerve repair, or grafting between 2002 and 2015. Bivariate analysis examined the association between demographic, injury, and treatment characteristics with secondary surgery.

Results
The rate of secondary surgery was 11 out of 48 (23%). In patients who underwent secondary surgery, most received neurolysis as the primary brachial plexus surgery (Table 1). The major indication was poor motor recovery. The most common secondary surgery was tendon and local muscle transfer transfer (Table 2). The association of obesity to secondary surgery approached significance (P=0.077; Table 1).

Summary Points
- About 1 out of 4 patients will undergo a secondary surgery to try to improve function.
- Nerve transfer is still good option for secondary surgery if it is performed within 12 months after initial injury.
Bibliography
2: Dubuisson AS, Kline DG. Brachial plexus injury: a survey of 100 consecutive cases from a single
Images
Hypothesis
Measurement of ulnar nerve cross-sectional area (UNCSA) at an optimal location by MRI or ultrasonography (US) can diagnose ulnar neuropathy at the elbow (UNE).

Methods
UNCSA was measured at 7 sequential elbow segment levels in 30 patients with UNE and 28 controls by MRI and at 15 sequential elbow segment levels in 12 UNE patients and 24 controls by US. MRI was performed with a 1.5 T system by transverse-plane, T2-weighted fast spin-echo images without fat suppression, while US was conducted with a 15 MHz probe in B-mode. The 30 UNE patients in the MRI study contained 7 females and 23 males aged 30-83 years. The 12 UNE patients in the US study were all males aged 55-83 years. The number of patients with McGowen classification I/II/III was 6/6/18 in the MRI study and 0/4/8 in the US study. We compared UNCSA as determined by MRI or US and determined optimal diagnostic cut-off values based on receiver operating characteristic (ROC) curve analysis.

Results
UNCSA measured by US had no significant relationships with patient age, gender, or BMI. UNCSA was significantly larger in the UNE group than in controls at 3, 2, 1, and 0 cm proximal and 1, 2, and 3 cm distal to the medial epicondyle (ME) for both modalities (P<0.05, Welch’s t-test)(fig.1 and fig2). UNCSA was largest at 1 cm proximal to the ME on both MRI (16.1±3.5 mm2) and US (17±7 mm2). A cut-off value of 11.0 mm2 was determined as optimal for differentiating between UNE patients and controls, with high specificities of 0.97 and 0.92 and areas under the ROC of 0.95 and 0.96 for MRI and US, respectively. UNCSA measured by MRI was comparable to that by US (P<0.05, paired t-test). Intra- and inter-rater reliabilities for UNCSA were all greater than 0.77. UNCSA in patients with McGowen grade III lesions was significantly larger than that in patients with McGowan grades I or II (P<0.05, Mann-Whitney U test).
Summary Points

- UNCSA increased significantly from 3 cm proximal and 3 cm distal to the ME as measured by MRI and US.
- UNCSA was maximal at 1 cm proximal to the ME in both MRI and US evaluations.
- In measurements of UNCSA using MRI or US at 1 cm proximal to the ME, patients with and without UNE could be discriminated at a cut-off threshold of 11.0 mm² with high sensitivity, specificity, and reliability.

Bibliography


Images
Hypothesis
Although several reports have linked prolonged or high-dose administration of agents such as anticonvulsants and psychotropic drugs with peripheral nerve impairment [1,2,3], possible aetiological mechanisms and effects on postoperative recovery in patients with cubital tunnel syndrome have not been explored. Here, we evaluated the effect of psychotropic drugs on evoked electromyography of patients with cubital tunnel syndrome by comparing patients undergoing surgery for cubital tunnel syndrome who were taking and not taking these drugs.

Methods
Using evoked electromyography, we sought to assess the effect of psychotropics and anticonvulsants on patients with primary cubital tunnel syndrome. Eighteen elbows of 16 patients who took psychotropic agents, including atypical antipsychotics, anxiolytics, antidepressants, and anticonvulsants to treat schizophrenia, bipolar disorder, depression, anxiety disorder, alcohol dependence, organic mental disorder, and dependent personality disorder (P group); and 29 elbows of 26 patients who were not diagnosed with a psychoneurologic disease (N group), were studied. All patients had been diagnosed with cubital tunnel syndrome and were awaiting surgery.

Results
Evoked electromyograms revealed that conduction velocities in the P group were significantly slower than those of the N group (Table 2). Amplitudes of compound muscle action potential of the abductor digiti minimi in the P group were significantly lower than those in the N group (Table 2). Surgical results using Akahori’s criteria [4] were not significantly different between the two groups.
Summary Points

- Our findings suggest that psychotropic drugs may be a cause or aggravating factor of cubital tunnel syndrome.
- Anterior subcutaneous transfer of the ulnar nerve was effective in improving symptoms in patients taking psychotropic and/or anticonvulsives.

Bibliography

Poster 302: Distinct motor weakness characteristics in cubital tunnel syndrome patients with medial elbow ganglion

Category: Pediatrics/Congenital/Nerve

Prognosis/Outcomes
Level 4 Evidence

Tomokazu Sawada, MD, PhD
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Hypothesis
The purpose of this study is was to clarify the characteristic symptoms of CuTS patients with medial elbow ganglion.

Methods
Thirteen patients who were diagnosed and operated for CuTS with a presence of medial elbow ganglion intraoperatively were retrospectively analyzed in this study. Fifty one patients with a diagnosis CuTS with the presence of osteoarthritis of the elbow (OA group) undergoing modified King method, were included as controls. The duration of symptom, preoperative muscle power of ulnar nerve area (flexor carpi ulnaris: FCU, flexor digitorum profundus: FDP, abductor digiti minimi: ADM, first interosseous muscle: IOD) and McGowan classification were analyzed between the two groups. Mann-Whitney U test was used for statistical analysis.

Results
Among the thirteen cases of CuTS with medial elbow ganglion, 12 showed osteoarthritic changes in plain radiographic. The preoperative intrinsic muscle power and the severity of CuTS by McGowan’s grading showed no significant differences between the two groups. However, the muscle strength of FCU and the 4th FDP was significantly weaker in the ganglia cases. In particular, FCU was below MMT 2 in more than half of the case. Interestingly, the funiculus of the FCU is located at the postero-lateral aspect of the ulnar nerve adjacent to ulnohumeral joint where ganglions are usually located. Thus, we consider that the characteristics of the CuTS with ganglion are associated with the anatomical features.

Summary Points
We conclude that the characteristic symptoms of CuTS with medial elbow ganglion are, osteoarthritic changes of the elbow, severe weakness of the 4th FDP and FCU. We should take
into consideration the presence of ganglion of the elbow when treating patients with these symptoms.
Poster 304: Identifying Patients with Concomitant Cubital Tunnel Syndrome and Carpal Tunnel Syndrome

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Treatment
Level 2 Evidence

Brandon S. Shulman
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Hypothesis
The incidence of concomitant Carpal Tunnel Syndrome (CTS) and Cubital Tunnel Syndrome (CuTS) has not been clearly defined. Our hypothesis is that patients with CuTS commonly also have CTS. Lack of awareness of this association increases the risk of missing a concomitant CTS. The aim of this study was to determine the incidence of concomitantly treated cubital and carpal tunnel syndromes by retrospectively reviewing patients from a large academic medical center and the New York Statewide Planning and Research Cooperative System (SPARCS) patient database.

Methods
We retrospectively reviewed 3052 consecutive patients who underwent surgical treatment for CTS or CuTS at our tertiary care institution over a 5-year period. We then used the SPARCS database to search for every patient that underwent operative treatment for CuTS or CTS from 2003 – 2014 (84,829 patients) in New York State. Statistical analysis was performed to determine how many individual patients with CuTS were also treated for CTS per year for both our institution and on a statewide level. Subgroup analyses for age and gender were performed.

Results
21% of patients surgically treated for CuTS at our institution from 2011-2016 also underwent concurrent ipsilateral carpal tunnel release (range 16-28%). In New York State, the number of patients receiving surgical treatment for CTS and CuTS ranged from 23% in 2003 to 45% in 2014 - an increase of 700% (p=<0.001). Patients treated surgically for concomitant CuTS and CTS were significantly older than patients treated for isolated CuTS (54.8 years old versus 46.4 years old, p=<0.001). Males were more likely to have either surgically treated CuTS (54.7%, p=<0.001) or concomitant CuTS and CTS (55.3 %, p=<0.001) but consisted of only 33.3% of those surgically treated for CTS alone.
Summary Points

- Approximately one quarter of patients requiring surgical treatment for cubital tunnel syndrome undergo concomitant carpal tunnel release.
- The incidence of treatment for concomitant CuTS and CTS is rapidly increasing. Possible explanations for this include: improved diagnosis, over-diagnosis/treatment, or increased willingness to perform concurrent releases.
- While all patients with CuTS should be screened carefully for CTS, male patients over age 50 presenting with symptoms of CuTS have the highest risk of concomitant CTS and should be examined with extra vigilance.

Bibliography

1: Descatha A et al. Do comorbid ulnar symptoms or ulnar neuropathy affect the prognosis of workers with carpal tunnel syndrome? J Occup Environ Med. 2014 Mar;56(3):e2-3

Images
Poster 305: Ulnar Nerve Injections about the Elbow: An Ultrasound-Guided Injection Pilot Study

*Category:* Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Treatment; Anatomy
N/A - not a clinical study

Grant Received from: Indiana Hand Research and Education Endowment Fund

Scott W. Rogers, MD
Greg Merrell, MD

**Hypothesis**
Our hypothesis is that it will be feasible to accurately inject the perineural space of the ulnar nerve at the elbow at the level of the medial epicondyle, 2 cm proximal to the medial epicondyle, and 2 cm distal to the medial epicondyle using ultrasound guidance. Also, we hypothesize that ultrasound-guided injections will be more accurate than non-guided injections.

**Methods**
Eighteen fresh-frozen whole arm cadaveric specimens were injected with latex using ultrasound guidance in one of three sites around the elbow: at the level of the medial epicondyle (ME), 2 cm proximal to the ME, and 2 cm distal to the ME. Twelve mid-humerus cadaveric specimens were injected with latex without ultrasound guidance at the level of the ME. All specimens were cycled through full elbow range-of-motion 10-times after each injection and then dissected. Accuracy and location of injection, spread of injectate, and anatomic blocks to injectate spread were evaluated.

**Results**
Results of injection, spread of injectate, and anatomic blocks to injectate spread were evaluated. Results: Seventeen of 18 ultrasound-guided injections were successfully placed into the ulnar nerve perineural space. Only 7 of 12 non-guided injections were successful. Ultrasound-guided injections were statistically more accurate compared to non-guided injections.

**Summary Points**
- Based on our results, ultrasound-guided injections of the ulnar nerve perineural space around the elbow are feasible and accurate at all 3 locations tested.
- We found ultrasound-guided injections to be more accurate than non-guided injections.
Bibliography
Images
Hypothesis
Several articles have demonstrated how low-grade thermal exposure (45-47°C) results in delayed nerve injury via heat-induced angiopathy 1,2,3 yet thermal injury is rarely discussed in regards to gunshot wounds. The purpose of this experiment was to examine the quantity of heat produced during the impact of medium-velocity handgun projectiles utilizing cadaveric peripheral nerves embedded in ballistics gel, and the histological effects on the nerve tissue. No studies to our knowledge have examined to what degree tissues are heated during impact of pistol projectiles and how the heat dispersion may effect nerve tissue. We hypothesize that there will be a significant release of heat energy to tissues immediately surrounding the area of impact with a medium-velocity handgun projectile but that histology will fail to show immediate thermal injury as heat-induced angiopathy is a delayed process.

Methods
Eleven segments of radial, median, and ulnar nerve were dissected from a thawed fresh frozen cadaver. The nerve segments were placed in a 10% ballistics gel block one centimeter from the end of the block nearest the shooter. 115-grain 9mm NATO ammunition was fired through the nerve and ballistics gel construct with a pistol form a distance of 3 meters. The impacts were recorded with an ultra high-speed infrared camera to determine maximum temperature upon impact. The nerve samples were sent for histological analysis by a board certified pathologist.

Results
The average velocities of the projectiles were 391m/s, 95%CI [387-395 m/s], with an average kinetic energy of 571J, 95%CI [588.03-581.34J]. Average observable temperature of the ballistics gel / nerve prior to impact was 28.81°C±0.59°C, 95%CI [26.4-30.3°C]. Average observable temperature of the surrounding ballistics gel / nerve during projectile impact was 55.10°C±2.42°C, 95%CI [51.3- 62.1°C], yielding an average observable increase of 26.40°C±3.24°C, 95%CI [20.2 - 35.4°C]. The histology of the impacted nerve tissue failed to show any sign of acute thermal injury. This may correspond with a well-documented time-delay between hyperthermic injury and histological changes.
Summary Points

- Medium-velocity 9mm NATO pistol projectiles increase the temperature of surrounding tissues 26.40°C±3.24ºC during impact and create tissue temperatures to levels which previous studies have demonstrated cause nerve heat-induced angiopathy.
- The values of our experiment may be used in further in-vivo studies to better understand how to care for patients with nerve injury via gunshots.
- Our findings suggest that nerve injury after collision with pistol projectiles may be secondary to heat-induced angiopathy in addition to the classic model of concussion and penetration.

Bibliography

Hypothesis
Analysis of setting and outcomes of digit replantations for traumatic amputations in the pediatric population have not been described with a national pediatric database. We sought to characterize the incidence of replantation over time with determination of hospital characteristics, associated in-hospital complications, cost, and frequency and risk factors for revision.

Methods
The Kid’s Inpatient Database (KID) from the Healthcare Cost and Utilization Project (HCUP) for 2000, 2003, 2006, 2009, and 2012 were queried for traumatic amputations of the thumb or finger (ICD-9: 885.0, 885.1, 886.0, 886.1). Subjects were then separated amongst those who underwent replantation (ICD-9-CM: 84.21, 84.22) and those who underwent amputation (ICD-9-CM: 84.01, 84.02). Patients who underwent replantation were further divided into those requiring revision amputation (ICD-CM: 84.01, 84.02) and/or microvascular revision (ICD-9-CM: 39.3, 39.4, 39.5). Age, sex, digit, insurance, cost, length of stay, and hospital characteristics were extracted for each patient. Complications (wound dehiscence, infection, hemorrhage, venous thrombosis, cardiac, respiratory, urinary complications) were defined with ICD-9 codes. Fisher’s exact tests and multivariable regressions were utilized with p values < 0.05 determined to be significant a priori.

Results
From 2000 to 2012, traumatic digit amputations occurred in 3,090 pediatric patients with 1,950 (63.1%) patients undergoing revision amputation and 1,140 (36.9%) undergoing replantation. Multivariable regression demonstrated no variation in replantation rates by year (p = 0.17). Public hospitals were less likely to perform replantation than private hospitals (OR = 0.556, 95% CI: 0.327-0.945, p<0.05), with no difference in urban teaching and urban non-teaching hospitals.
performing replantations (p=0.5). Replantation did vary significantly by hospital location where urban hospitals performed a higher rate of replantations than rural hospitals (OR=0.436, 95% CI: 0.268-0.71, p<0.01). Total charges, length of stay, and in-hospital complication rates were significantly greater with replantation than amputation (p < 0.001). Following replantation, 237 (20.8%) underwent revision amputation, 209 (18.3%) with vascular revision, and 388 (34%) required vascular revision and amputation. Multivariable regression demonstrated that older patients, males, and recent treatments were associated with increased rate of revision following replantation (p < 0.05).

Summary Points
- Patients who were older, male, and treated more recently were at greater risk for revision procedures.
- Total charges, length of stay, and complication rates were significantly greater with replantation than with revision amputation following traumatic digit amputations.
- Appropriate patient selection, hospital setting and resources, and experience to pursue such procedures must be taken into account to provide optimum outcomes in pediatric replantations.

Bibliography
Poster 309: Use of Single Forearm Incision for Tendon Transfer for Radial Nerve Palsy

Category: Pediatrics/Congenital/Nerve

Treatment; Surgical Technique
Level 4 Evidence

Wael Ghebery, MD

Hypothesis
Loss of radial nerve function in the hand creates a significant disability. The patient cannot extend the fingers and thumb and has great difficulty in grasping objects. Perhaps more importantly, the loss of active wrist extension robs the patient of the mechanical advantage that wrist extension provides for grasp and power grip. Tendon transfer using a single incision in its place can solve these problems in short time.

Methods
In prospective analysis, A total of 18 patients of radial nerve injury (17 men and 1 woman) with a mean age of 30 years (range, 22–40 years) underwent tendon transfer after failed nerve reconstruction. The exclusion criterion was radial nerve dysfunction resulting from brachial plexus injury.

For all tendon transfer procedures, critical components of the procedure include intraoperative confirmation of the ROM of all joints will be used and confirmation of appropriate donor muscles selection. With the patient supine after application of tourniquet, a 10 cm long incision is first marked over the radial aspect of the forearm, extending from the middle third of the radial side of the forearm to 1 cm proximal to the radial styloid distally. All the tendons required for the transfer are explored and identified through the same incision. By good retraction of the wound proximally, Pronator teres muscle is raised from its insertion with a 4 cm sleeve of periosteumsuturing of flexor carpi radialis tendon to extensor digitorum communis tendons, and finally, the palmaris longus tendon is sutured to the extensor pollicis longus tendon. (Fig.5) Pronator teres is sutured to the extensor carpi radialis brevis tendon.

Results
After surgical treatment, the average ranges of wrist movement were as follows: mean extension was 56° ± 5°, which was 85% of the maximum mobility of the opposite side. Mean flexion was 57° ± 5°, equivalent to 75% of the maximum degree of movement of the healthy side. Radial deviation was 17° ± 5°, and ulnar deviation was 55° ± 5°. The mean finger extension during wrist extension was 75° ± 5° and was almost similar in the wrist neutral position at 75° ± 5°. The mean
palmar abduction of the thumb was 41°± 5°, which was 80% of the maximum mobility of the opposite side

Summary Points
All our patients were satisfied with procedure with no refusal to do same operation if they had same injury to his healthy limb even with the patient who developed the SRN neuroma, sure after

Bibliography
Images
Poster 310: Primary closure of simple syndactyly without the use of full thickness skin grafts following excision of fat from the digit – A Case Series

Category: Pediatrics/Congenital/Nerve

Treatment; Surgical Technique
Level 4 Evidence

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Paul McArthur

Hypothesis
Traditionally syndactyly has been managed with release and closure using local flaps taken from the dorsum of the hand, with the donor site requiring full thickness grafts. We present a consecutive case series in which the senior author excised and measured the volume of fat to enable closure without the need for full thickness skin grafts.

Methods
A retrospective analysis of simple syndactyly release was performed from July 2015 to November 2016.
Data was collected on patient demographics, digits involved and grade of syndactyly. All patients underwent surgical release, with use of “Stingray” flaps fashioned from the dorsal skin. The fat excised from the digit was transferred to a 1ml syringe and following the expression of air, a volume was objectively measured and recorded. Closure of the donor site was possible without a full thickness skin graft.
Patients were followed up in dressing clinic at 2 weeks, outpatient clinic at 3 months, 6 months, 1 year then 2-yearly until the age of 16 years old.

Results
Nine patients (1 female, 8 males) with simple syndactyly were treated over a 15-month period, with 10 releases performed and 3 currently awaiting surgery on other digits. Six patients had single syndactyly involvement, 3 patients had multiple syndactyly involvement and 1 patient also had bilateral foot involvement. Seven patients had simple complete syndactyly and 2 patients had incomplete syndactyly. The mean volume was 0.4ml (0.1-0.9), the mean age at surgery was 24 months (10-55) and the mean follow-up is 6.6 months (1-16).

Summary Points
- Previous published papers have discussed excision of fat around the neurovascular bundles to reduce the bulk of closure. Our experience indicates that excision of small
volumes of fat during simple syndactyly release assists primary closure without the need for full thickness skin grafts for donor sites.
Poster 311: Long-Term Functional Upper Extremity Outcomes In Adult Apert Syndrome Patients

Category: Pediatrics/Congenital/Nerve

Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
Currently, limited data exist on long-term functional outcomes for patients with Apert syndrome, a rare congenital condition characterized by craniofacial anomalies and complex syndactyly of hands and feet. The study aimed to evaluate upper extremity function and health-related quality of life (HRQOL) in adult Apert syndrome patients.

Methods
Following Institutional Review Board approval, medical records were queried for patients between ages 18 and 65 years old with Apert syndrome. Recruitment was conducted via postal mail, followed by telephone calls. After obtaining consent, demographic and clinical data, including syndactyly type, were collected during visits, from medical records, and interviews. Participants completed two self-reported HRQOL instruments: the 36-Item Short Form Health Survey Instrument, version 2 (SF-36v2), and the Disabilities of the Arm, Shoulder, and Hand (DASH) Outcome Measure. Functional outcomes included moving two-point discrimination, metacarpophalangeal joint range of motion, pinch strength, and the Jebsen Hand Function Test (JHFT).

Results
Between July 2016 and April 2017, 14 participants completed the study. 57% of participants were male, 86% were Caucasian, and age ranged from 18 to 43. 64% were right-hand dominant, and 21% had one digit amputated. Average SF-36 scores were 51.29 ± 11.18 for mental health and 54.64 ± 6.99 for physical health. Average total DASH score was 14.58 ± 14.32. Average total JHFT scores for dominant hand were 70.32 seconds for males and 66.10 seconds for females; averages for non-dominant hand were 82.77 for males and 87.11 seconds for females. Average lateral and chuck pinch strengths were 7.21 ± 2.91 and 5.56 ± 1.98 kilograms for dominant hand, respectively, and 6.48 ± 2.53 and 5.38 ± 2.09 kilograms for non-dominant hand, respectively.
Average two-point discrimination was 4.01 ± 1.01 millimeters. Average total metacarpophalangeal joint range of motion was 52.85 ± 20.46 degrees. All participants reported completing high school, several had completed college, and all reported being employed or volunteering at some point during their adulthood. Participants reported living situations that ranged from living with immediate family or a spouse, to living alone.

Summary Points

• This study offers novel data on long-term functional upper extremity and HRQOL outcomes in adult Apert patients.
• Self-reported HRQOL outcomes were more favorable than functional measures alone would suggest.
• One study limitation is small sample size; Apert syndrome is rare, and recruitment efforts from a pediatric facility are limited, since most participants are no longer patients. A larger cohort would increase understanding of long-term outcomes.
Poster 312: Functional Workspace of the Hand in Normal Children

*Category: Pediatrics/Congenital/Nerve*

Evaluation/Diagnosis
N/A - not a clinical study

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Mitell Sison-Williamson, MS
Anita Bagley, PhD
Michelle A. James, MD

**Hypothesis**
Objective reproducible measurements of thumb prehension are limited in children. We developed a three-dimensional (3D) kinematic model for measuring functional workspace of the thumb[1,2]. Our hypothesis was that this model can assess thumb range of motion (ROM) and functional workspace in normal children.

**Methods**
Forty-eight healthy subjects (Age = 11.3 ± 3.9 years) were studied. The motion of 12 retro-reflective markers placed on bony landmarks of the thumb, fingers, and hand was recorded using a 12-camera motion analysis system [1]. Each subject performed 3 trials of ROM, including thumb flexion (F), extension (E), opposition, radial and palmar abduction-adduction, and finger F, E, and functional tasks to simulate activities of daily living (ADL). Functional tests included the Jebsen Taylor Hand Function Test (JTHFT), Functional Dexterity Test (FDT), and Box and Blocks Test (BBT).

A 3D model of the hand was generated from marker positions. Functional workspace of the thumb was determined by calculating the volume of intersection between total thumb-tip ROM and fingertip ROM tasks using custom MATLAB software. Volumes were normalized by subject thumb length for comparison. Pearson’s correlation coefficient was calculated for volumetric data and functional testing.

**Results**
The normalized functional workspace of the thumb was 2.7 ± 1.4 cm² and the normalized total thumb reach space was 13.5 ± 4.7 cm² (Fig. 1). There was a strong positive correlation between thumb size and thumb reach space (r = 0.77) and functional workspace (r = 0.74). Most simulated ADL were completed with a combination thumb radial abduction and palmar flexion in contact with the index finger. There was a moderate correlation between JTHFT score and both the total thumb reach space (r = 0.36) and functional workspace (r = 0.40). There were weak correlations between volumetric measurements and FDT and BBT test scores.
Summary Points

- This study describes use of a kinematic model of the thumb, finger and hand for measurement of the functional workspace of the thumb in children.
- The simulated ADLs performed used predominantly combinations of radial abduction and palmar flexion for completion.
- The functional workspace had a moderate correlation with JTHFT
- Future investigations will examine the functional ROM and workspace of the thumb in children with congenital hand differences.

Bibliography

Images
Poster 313: Bone lengthening of the radius with temporary external fixation of the wrist for mild radial club hand

Category: Pediatrics/Congenital/Nerve

Treatment; Surgical Technique
Level 4 Evidence

Takehiko Takagi, MD, PhD
Atsuhi to Seki, MD, PhD
Shinichiro Takayama
Masahiko Watanabe

Hypothesis
The goals in the treatment of radial deficiency are to correct the wrist deformity, to maintain the corrected position, to provide wrist-like mobility, and to preserve the maximal forearm longitudinal growth capacity as well as to achieve an acceptable cosmetic result. However, it is difficult to acquire alignment as well as mobility. We report the utility of a surgical approach to treat mild (Bayne type I or II) radial club hand with a combination of radial bone lengthening and temporary external fixation between the ulna and the metacarpals to support the radial side of the wrist and avoid the loss of correction.

Methods
We evaluated five radial club hands that received a new procedure involving radius lengthening with external fixation to support the radial side of the wrist. The evaluation included an assessment of radial deficiency deformity recurrence from the anteroposterior radiographs and a measurement of the passive range of wrist motion with the use of a goniometer before surgery and at the time of the final follow-up. We recorded complications such as infection and nerve palsy.

Results
The healing index (external fixator duration/extended length of the radius) of the radius was from 72.2 to 298.9 day/cm (mean, 176.8 day/cm). The mean radial/ulnar deviation was 84.0/-14.0° before surgery and 37.0/13.0° at the time of the final follow-up. No correction loss was detected during the follow-up. All patients were able to hold and bring an object to the mouth after surgery. No patient had a postoperative infection and there were no cases of nerve palsy.

Summary Points
- We applied a method of radius lengthening to support the radial side of the wrist after soft-tissue release at the radial side of the wrist.
Correction loss is avoided during growth in the present method because the lengthened bone includes the growth plate. In addition, a good range of motion may be also acquired due to temporary traction of the wrist using an external fixation device without producing growth plate damage despite a poor healing index in the present series.

Our novel technique can be performed for cases with mild radial deficiency and with mild radius deficiency including growth plate injuries.

Bibliography

Images
Poster 314: Congenital Hand Anomalies Associated with Moebius Syndrome

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis
Level 4 Evidence

Lindley Wall, MD
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Hypothesis
We hypothesized that congenital hand anomalies in Moebius syndrome are classifiable on the spectrum of symbrachydactyly and that the incidence of bilateral hand anomalies is higher than in isolated symbrachydactyly.

Methods
Medical records were reviewed for all patients with the diagnosis of Moebius Syndrome at two institutions. 24 patients were identified and included in the study. Evaluation of medical records and radiographs was performed and families were contacted to identify the presence of congenital hand anomalies. 14 patients were found to have involvement of the hands. Of these, 13 patients had bilateral involvement. 2 patients also had a diagnosis of arthrogryposis. Upon classifying the 12 patients with congenital hand anomalies, 11 could be classified as symbrachydactyly by the Blauth and Gekeler classification. 5 hands were transverse deficiency with no digits and 12 were short finger type with 9 of the 12 with radial-sided involvement.

Results
The prevalence of congenital hand anomalies in Moebius syndrome is higher than expected at 58%. The presence of bilateral involvement, 92%, is significantly higher than in isolated symbrachydactyly that classically presents with unilateral involvement. Lastly, when short finger type symbrachydactyly is present, there is often involvement and shortening of the radial digits.

Summary Points
- Congenital hand anomalies were found in 58% of individuals with Moebius syndrome.
- 92% of patient with Moebius syndrome and congenital hand anomalies have bilateral involvement.
• When short finger type symbrachydactyly is seen in Moebius syndrome, the radial side of the hand is more significantly affected than the ulnar side.

Bibliography
Images
Poster 315: Open wedge osteotomy of the proximal phalanx with an intramedullary single wire fixation for the treatment of the little finger valgus deformity in children

Category: Pediatrics/Congenital/Nerve

Treatment; Surgical Technique
Level 5 Evidence

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Shuichi Matsuda, MD, PhD

Hypothesis
In the treatment of the pediatric little finger valgus deformity, the accurate correction of angular and rotational deformity using closed wedge osteotomy is usually difficult at the time of bone resection and K-wire fixation. Our hypothesis was open wedge osteotomy with an intramedullary single K-wire fixation allowed fine adjustment of the correction angles even after the wire insertion because of the elasticity of the preserved radial cortex of the osteotomy site and the slight looseness of the wire within the medullary cavity and showed excellent results.

Methods
Using a 1mm K-wire, multiple drilling was made at the preplanned osteotomy line through an ulnar midlateral skin incision. A 1.2mm K-wire was inserted through the most distal ulnar portion of the proximal phalanx and the tip of the wire was advanced to just distal to the preplanned osteotomy line at the preplanned angle. Osteotomy with a thin osteotome was performed leaving the radial cortex of the phalanx intact as a fulcrum. The deformity was gently corrected and then the tip of K-wire was advanced along the radial side of the intramedullary cortex and stopped at just distal to the epiphyseal line. After the fine manual adjustment of the deformity, the little finger was loosely buddy taped with the ring finger to allow active range of motion exercise. We performed this surgery in 2 cases. Both were 11 years old girls. They were worried about their appearance and/or function. Mean follow up time was one year and 2 months.

Results
In both cases, wires were removed at 5 weeks after the surgery. The angles between the growth plate and the distal articular surface of the proximal phalanx improved from 15 to 4.5 degrees and from 30 to 5 degrees, respectively. In the full extended and adducted finger position, there
was no gap between the little and ring finger. In the full flexed finger position, there was no overlapping.

**Summary Points**

- Open wedge osteotomy with an intramedullary single K-wire fixation allowed the fine manual adjustment of the correction angles even after the wire insertion and showed excellent results in the treatment of the pediatric little finger valgus deformity.
- The preservation of the radial cortex of the osteotomy site and the insertion angle of the K-wire were important.
**Poster 316: Variation Among Pediatric Hand Surgeons When Diagnosing and Treating Distal Radius Fractures**

*Category: Pediatrics/Congenital/Nerve*

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

N/A - not a clinical study

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Nathan O’Hara, MHA  
Joshua M. Abzug, MD

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**Hypothesis**

Distal radius fractures are the most common injury in the pediatric population, but radiographic examination and subsequent classification of these fractures are not standardized. A recent study found poor agreement among pediatric orthopaedic surgeons when diagnosing and treating these fractures. The authors hypothesize substantial variation also exists among pediatric hand surgeons when diagnosing and treating pediatric distal radius fractures.

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**Methods**

Ten pediatric hand surgeons who commonly treat pediatric distal radius fractures at different institutions reviewed 100 sets of posteroanterior (PA) and lateral pediatric wrist radiographs. The surgeons were asked to complete a questionnaire describing the fractures, the type of treatment they would recommend and the recommended length of immobilization. Additionally, the surgeons were asked when the next follow-up visit would be scheduled for, and whether or not they would obtain new radiographs at the subsequent and final follow-up visits.

Kappa statistics were performed to assess the agreement amongst examiners with the chance agreement removed. Strength of agreement was determined based on guidelines outlined by Landis and Koch. Kappa values of <0.00 were considered poor agreement, 0.00 to 0.20 slight agreement, 0.21 to 0.40 fair agreement, 0.41 to 0.60 moderate agreement, 0.61 to 0.80 substantial agreement, and 0.81 to 1.00 almost perfect agreement.

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**Results**

Only fair agreement was present when diagnosing and classifying the distal radius fractures ($K = 0.312$). Diagnoses included torus, greenstick, Salter-Harris II, and extra-physeal fractures. There was also only fair agreement regarding the type of treatment that would be recommended ($K = 0.242$) and only slight agreement regarding the length of immobilization ($K = 0.187$).

Only slight agreement was present regarding when the first follow-up visit should occur ($K = 0.188$), there was only fair agreement whether or not new radiographs should be obtained at the
first follow-up visit ($K = .396$), and if radiographs were necessary at the final follow-up visit ($K = .368$). Surgeons had slight agreement regarding stability of the fracture ($K = .139$).

**Summary Points**

- The inter-reliability among pediatric hand surgeons of diagnosing pediatric distal radius fractures showed only fair agreement. Both pediatric orthopaedic surgeons and hand surgeons have wide variability in their treatment of pediatric distal radius fractures.
- Better classification systems of pediatric distal radius fractures are needed that standardize the treatment of these injuries in order to provide the best health outcomes with the least patient morbidity.
Poster 317: Nonoperative management of pediatric phalangeal neck fractures

*Category: Pediatrics/Congenital/Nerve*

Treatment; Prognosis/Outcomes
Level 4 Evidence

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**Hypothesis**
Displaced phalangeal neck fractures can remodel sufficiently to result in excellent functional outcomes.

**Methods**
Since 2013, families were educated regarding the option to treat displaced phalangeal neck fractures non-operatively, provided there was no malrotation. Of the total population of 45 children, 17 required surgery, 8 were non-displaced, and 37 were displaced of which 20 elected non-operative treatment. Twelve met inclusion criteria. The children were casted and followed frequently to monitor alignment. Once healed, children were allowed to slowly regain their mobility, and followed until the mobility was functional and the radiographs demonstrated remodeling or until they plateaued. Only patients with radiographs available for measurement were included. Range of motion and function outcomes were recorded, and displacements in the coronal and sagittal planes were measured.

**Results**
Of the twelve patients, 5 were males and seven females, with an average age of 8.3 years (range 6-11). There were 8 proximal phalangeal fractures, and 4 middle phalangeal fractures. The small finger was most frequently involved (9). Average follow-up was 91 days. Average sagittal translation was 26.5%. Radiographs showed marked remodeling of these fractures; sagittal angulation improved an average of 15 degrees (range -4 to 47 degrees remodeling); and, coronal plane angulation an average of 8 degrees (range -3 to 22 degrees). Nine patients (75%) regained full mobility. The remaining patients were limited by an average followup of 31 days with 55 degrees, 70 degrees, and 60 degrees of range of motion at the PIP joint respectively.
Summary Points

- Nonoperative management is an option with acceptable outcomes for displaced phalangeal neck fractures if regaining mobility quickly is not a priority.

Bibliography


Images
Poster 318: Using Ultrasonography to Evaluate Thumb Basal Joints in Infants: What is “Normal”?

Evaluation/Diagnosis;Anatomy
Level 3 Evidence

Julie Samora, MD, PhD
Patrick Warren, MD
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Hypothesis
We hypothesize that ultrasonographic evaluation of the thumb basal joint in infants without upper extremity pathology will provide detailed information of the surrounding structures, and will ultimately be a valuable tool to evaluate hypoplastic thumbs.

Methods
This was a prospective pilot study conducted at a single large pediatric institution with the primary aim to develop a protocol for ultrasound evaluation of thumb basal joints in infants. Prospective ultrasounds were obtained from healthy infants under 12 months of age who were receiving outpatient non-extremity screening ultrasound exams. All studies were performed or directly supervised by a pediatric radiologist. Inclusion criteria were infants less than 12 months of age receiving renal, hip, and spine ultrasound exams. Exclusion criteria were infants with congenital heart defects, myelomeningocele, or with hypoplasia of the digits. Data were analyzed to establish the components of “normal” thumb basal joints in an infant population. The physical characteristics, ultrasonographic appearance, and range of motion of “normal” thumb basal joints were quantified.

Results
Ultrasound evaluation of the thumb basal joint was performed for ten infants. Greyscale images of the thumb and carpometacarpal joint were obtained utilizing a high resolution 17MHz linear array ultrasound transducer. Both long and short axis images were obtained with the transducer orientation based on the long axis of the thumb. Due to the superficial position and small size of the non-ossified carpal bones, a stand-off pad was initially utilized for adequate delineation of the structures. We then transitioned to using the waterbath method, which provided the best visualization. We developed a standardized protocol and found consistent results, reliably
defining the trapezium, thumb metacarpal, scaphoid, and capitate. The soft tissue structures were not as clearly identified in this patient population.

**Summary Points**
- A standardized protocol was established to evaluate the thumb basal joint in an infant population
- Ultrasound evaluation is a quick, low-cost, easy modality which precludes the need for sedation in the infant population
- Ultrasound of the basal joint in infants provides reliable information about the status of the trapezium and surrounding structures

**Bibliography**

Images
Poster 319: A surgical algorithm for chronic hand ischemia: an experience in saving time and tissue

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
Chronic ischemia of the hand can cause intractable pain, cold intolerance, and digital necrosis and is often a significant challenge for hand surgeons. In this study we aim present our experience with various techniques and formulate an algorithmic approach to working up and treating this difficult problem.

Methods
A retrospective review was conducted of all patients treated for chronic hand ischemia by the senior author over a six year period. Charts were reviewed for operative technique, postoperative course and follow up. Primary outcome measures for both portions of the study included improvement in pain, wound healing, development of new ulcerations, and reduction in antispasmodic medication.

Results
Chart review identified 16 patients with 19 affected hands (mean follow up = 9.0 months). Fourteen patients (87.5%) suffered from Raynaud's phenomenon, most commonly secondary to Scleroderma (n=12, 75%). Eighteen hands had arterial sympathectomies, 6 hands had ulnar artery bypass with vein graft, and 2 hands had venous arterialization. Seventeen hands (89.5%) had improvement in their chronic wounds and this was highest in the arterialized hands (100%; arterial bypass = 83.3%; sympathectomy = 88.9%). Fifteen hands (78.9%) had improvement in their pain symptoms (sympathectomy = 83.3%; arterial bypass = 83.3%; arterialization = 50%). Two patients (12.5%) were able to reduce antispasmodic medication regimens after surgery. Zero patients developed new ulcerations postoperatively, although one patient required secondary amputation after failing to heal chronic wounds.
Summary Points

- Sympathectomy, arterial bypass, and venous arterialization are effective treatments for chronic ischemia of the hand.
- An algorithmic approach to chronic hand ischemia relies on imaging studies which categorizes patients as having no identifiable vascular lesions, discrete interruptions of patency with reconstitution of flow, or occlusive lesion without reconstructible targets. (Figure 1)
- Based on vascular anatomy and occlusive lesions, appropriate counseling can be given and one of the three surgical techniques can be selected for each patient.
Poster 320: The 'TouchSurgery' Surgical Simulation App: A Comparative Analysis of Efficacy Using a Carpal Tunnel Release Module?

Category: Pediatrics/Congenital/Nerve

Asif Ilyas, MD
Kamil Amer

COI
Royalty: Jaypee Medical Publishers
Consulting Fee: Globus
Speakers Bureau: Depuy Synthes

Hypothesis
The need and utilization for surgical simulation training in medical school and residency programs continue to grow. The "TouchSurgery" application (app) is a new interactive virtual reality smartphone or tablet-based application that offers a step-by-step tutorial and simulation for the execution of various operations. The purpose of this study was to compare the efficacy and validity of the app versus traditional teaching modalities utilizing the "Carpal Tunnel Surgery" module.

Methods
A total 100 medical students were recruited to participate. The control group (n=50) consisted of medical students learning about carpal tunnel release surgery using the "traditional" medium consisting of a video lecture on powerpoint. The study group (n=50) consisted of students learning the procedure through the app. Each group was blinded to the other. The content covered was identical in both groups but delivered through the different mediums. Outcome measures included comparison of standardized test scores and overall app satisfaction.

Results
The study group using the "TouchSurgery" app significantly outperformed the control group with the given assessment by 14.2%. The average grade on the assessment for the application study group was 89.3 % with a Stdev of 6.05%. The average grade for the control group was 75.6% with a Stdev of 8.71%. A two-tailed T-test was conducted and demonstrated that the difference was statistically significant (p <0.001). The students rated the overall quality of the application including content validity, quality of graphics, and ease of use as (Median: 5, Mean 4.81 ± 0.38), Usefulness for surgical training (Median: 5, Mean: 4.74 ± 0.41), Willingness to use the app to
learn more procedures (Median: 5, Mean: 4.83 ± 0.33), and willingness to add this application as a part of their training curriculum? (Median: 5, Mean: 4.85 ± 0.35).

Summary Points

- The "TouchSurgery" app was found to be superior than the traditional teaching methods for preparing medical students about the steps of a carpal tunnel release surgery.
- With regards to secondary objective regarding content validity, usefulness, and willingness to include this simulation as a part of the surgical education curriculum, students strongly agreed in the study group that this should be implemented within the curriculum and preferred to use it to learn other surgical procedures.
- The study findings lend support for the use of the app for medical students to prepare for and learn the steps for various surgical procedures.
HYPOTHESIS INTRODUCTION
Achieving an adequate cast mold is critical for maintaining reduction of pediatric forearm fractures. The cast index is a radiographic measurement that assesses the quality of a mold. A high cast index (>0.8) is associated with a higher risk of fracture redisplacement [1]. Waterproof cast liners offer improved patient comfort and satisfaction compared to conventional cotton liners [2]. We sought to determine whether cast index differs between waterproof and standard cotton cast liners when used to stabilize pediatric forearm fractures.

Hypothesis
We hypothesized that waterproof cast liners would lead to higher cast indices compared to cotton cast liners.

Methods
We retrospectively reviewed all forearm fractures casted in a pediatric orthopedic surgeon’s clinic between December 2009 and January 2017. Either a waterproof or cotton cast liner was utilized according to parent and patient preferences. Patients were included if they were treated with a short-arm cast and had follow-up radiographs in fiberglass. All casts were applied by the same set of cast technicians with a protocol of four layers of padding followed by fiberglass short-arm casting with an interosseous mold. No fractures required a reduction at the time of casting, as they had previously been reduced in the emergency room or were minimally displaced not requiring a reduction. The cast index was assessed by calculating the ratio of the internal width of the cast in the sagittal and coronal planes at the level of fracture site on follow-up radiographs (Figure 1). Non-parametric Mann-Whitney U tests were performed to assess for statistical differences given unequal subgroups.
Results

292 distal radius or forearm fractures were treated with casting during the time period. 127 fractures met the criteria for this study. 25 fractures had waterproof liners and 102 fractures had cotton liners placed. No statistically significant differences were found between groups with regard to fracture laterality, age, gender, time since casting, and fracture location (Table 1). Waterproof liner casts showed a significantly higher cast index (0.832 vs 0.777; p=0.001), with a significantly higher proportion of casts with index greater than 0.8 (64.0% vs 35.3%; p=0.009).

Summary Points

- Waterproof cast liners compared to cotton cast liners achieved a significantly higher cast index (>0.8).
- Given the higher cast index in waterproof casts, waterproof cast liners may be associated with an increased risk of forearm fracture displacement.
- Surgeons should be cautious in using a cast liner that compromises mold quality for the sake of convenience.

Bibliography

Poster 322: Distraction ulna osteogenesis associated a Ligamentous reconstruction of the interosseous membrane in Child with Multiple Cartilaginous Exostosis: showed new technique and a case report.

Category: Pediatrics/Congenital/Nerve

Treatment;Surgical Technique;Prognosis/Outcomes
Level 5 Evidence

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Daniel Rebolledo
Danilo Gabriel Barronovo

COI
Consulting Fee: US$ 1350,00/day by Arthrex, Inc. ( BRA ) R$ 1650,00 / day by Orthofix, Inc.

Hypothesis
Is possible ulnar lengthening combined with excision of exostosis with DRUJ stable?
Is possible reduction the radial head with this technique?

Methods
Measure quality of life, clinical and functional outcomes of patient underwent ligament reconstruction of the forearm interosseous membrane, using brachioradialis tendon more ulna distraction osteogenesis in treatment Multiple Cartilaginous Exostosis. By presenting one patient with such a disease, 11 y.o., boy, congenital deformity his right, dominant forearm, type II b, by Masada classification. Distraction the ulna, resection de exostosis and reconstruction of the distal oblique band (DBO) the interosseous membrane was performed.

Results
One year later, the patient experienced good evaluation. Wrist flexion was 70°, extension 60°, radial deviation 20° and ulnar deviation 30°. Forearm pronation was 60°, supination = 90°. Elbow flexion = 120°, extension = - 5° and digit motion were full. DASH score was 5, VAS = 0 and grip strength = 92% of non affected side. Forearm radiographic aspects showed healing the distraction, articular congruency the DRUJ and radiocapitellum joint. The distraction distance was 28 mm, the distraction period was 67 days, the consolidation period was 96 days, the period of fixator treatment was 92 days. The distraction speed was 0.5 mm/day. This method is safe and we can obtain the stability and joint congruency of the DRUJ and Elbow.
Summary Points

• We agree that the best time for to perform the corrections is early and graduate correction the ulna, the radius, DRUJ and elbow is better than only one step.
• We would like to suggest a interosseous membrane (distal oblique band) reconstruction for to improve this treatment. We believe this suggestion could maintain DRUJ, elbow stable and functional.
• This method is safe and we can obtain the stability and joint congruency of the DRUJ and Elbow. The good radiographic, clinical and functional results were obtained, then, improving life quality this patient.

Bibliography
Poster 323: Ultrasound-guided sensory nerve block for wide awake multiple tendon reconstruction in the forearm

*Category: Pediatrics/Congenital/Nerve*

Surgical Technique
Level 4 Evidence

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**Hypothesis**
Wide-awake hand surgery is useful for tendon reconstruction because surgeons can observe the actual movement of the reconstructed tendons during the surgery. We hypothesized that accurate ultrasound-guided injection of local anesthetics into the sensory nerves contributes to reliable analgesia with a relatively small amount of anesthetic. The purpose of this study was to introduce our novel technique of ultrasound-guided sensory nerve block for wide awake forearm multiple tendon reconstruction and to evaluate the safety and effectiveness of the technique.

**Methods**
Since February 2013, We have conducted wide awake tendon reconstruction surgery using ultrasound-guided sensory nerve block in 30 consecutive patients who underwent tendon transfer or tendon graft surgery at the forearm in our department. Eighteen of the 30 patients underwent multiple tendon reconstruction at the forearm. Of these, 15 patients had flexor or extensor tendon ruptures caused by attrition on bone spurs in wrist osteoarthritis or rheumatoid arthritis. Two underwent tendon transfer according to Brand’s procedure for posterior interosseous nerve palsy, and 1 underwent tendon lengthening for Volkmann's contracture. All patients underwent ultrasound-guided injection of ropivacaine to each sensory nerve branch of the upper arm and forearm and into the subfascial layer of the forearm. The mean amount of total ropivacaine was 123 mg.

**Results**
In 11 of the 18 patients, we confirmed adequate active contraction of the flexor or extensor muscles during surgery. The expected active motion of the flexor pollicis longus was not found in 2 patients during surgery because the effect of the anesthetic had spread too widely, involving the motor branch of the median nerve. Six patients required additional infiltration of 2–3 mL of local anesthetic because of local wound pain. All patients gained satisfactory function of the
transferred tendons after the surgery, and no remarkable perioperative complications occurred related to local anesthetic systemic toxicity.

Summary Points
- Selective administration of an anesthetic to the sensory nerve branches and subfascial layer enables the performance of wide-awake forearm tendon surgery.
- The ultrasound-guided injection technique provides safe and effective regional anesthesia for wide-awake surgery.

Bibliography

Images
Hypothesis
Emergency room (ER) and urgent care center (UCC) providers are often the first evaluators of acute pediatric upper extremity injuries, including obtaining radiographs. After evaluation of these patients in the ER/UCC, they are commonly referred to hand surgeons for further evaluation, who sometimes need to obtain additional radiographs. Additional radiographs may increase the length of the visit, the healthcare costs associated with the injury, and the radiation exposure to the patient. The purpose of this study was to determine the adequacy of the initial radiographs obtained by ER and UCC providers for pediatric upper extremity injuries.

Methods
A prospective study was performed of patients who presented to the pediatric upper extremity office for injury evaluation after being seen at an outside ER/UCC, during which radiographs were obtained. The adequacy of the initial radiographs was determined in a binary fashion with images deemed ‘adequate’ if no additional radiographs were obtained, and considered ‘inadequate’ if the senior resident or attending physician ordered new radiographs. Patients who required additional radiographs to assess a potential loss of reduction were excluded from the study. The duration of the office visit was recorded for all patients.

Results
51 patients were enrolled of in the study. The average number of radiographs obtained by an outside ER/UCC was 2.9 (SD=0.87). Fifty-three percent (n=27) of ER/UCC radiographs were deemed adequate and 47% (n=24) were considered inadequate. Patients with inadequate radiographs required an average of 3.4 (95% CI: 2.7-4.0) additional images. The most common reasons for repeat radiographs were missing views (n=8, 33.3%), an inadequate lateral view (n=7, 29.2%), and poor image quality (n=4, 16.7%). Patients with adequate images had a significantly shorter clinic visit time (p <0.0001) compared to patients with inadequate radiographs, with a mean difference of 32.0 minutes (95% CI: 22.4-41.6). Preliminary analysis
showed physician assistants took a lower proportion of inadequate images compared to physicians and nurse practitioners. There was a trend in hand/finger radiographs being more adequate.

Summary Points

- ER/UCC pediatric upper extremity diagnostic imaging is often insufficient to permit the adequate diagnosis and treatment by surgeons. Repeat injury radiographs increases radiation exposure to the patient, require longer clinic visits for the patient and family, and increase the financial cost to the overall healthcare system.
- ER/UCC providers would benefit from better education regarding how to optimize the radiographs obtained during acute pediatric upper extremity injury evaluations, which would lower patient morbidity and healthcare costs.
Poster 325: The effect of blocking fibrotic pathways on the expression of profibrotic markers in fibroblasts derived from the subsynovial connective tissue of patients with carpal tunnel syndrome

Category: Pediatrics/Genetics/Nerve

Basic Science
N/A - not a clinical study

Grant Received from: NIH/NIAMS, AR49823 and F32 AR063596, as well as by funds provided by Mayo Clinic

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Anne Gingery, PhD
Chunfeng Zhao, MD
Peter Amadio, MD

Hypothesis
This study tested the hypothesis that inhibition of profibrotic cytokine receptors would reduce the expression of profibrotic genes in fibroblasts derived from the subsynovial connective tissue (SSCT) in carpal tunnel syndrome (CTS) patients.

Methods
The subjects included five patients with CTS (2 males, 3 females; mean age 63 years; range 59 to 65 years). Primary SSCT fibroblast were derived from harvested CTS patient SSCT tissue. Fibroblasts were stimulated with transforming growth factor β1 (TGF-β1), and then treated either with a specific fibrosis pathway inhibitor targeting TGF-β receptor type1 (TβRI); SD208, platelet-derived growth factor receptor (PDGFR); AG1296, epidermal growth factor receptor (EGFR); Lapatinib and vascular endothelial growth factor receptor (VEGFR); Axitinib. Fibrosis array and quantitative real-time polymerase chain reaction (qRT-PCR) of fibrotic genes were evaluated. In addition, since canonical TGF-β/Smad activation is an important mediator of fibrosis in CTS, we also evaluated the effect of inhibition on Smad reporter activity.

Results
Array gene expression analysis revealed significant down-regulation of multiple fibrotic genes in upon treatment with TβRI, PDGFR and VEGFR inhibitors (p < 0.05). No array fibrotic genes were down-regulated with EGFR inhibition (Figure1). Further gene expression analysis of known CTS fibrosis markers collagen type I A2 (Col1), collagen type III A1 (Col3), connective tissue growth factor (CTGF) and SERPINE1 using qRT-PCR showed that inhibition with TβRI inhibitor significantly down-regulated Col1 expression (p < 0.01), whereas all other receptor inhibitors did
not regulate this gene. Col3 regulation was significantly decreased with TßRI (p < 0.01), PDGFR and EGFR (p < 0.05) inhibition; however VEGFR inhibition did not significantly regulate this gene expression. CTGF, another important marker of CTS fibrosis, was significantly down-regulated by TßRI (p < 0.01) and VEGFR (p < 0.05) inhibition; however inhibition of PDGFR and EGFR had no impact on CTGF expression. Finally, we evaluated SERPINE1 expression with inhibition and found, just as in the fibrosis arrays, that only TßRI and VEGFR significantly (p < 0.01) inhibited SERPINE1 expression. (Figure2). Taken together the inhibition of TßRI appears to be the primary mediator of fibrotic gene expression in fibroblasts from CTS patients. TGF-ß/Smad activity was further evaluated and as expected inhibition Smad activity was significantly down-regulated in upon inhibition of TßRI, but not with PDGFR, VEGFR or EGFR inhibition.

**Summary Points**

- These results indicate that local therapies specifically targeting TGF-ß signaling alone or in combination offers the potential of a novel local antifibrosis therapy for patients with CTS.
Poster 326: Initial Steroid Injection is an Overwhelmingly Cost Minimizing Approach to Carpal Tunnel Syndrome

Category: Pediatrics/Congenital/Nerve

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John Capo, MD

Hypothesis
Nationwide utilization data has recently delineated that 29% of patients with carpal tunnel syndrome (CTS) receive steroid injections as first line treatment (1). Of those, 39% eventually undergo operation, and many receive multiple injections prior to operation (1). The logical pertinent question is the cost efficiency of this practice, especially since many authors have reported a favorable cost-effectiveness profile of surgical treatment when compared to nonoperative management (2,3). We hypothesize that an analysis of expected costs of repeated steroid injections and likelihood of need for subsequent surgical release will reveal that an initial nonsurgical approach to CTS is indeed cost-minimizing.

Methods
We conducted a series of analyses to evaluate the expected cost of various treatment strategies based on likelihood of need for further treatments. We evaluate (#1) a steroid injection followed by surgical release, (#2) a steroid injection followed by a second injection before surgical release; (#3) 3 steroid injections before open surgery, and (#4) immediate surgical release. To reflect costs, we used 2 sources of data: our institution’s billing charges to private payers and our institution’s reimbursements from Medicare based on a previously described payor model (4). Expected success rates are based on nationwide utilization patterns published in 2016 by Sears et al in the American Journal of Hand Surgery (1) and are depicted in our Decision Tree (see Figure).

Results
With current success rates, strategy (#4) - immediate surgical release - is the most costly treatment of those considered in this study, with an expected cost of $2149. Strategy (#3) is the least costly treatment, with an expected cost of $717 per patient. Nationally, this amounts to a direct cost difference of $716 million annually. For immediate surgical release to be the most cost effective, the surgical reimbursement would need to be just 170% of that of a steroid injection, or just $601. Alternatively, the probability of surgery after injection would need to
more than double from a reported 39% to 84% for immediate surgical release to be the most cost effective measure. See Table 1 for summary of results.

Summary Points
• Carpal tunnel syndrome is a common problem with many reported treatment algorithms.
• Although many factors must be considered, so must costs, and the management of carpal tunnel syndrome with up to three repeated steroid injections is the least costly strategy.

Bibliography

Images
Poster 327: Three-dimensional finite element simple model of carpal tunnel using hyperelastic material properties

Category: Pediatrics/Congenital/Nerve

Basic Science
N/A - not a clinical study

Koji Sukegawa, MD, PhD
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Hypothesis
The aim of the present study is to create a simple three-dimensional finite element model of the carpal tunnel. Furthermore, the difference in the stress acting on the median nerve when the flexor digitorum superficialis of the middle finger (FDS3) is displaced under hyperelastic material properties of two different subsynovial connective tissue (SSCT)s obtained from a normal cadaver and a patient with carpal tunnel syndrome (CTS) was investigated.

Methods
Based on magnetic resonance imaging of the carpal tunnel inlet, a two-dimensional model of the carpal tunnel was created using ABAQUS ver. 6.9. The transverse carpal ligament (TCL) was placed at the lateral wall on the palm side, and the cartilage was placed at the lateral wall on the dorsal side. Nine flexor tendons, the median nerve, and the SSCT were placed at the lumen. A simple three-dimensional model was created by enlarging the two-dimensional model in the z-axis by 25 mm. The model was divided into meshes. Hyperelastic material properties were applied to the TCL1), flexor tendon2), median nerve2), and SSCT3), while elastic material properties were applied to the cartilage4). A normal cadaver model and a CTS model were created, in which the material properties obtained from a normal cadaver and a CTS patient, respectively, were applied to the SSCT. For the boundary conditions, the adherence condition was applied only to the boundary between the FDS3 and the SSCT, while the friction condition (friction coefficient 0.01) was applied to the boundaries between the TCL and SSCT, the cartilage and SSCT, and the flexor tendons (other than the FDS3) and SSCT. The difference in the stress acting on the median nerve when the FDS3 was displaced by 5 mm in the proximal direction in the normal cadaver and CTS models was examined.
Results
For the CTS model, the maximum value of the von Mises stress acting on the median nerve when the FDS3 was displaced by 5 mm was 1.4 times that of the normal cadaver model.

Summary Points
- We created a simple three-dimensional finite element model using hyperelastic material properties, and examined the change in the stress acting on the median nerve due to the qualitative change in the SSCT when the tendon was displaced.
- The value of the maximum stress acting on the median nerve when the FDS3 was displaced by 5 mm was larger in the CTS model than in the normal cadaver model.

Bibliography
Images
Poster 328: Consideration of MRI and nerve conduction velocity of the carpal tunnel syndrome

Category: Pediatrics/Congenital/Nerve
Evaluation/Diagnosis;Prognosis/Outcomes
Level 2 Evidence

Shinji Taniguchi, MD
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Hypothesis
Though, magnetic resonance imaging (MRI) has been reported to be used as a diagnostic tool for carpal tunnel syndrome (CTS) in the recent years, the most useful parameters of MRI for diagnosing CTS are yet to be elucidated. We hypothesized that the fractional anisotropy (FA) value of MRI is the most sensitive parameter for diagnosing CTS.

Methods
We scanned 67 wrists of 35 patients (18 females, 17 males; mean age: 68.7 years; range: 33-90 years) with suspected CTS in Eastern Chiba Medical Center from April 2015 to December 2016. Exclusion criteria were a prior history of trauma or surgery of the wrist, the presence of rheumatoid arthritis, and the presence of space-occupying lesions in the carpal tunnel. We performed nerve conduction velocity test (NCV) and MRI on each patient with suspected CTS. The cross-sectional area (CSA) of the median nerve and the subsynovial connective tissue (SSCT) as well as the FA value were measured at four points (distal radius, pisiform bone, middle portion of the carpal tunnel, and hamate bone), with an axial view of T2-weighted MRI. We divided CSA of the median nerve at the hamate bone by CSA of the median nerve at the distal radius to obtain the median nerve cross-sectional ratio (CSR). Spearman’s correlation analysis was used to evaluate the correlation between NCV and the median nerve CSR, SSCT CSR, and FA value.

Results
There was a negative correlation between the latency of NCV and the FA value (R²= 0.2997) and the latency of NCV and the median nerve CSR (R²= 0.4927); however, there was no correlation between the latency of NCV and the SSCT CSR.
Summary Points

- The FA value and the test value of NCV were found to be correlated, but the FA value would require revision as it varies with age.
- The correlation between the latency of NCV and the median nerve CSR of the MRI were higher than that between the latency of NCV and the FA value.
- The possibility that the median nerve CSR can be used as an index of severity of CTS was suggested.
Hypothesis
The study of determinants and characteristics of the population has a long tradition in Epidemiology and is indispensable for controlling diseases and promoting health. This study is usually materialized in three interrelated approaches: (1) mapping of diseases and their determinants, (2) the study of geographic correlations and (3) clustering, or agglomeration -temporal. The present work is focused on the clustering of patients with Carpal Tunnel Syndrome (CTS).

Methods
This is a retrospective and observational study that analyze the data from the patients operated between 2010 and 2015 with CTS.
The risk factors evaluated were: sex, age, comorbidities such as Dupuytren Disease, Trigger Finger, De Quervain Disease, Synovial Cysts, Diabetes, Arterial Hypertension, Obesity, Anxiety, Depression, Thyroid Diseases, Degenerative Osteoarticular Diseases, Benign Prostatic Hyperplasia, Asthma, Dyslipidemia, Anemia, Auricular Fibrillation, Smoking, Rhinitis and American Society of Anesthesiologists (ASA) Score.
It was made distribution by city of residence.
The data were processed in statistical software version 20.0 of SPSS (SPSS). It was considered a probability of type 1 error of 0.05 in all inferential analyzes. The classification of subjects was performed with a non-hierarchical cluster analysis K-means with the Ward method using the square Euclidean distance as dissimilarity measure between subjects

Results
3077 patients with mean age 53,1 years, 82,2% female and 17,8% male. 45,1% of the patients reside in Santa Maria da Feira, 23,6% in Oliveira de Azeméis, 10,6% in Arouca, 8,5% in São João da Madeira and 6,9% in other places, meaning that most patients lived in a industrialized area instead of rural.
Following the R2 criteria, there were established 4 clusters (that explained more than 80% of total variance). The subjects classification were refined with the K-means method. Cluster 2 and 4 were the more dissimilar. The dimension that best differentiated the clusters were auricular fibrillation (F=314616), followed by smoking (F=5337) and arterial hypertension (F=2349). Other dimensions that affected clusters were: age, synovial cyst, diabetes and dyslipidemia. Cluster 1 is the biggest (n=1867) and comprise the youngest and healthy patients.

**Summary Points**
- This study identifies that the dimensions that best differentiated the clusters are auricular fibrillation, smoking and arterial hypertension. The biggest group are the young and healthy patients.
- Knowledge of the reality of each hospital unit (and the national territory as a whole) is the first step in controlling diseases and promoting health. Patient clustering is a useful tool in building best practices, better clinical information and a cornerstone for protocol implementation.

**Bibliography**

Images
Poster 332: Peripheral Nerve Compression Disorders in Competitive Cyclists

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis
Level 4 Evidence

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HYPOTHESIS BACKGROUND
Cyclist palsy is typically defined as transient ulnar nerve compressive neuropathy. There have been varying rates reported (10-92%). EMG studies have shown changes in the ulnar motor branch, and symptomatic worsening of carpal tunnel syndrome in cyclists. Foot numbness has also been documented at rates as high as 30%.

Hypothesis
It was hypothesized that usage of padded gloves would be correlated with lower rates of cyclist palsy, and that usage of custom shoes/inserts would be correlated with lower rates of foot numbness.

Methods
A survey based cohort study of competitive cyclists was conducted investigating the rate of peripheral nerve compressive symptoms. Competitive cyclists were enrolled and answered questions in regards to the prior year. Data was collected with RedCap and analyzed using STATA. Fisher’s Exact testing of groups based on hand position and modifier use was performed to test statistical significance of differences in development of nerve symptoms.

Results
The cohort (351 competitive cyclists) averaged over 1.4 hours/day of riding and 30 race days/year. Hand numbness was reported by 59% of participants (26% in the median nerve, 35% in the ulnar nerve and 38% in the whole hand), and 21% reported experiencing hand weakness. Thirty-two percent had symptoms on rare occasion, 49% only on some rides, and 12.6% on nearly every ride. Seventy-one percent reported symptoms while hands were on the brakehoods, 12% on the tops, and 17% in the drops (Figure 1). Of those who had hand numbness on the brakehoods, 41% were ulnar nerve distribution, while on the tops 16% were ulnar nerve distribution (Figure 2, p=0.10). The rate of hand numbness in those that always wore
gloves was 60%, compared to 54% in those that never wore gloves (p=0.14). Eighty percent of participants reported symptoms resolved quickly to a few minutes after repositioning hands, but 20% did not improve until after finishing the ride or race. Foot numbness was reported by 40% of competitive cyclists. Forty-one percent of those with custom shoes experienced foot numbness compared to 37% of those with standard cycling shoes (p=0.69).

**Summary Points**
- Peripheral nerve symptoms are common in competitive cyclists
- Ulnar nerve compression is reported more commonly in the literature. Whole hand and median nerve symptoms were also common in this cohort
- The brakehood is a high-risk area for hand symptoms
- Common aids suggested to improve symptoms include custom shoes and padded hand gloves, but these do not correlate with improved rates of symptoms

**Bibliography**

Images
Poster 333: Sonographic Changes in the Median Nerve Correlate to Symptom Severity and Nerve Conduction Severity in Patients with Carpal Tunnel Syndrome

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis;Anatomy
Level 3 Evidence

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Hypothesis
Ultrasound has proven useful in the diagnosis of carpal tunnel syndrome (1-3). Further, cross-sectional area (CSA) of the median nerve has been shown to correlate to nerve conduction studies (4). However, while severity of nerve conduction abnormalities have not proven to be a reliable predictor of clinical symptom severity, no study has yet described whether sonographic measurements correlate to clinical symptoms. As such, our research interest lies in identifying sonographic measurements that correlate to severity of clinical manifestations of carpal tunnel syndrome. We hypothesize that sonographic changes in median nerve CSA along the carpal tunnel will correlate to symptom severity scores.

Methods
We report on twenty patients with clinical signs and symptoms of carpal tunnel syndrome in our ongoing, prospective investigation. Subjects underwent ultrasound measurement of the CSA of the median nerve at the level of the pisiform, hamate and pronator quadratus (PQ) by a fellowship-trained musculoskeletal radiologist, nerve conduction studies (NCS) by a certified electrodiagnostic technician, and physical examination by a fellowship-trained hand surgeon. Each practitioner was blinded to all but their own results. Patients completed Levine Katz questionnaires to characterize severity of clinical symptoms. Data was analyzed using student t-test.

Results
The median nerve CSA decreased over the course of the carpal tunnel in 15 of 20 patients. The absolute change in the CSA of the median nerve between its measurement outside the carpal tunnel at the pronator quadratus and its measurement inside the tunnel at the hamate (Delta
CSA) was correlated with severity of clinical symptoms and nerve conduction data. In patients with mild symptom severity on Levine Katz questionnaire (LK < 2.5), the average Delta CSA was 1.43 mm2 as compared to 3.01 mm2 in patients with greater symptom severity scores (p = 0.36). Similarly, in patients with mild motor conduction slowing (DML < 6 ms), the average Delta CSA was 1.91 mm2 as compared to 4.02 mm2 in patients with severe changes in distal motor latency (p = 0.23).

Summary Points

• Decreased size in the median nerve size as it courses through the carpal tunnel can be characterized by sonographic measurement of delta CSA.

• This non-invasive exam correlates to carpal tunnel symptom severity and nerve conduction severity making it a useful adjunct to clinical diagnosis.

• Further research is necessary to characterize whether sonographic measurements may also prove useful in predicting clinical response to conservative or surgical interventions for carpal tunnel syndrome in ways that electrodiagnostic studies have been unable.

Bibliography


Images
Poster 334: Risk Factors in the Development of Pillar Pain: Does Preoperative Pain or Palmaris Brevis Play a Role?

Category: Pediatrics/Congenital/Nerve

Prognosis/Outcomes;Anatomy

Level 4 Evidence

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Hypothesis
There is a lack of data regarding preoperative risk factors associated with the development of pillar pain (PP) following carpal tunnel release (CTR). We hypothesize that preoperative pillar tenderness, preoperative subjective pain, and the presence of a palmaris brevis muscle (PB) are associated with increased rates of PP following CTR.

Methods
Patients undergoing mini-open CTR by one of two senior authors (APCW, EA) were enrolled in the study. Subjects were evaluated preoperatively and at 2 weeks, 1 month, 3 months and 6 months postoperatively. At the preoperative visit, patients were asked to report predominant symptoms (pain, paresthesias, numbness, weakness). Assessments included an examination for tenderness along the four pillars of the carpal tunnel (pisiform, hook of hamate, scaphoid tubercle, trapezial ridge). Based on the amount of pillars that were tender, a PP score of 0 to 4 was generated for each examination. Finally, during each CTR, the presence or absence of a palmaris brevis muscle was noted and documented in the operative report.

Results
We enrolled 34 patients with carpal tunnel syndrome, including 9 males (26.5%) and 25 females (73.5%). The average age was 60 years and average duration of symptoms 31 months. Average PP score at each time interval is illustrated in Figure 1. A significant increase in PP score was observed post-operatively compared to pre-operatively (P = 0.01). By the 3 and 6-month visit, the average number of painful pillars was significantly decreased compared to the post-operative number (0.42 versus 1.41, P = 0.002; 0.58 versus 1.31, P = 0.02, respectively). There was no significant difference in PP in patients with a PB (n = 6) compared to those without at any visit. In patients who had PP prior to surgery (n = 14) and those whose chief complaint was pain (n = 18), significantly higher rates of pillar pain were observed at 3 months (p = 0.02, p = 0.02
respectively). No significant differences were observed between these two groups by the 6 month visit.

**Summary Points**
- The presence of a PB was not associated with an increase in pillar pain after CTR.
- The presence of preoperative pillar tenderness and a chief complaint of pain are associated with increased rates of pillar pain, particularly at three months following surgery.
- The etiology of PP is poorly understood. This is the first study to investigate whether there are patient-related risk factors associated with the development of this syndrome following CTR.

**Bibliography**

Images
Poster 335: Postoperative Result of The Carpal Tunnel Syndrome, 2nd report: A Prospective Multicenter Study

Category: Pediatrics/Congenital/Nerve

Prognosis/Outcomes
Level 4 Evidence

Yukinobu Kamiya
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Hypothesis
Carpal tunnel syndrome (CTS) is one of the most common disease in the field of hand surgery. There have been many studies regarding postoperative results of open carpal tunnel release for CTS. However, postoperative course of recovery of nerve function and how to evaluate nerve function is still uncertain.
Objectives in this study are (1) how to evaluate relationship between postoperative ADLs and physiological findings, (2) how to evaluate postoperative recovery and (3) how many months (or years) are necessary to determine final results after carpal tunnel release.

Methods
We performed carpal tunnel release in 169 hands of 144 patients with CTS at five institutions during April, 2014 and December, 2016. There were 29 males and 115 females. The average age was 67.8 years old ranging from 25 to 91. Eighty-seven hands were followed 6 months, and 59 hands were followed 1 year after surgery.
Postoperative results were evaluated by physical findings including Phalen test, Tinel-like sign, and motor deficits (in particular, muscle weakness of abductor pollicis brevis muscle) and sensory deficits (2-PD and Semmes-Weinstein monofilament tests). In addition, we evaluated ADLs by quick DASH questionnaire. Motor nerve distal latencies of the median nerve were also measured.
Physical findings, quick DASH and distal latency were collected in all patients at the time of preoperative, 6 months postoperative and 1 year postoperative.

Results
Postoperative quick DASH scores and distal latencies of the median nerve significantly improved six months after surgery compared with preoperative values (p<0.05). On the other hand, there
was no significant difference in postoperative improvements between six months and one year after surgery. All hands were divided into two groups by the value of the distal latency. One is hands belonging greater than 8.0 milliseconds or unmeasurable (severe group), and the other is less than 8.0 milliseconds (mild group). Forty-two hands were classified as severe group and 45 hands as mild group.

Quick DASH scores in both groups postoperative results were significantly improved compared with the preoperative (p<0.05). There was no tendency suggesting a correlation of preoperative severity and postoperative ADLs. On the other hand, the possibility that sensory test reflects the severity was inferred.

**Summary Points**

- The purpose of this study is to analyze the relationship of postoperative ADLs and physiological findings for CTS.
- Quick DASH scores and distal latencies significantly improved six months after surgery compared with the preoperative values(p<0.05).
- The possibility that sensory test reflects the electrophysiological severity was inferred.
Poster 336: Median nerve injury in patients with distal radius fractures
Carpal tunnel pressure is correlated with increased carpal tunnel pressure

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis
Level 2 Evidence

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Hypothesis
The purpose of our study has confirmed that the possibility of a direct relationship between elevated pressures within the carpal tunnel and the median nerve injury in patients with distal radius fractures.

Methods
This study included 56 patients (44 female and 12 men, mean age; 68.2 years) treated by internal fixation using volar locking plate for dislocated distal radial fracture. In the fracture distribution based on AO classification, 29 patients were classified as Type A; one patient, as Type B; and 26 patients, as Type C. During surgical operation, we measured pressures within the carpal tunnel (CTP) both before reduction and after fixation. In this study, we recorded numbness of the particular area dominated by median nerve as median nerve injury. The mean CTP were compared between before and after fixation, between types of AO classification, and between patients with (group S) and without median nerve symptoms (group N).

Results
Eleven (19.6 %) patients complained of median nerve symptoms at the initial physical examination, while 3 (5.3%) patients had numbness in affected hand after fixation. Furthermore, the mean CTP was 52.4 mmHg before reduction, and the value was significantly decreased 10.9 mmHg after fixation (Figure 1). In addition, the mean CTP before reduction was 43.6 and 62.9 mmHg in patients with type A and C, respectively. The values were not significant between patients with type A and C. After fixation by volar locking plate, the mean CTP in group was also significantly decreased in both types (type A, 10.6 mmHg; type C, 11.2 mmHg) (Figure 2).
Moreover, the patients in group S had the mean CTP of 81.7 mmHg, which was significantly higher than the mean CTP of 45.2 mmHg in group N.

Summary Points
The present study showed that the mean value of CTP was clearly high to 52.4 mmHg due to distal radial fracture, since CTP was previously reported to be about 10 mmHg in healthy volunteers [1]. Additionally, reduction and fixation of fracture decreased the CTP to 10.9 mmHg without dependence on fracture type. The data let us importance of the proper reduction to protect the median nerve following distal radius fracture through the downregulation of CTP. Interestingly, the patients with median nerve symptom had significantly higher CTP than them without nerve injury, suggested the elevated pressure within carpal tunnel could be one of cause of the symptom derived from median nerve injury following distal radius fracture.

Bibliography
Images
Poster 337: Intrinsic Median Nerve Compression by a Bone Fragment Following Distal Radius Fracture

Category: Pediatrics/Congenital/Nerve

Treatment;Surgical Technique;Anatomy

Level 5 Evidence

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Hypothesis
Median nerve compression after distal radius fracture occurs sometimes and relates to multiple causes, including haematoma, swelling, and scar formation. We report an unusual postoperative cause for intrinsic median nerve compression that has not previously been documented in the literature.

Methods
A 46-year-old fit and well lady with a comminuted distal radius fracture underwent open reduction internal fixation with volar plating. Three years later she had the plate removed and tenolysis of the flexor tendons, for triggering of the index finger in the volar scar tissue. Four years after plate removal, she complained increasingly frequent disabling paraesthesia in the median nerve distribution to the hand. Reviewing her radiographs, a portion of bone was noted in the volar soft tissues following fixation at the time of the first surgery. Ultrasound scan and MRI examination revealed a 4mm bony fragment within the median nerve.

Results
During surgical removal the lesion was found to be contained entirely within the median nerve. The nerve was mobilised and the lesion was excised from the nerve using microsurgical instruments and a surgical microscope. There was no clear envelope around the lesion and it was not possible to enucleate without division of nerve fascicules, which were repaired. Satisfactory symptom resolution was achieved six months post-operatively.

Summary Points
We suggest during complex distal radius fracture fixation, attention should be paid to ensure bone fragments are not left in the soft tissues close to the median nerve. If a bone fragment is noticed close to the median nerve, we suggest an early postoperative ultrasound to analyse its relation with the median nerve, and inform the patient of the risk of damage from the fragment
to the median nerve. If the patient develops median nerve compression, the fragment should be considered a possible cause.
Poster 338: Second lumbrical-interossei nerve test predicts clinical severity and surgical outcome of carpal tunnel syndrome

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Treatment; Basic Science

Level 4 Evidence

Tomoo Inukai

Hypothesis

The second lumbrical-interossei nerve test (2L-IN, also known as the second lumbrical-interosseous distal motor nerve latency test, or 2LI-DML test) is a motor conduction technique initially described as being fairly valuable in the diagnosis of CTS. Several studies reported the high diagnostic sensitivity of 2L-IN in CTS, leading the American Association of Electrodiagnostic Medicine to recommend the 2L-IN test for the diagnosis of CTS when the standard median motor response at abductor pollicis brevis is difficult to record. The purpose of this study was to examine the utility of the 2L-IN test in the diagnosis of CTS.

Methods

We examined 65 patients with suspected unilateral CTS using the 2L-IN test, in addition to the standard electrophysiological test. The operative cases were divided into three classes of severity based on Padua’s neurophysiological classification. With the 2L-IN test, the extreme CTS group could be further subdivided into extreme CTS-A (both APB-CMAP and 2L-CMAP not recordable) and extreme CTS-B (2L-CMAP recordable, APB-CMAP not recordable). The age, duration of symptoms and BMI of the four groups, stratified according to preoperative electrodiagnostic severity, were compared using one-way analysis of variance (ANOVA). The postoperative clinical results collected at 6 months after surgery were analyzed and classified into four categories (excellent, good, fair and poor) according to relief of symptoms.

RESULTS: The extreme CTS-A group included eight hands (12%). The extreme CTS-B group included nine hands (14%). The severe CTS group included 14 hands (21.5%). The moderate CTS group included 34 hands (52%) (Table1). The clinical results for the extreme CTS-A were fair in five cases and poor in three cases, while for extreme CTS-B, six patients had good results and three with fair results. The clinical results for severe CTS were excellent in three cases, good in eight, and fair in three cases, while for moderate CTS they were excellent in 24 hands and good in 10 hands, with no fair or poor results (Table2).

Summary Points

- Patients with extreme CTS and severe CTS were older, had chronic symptoms, and poorer outcome compared with the moderate CTS patients.
• Patients of the moderate CTS group were almost satisfied with the results of surgery
• The electrodiagnostic severity correlated with the clinical outcome. Severe strangulation of the thenar muscle branch was identified in patients of the extreme CTS-B group, requiring decompression of the thenar muscle branch rather than conventional transverse ligament detachment.

Bibliography

Images
Poster 339: Prospective Evaluation of Sleep Improvement Following Carpal Tunnel Release Surgery

Category: Pediatrics/Congenital/Nerve

Treatment; Prognosis/Outcomes; Patient Education
Level 2 Evidence

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COI
Royalty: Jaypee Medical Publishers
Consulting Fee: Globus
Speakers Bureau: DePuy Synthes

Hypothesis
Sleep disturbance due to nighttime awakening is a well documented symptom of carpal tunnel syndrome (CTS). While carpal tunnel release (CTR) has been demonstrated to relieve symptoms of CTS, the objective effect of CTR on overall sleep quality has not been fully investigated. We hypothesized that CTR would result in significant improvement in overall sleep quality as well as patient’s overall satisfaction with their sleep habits.

Methods
Consecutive cases of EMG-confirmed CTR were prospectively enrolled. Demographic data, EMG severity, surgical characteristics, QuickDASH questionnaire, and Insomnia Severity Index (ISI) Scale data were collected and statistical analysis was performed.

Results
A total of 398 patients were enrolled, with 64% available at final follow-up. QuickDASH score decreased from 44.0 preoperatively to 17.8 at final follow-up (p<0.001). Average ISI score on all 7 sleep categories on the survey decreased significantly from 12.0 pre-operatively to 4.6 (p<0.001) by the first post-operative visit, bringing the scores below the 10-point cutoff for insomnia. However, the total ISI score did not further improve significantly between the first and 3-month post-operative visits. ISI score improvements were not related to EMG severity.

Summary Points
- Patients undergoing CTR demonstrated significant improvement in all 7 aspects of sleep quality: difficulty falling asleep, staying asleep, early wakings, sleep satisfaction, quality of
life, sleep distress, and interference with daily functioning; thereby upholding the study hypothesis.

- All sleep improvement was unrelated to preoperative EMG severity.
- All sleep improvement occurred predominantly within 2 weeks of surgery.

Category: Pediatrics/Congenital/Nerve

Treatment;Anatomy
Level 5 Evidence

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Hypothesis
Background: Brachial plexus injury is one of the complications for clavicle fracture, but tardy brachial plexus paralysis followed by a clavicle fracture is rarely encountered. Here we report 4 cases of tardy brachial plexus paralysis resulting from clavicular fractures.

Cases: The patients consisted of three males and one female, with the age ranging from 57 to 71 years. All the patients sustained clavicle diaphyseal fractures. Two fractures developed paralysis of the upper extremity following a conservative treatment, with the symptom arising 10 days in one case and 5 months in the other. The other two cases were postsurgical paralysis which occurred 11 days after open reduction and internal fixation (ORIF) with bone grafting for a treatment of nonunion, and 1 day after ORIF in the other. The types of injury were total paralysis in three cases and upper type in one case. The causes of the paralysis were a result of compression by hypertrophic callus, dynamic instability of nonunion, angular deformity of the clavicle accompanied by the post-operative swelling. Two patients improved with conservative treatment, but the remaining two required neurolysis of the plexus and internal fixation of the clavicle.

Discussion: The incidence of tardy brachial plexus paralysis followed by a clavicle fracture is reported as 1%, and the causes vary from compression by pseudoaneurysm, hematoma and clavicle brace, deformity, hypertrophic callus and instability due to nonunion. Due to the anatomical location, the medial and the posterior cords are likely to be affected. However, three of our cases showed incomplete total paralysis which does not agree with the previous reports. For the treatment of clavicle fractures one should be aware of the presence of tardy brachial paralysis that can occur regardless of the treatment for the fracture.
Poster 341: LaT Branch Transfer for Biceps Reinnervation

Category: Pediatrics/Congenital/Nerve

Treatment; Surgical Technique; Anatomy
Level 4 Evidence

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Alexander M. Spiess, MD

Hypothesis
In cases of significant upper extremity trauma, the thoracodorsal nerve is a reliable secondary option for the restoration of elbow flexion. In all previous descriptions, however, the entire nerve is transferred. We describe a case utilizing the lateral thoracodorsal nerve (LAT) branch for biceps reinnervation with an associated cadaver study.

Methods
Transfer of the LAT branch to the biceps branch was performed on a patient who had sustained a traumatic brachial plexus injury that left him without elbow flexion. The patient was seen for follow-up in clinic for one year and also underwent pre- and post-operative electromyography (EMG) testing to assess for reinnervation and remaining latissimus function. Also, four cadavers (eight upper extremities) were dissected to identify the bifurcation of the thoracodorsal nerve, confirm the feasibility of transferring the LAT branch to the biceps motor branch, and define a consistent location of the bifurcation. Axon counts of the thoracodorsal proper, LAT branch, musculocutaneous proper and the biceps branch were also obtained.

Results
The bifurcation of the thoracodorsal nerve was present in all cadaver specimens, and was located, on average, 7.5 cm (range 6.2 – 9.8 cm) inferior to the insertion of the latissimus dorsi muscle on the humerus. Axon counts revealed the LAT branch contained, on average, 1453 ± 289 axons and the biceps contained 1715 ± 699 axons, resulting in a donor-to-recipient ratio of 0.85:1. Follow-up of our patient at one year showed improvement of elbow flexion manual muscle testing grade from 0 to 4/5. Furthermore, EMG at one year confirmed biceps reinnervation and showed normal readings of the latissimus dorsi compared to preoperative EMG.

Summary Points
- Transfer of the LAT branch is a viable and minimally morbid option for biceps reinnervation after traumatic branchial plexus injury.
• It is effective and available in nearly all patients, and spares the medial branch of the thoracodorsal nerve, preserving innervation to the latissimus dorsi muscle.
• Further follow-up of our patient and larger prospective studies are needed to understand the true potential of this nerve transfer.
Poster 342: Patterns of production of collagen-rich deposits in peripheral nerves in response to injury: a pilot study in a rabbit model

Category: Pediatrics/Congenital/Nerve

Basic Science
N/A - not a clinical study

Grant Received from: AFSH

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Andrew J. Miller, MD
Jacob E. Tulipan, MD
Pedro Beredjiklian, MD
Andrzej Steplewski, PhD
Andrzej Fertala, PhD

COI
Contracted Research: AxoGen, Baxter
Ownership Interest: Dimension Orthotics, LLC

Hypothesis
Although collagen-rich deposits are the main component of neural scars, the patterns of their formation are ill defined. Essential to the biosynthesis of collagen fibrils are enzymes catalyzing posttranslational modifications and chaperones that control the formation of the collagen triple helix. Prolyl-4-hydroxylase (P4H) and heat shock protein-47 (HSP47) play a key role, and their production is upregulated during scar formation in human tissues. Alpha smooth muscle actin (aSMA) is also produced during fibrotic processes in myofibroblasts that participate in fibrotic response. In injured peripheral nerves, however, the distribution of cells that produce these markers is poorly understood.

Methods
The goal of this study was to determine the distribution of the aSMA-positive, HSP47-positive, and the P4H-positive cells to better understand the formation of collagen-rich fibrotic tissue in response to peripheral nerve injury. To reach this goal we employed a rabbit model of crush-injury and partial-transection injury of the sciatic nerves.

Results
Our study demonstrated that aSMA is expressed in a relatively small number of cells seen in neural fibrotic tissue. In contrast, cells producing P4H and HSP47 are ubiquitously present in sites of injury of the nerves.

**Summary Points**

- We contemplate that these proteins may serve as valuable markers that define fibrotic activities in the injured peripheral nerves and serve as potential targets for promoting nerve regeneration and repair.
Poster 344: Evaluation of Tension at Median and Ulnar Nerve Repairs at the Wrist in a Cadaveric Model

Category: Pediatrics/Congenital/Nerve

Hypothesis
In acute nerve laceration at the wrist level, nerve tension will remain within acceptable parameters (Tension not great enough to rupture a single 10-0 stitch and <5% elongation when repaired with a 9-0 nylon epineurial repair) in up to 15-30 degrees of wrist extension to allow for an active range of motion protocol.

Methods
In 6 cadaveric specimens, marking sutures (8.0 nylon) were placed approximately 1 cm proximal and distal to site of future nerve transection at wrist to assess elongation. Nerves cut and repaired with a single 10-0 nylon stitch and then assessed for rupture to pullout with wrist range of motion. Next, that suture was removed and a standard 4 strand epineural repair with 9.0 nylon was made at 90 degrees of spacing between stitches with no stitch placed at the site of the former 10-0 nylon stitch. Percent elongation measured from flexion to extension (30, 15, 0, 15, 30, 45) with suture and micrometer.

Results
No suture ruptured or pulled out when ranged from 30 degrees flexion to 45 degrees extension. 30 degrees of extension produced 4.1% elongation as a mean with one outlier of 9.4%. 45 degrees of wrist extension produced a mean of 6.2% elongation.

Summary Points
- Median and ulnar nerves both had means of elongation within an acceptable range (5%) up to 15 degrees of wrist extension
• To allow for tendon excursion to minimize adhesions in volar wrist lacerations, a postoperative protocol allowing for wrist extension of up to 15 degrees should not compromise nerve repair viability

Bibliography

Images
Poster 345: The Prevalence and the Characteristics of Female Cubital Tunnel Syndrome Patients

*Category: Pediatrics/Congenital/Nerve*

Evaluation/Diagnosis
Level 3 Evidence

Takao Omura, MD, PhD
Tomokazu Sawada, MD, PhD
Shigeya Suzuki, MD
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Hiroaki Oghihara, MD
Yukihiro Matsuyama, MD, PhD

**Hypothesis**
Cubital tunnel syndrome (CuTS) is symptomatic ulnar nerve dysfunction at the level of the elbow resulting from a combination of compression, traction, and friction. In Japan, the most common cause for CuTS is osteoarthritis (OA) with the prevalence rate of 64%, followed by Constriction of arcuate ligament of Osborne (9%). Due to this etiology, the prevalence of patients with female CuTS is much lower in comparison with female CTS patients. The purpose of this study is to identify the prevalence and the features of female CuTS patients.

**Methods**
198 patients who presented sensory disturbance of the little finger and ulnar half of the ring finger and operated under the diagnosis of CuTS at three different institutes were included in this study. All the patients were examined with a plain radiographic for the prevalence of OA of the elbow and all the subjects except one, who had a pace maker of the heart received motor conduction velocity (MCV) recordings. The prevalence of female patients, the cause, the initial severity of CuTS and MCV were analyzed.

**Results**
There were 49 female and 149 males with an average of 58.3 ± 2.7 and 58.6 ± 1.3 years old. The prevalence of females was 24.7%. The most common cause was OA in 23 females (prevalence rate 46.7%) and in 114 males (76.5%), followed by trauma of the elbow in 8 females (16.3%) and 10 males (6.7%) which was significant different between gender. According to McGowan’s classification, 6 females (12.2%) and 7 males (4.7%) were classified as grade I, 30 females (61.2%) and 75 males (50.3%) were classified as grade II and 13 females (26.5%) and 67 males (45%) were classified as grade III showing significant difference in the severity. Preoperative MCV
measured between the elbow was 33 ± 2.7 and 32.2 ± 1.3 m/s showing no significant difference between gender.

Summary Points
Interestingly, according to Adkinson et al, the prevalence of female patients operated for CuTS was 52% in Florida State, which could be reflecting the cultural or racial difference between the United States and Japan. In Japanese patients, although there was no statistical difference in age and disease severity between female and male patients, the presence of OA in female patients were much lower and the degree of CuTS was less severe. We conclude that the lower prevalence of CuTS in Japanese female subjects is likely due to the lower incidence of OA in females.

Bibliography

Images
Poster 346: Nerve Transfers for C5/6 Brachial Plexus Injury, 1-2 yrs results with Dorsal Approach at University of Stellenbosch

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Treatment; Surgical Technique
Level 4 Evidence

Ajmal Ikram, MD
Dirk Van der Spuy, MD

Hypothesis
Assess the functional results of double or triple nerve transfers for the C5/6 Brachial Plexus injury performed in lateral position with dorsal approach to the spinal accessory nerve

Methods
All adult patients who presented to our institution in last two years with loss of C5 and C6 after the Brachial plexus Avulsion injury and where primary repair was not possible underwent the Nerve transfers to reconstruct the shoulder abduction, external rotation and elbow flexion as a single or two stage procedure. Dorsal approach to the spinal accessory nerve was used for neurotisation to the SSN, Radial nerve branch to the long head of triceps was used to restore the axillary nerve function and single fascicle of ulnar nerve to the wrist flexor was utilized to target the MCN nerve to the biceps muscle. The patients were follow-up at 6 weeks, 3 months, 6 months, 1 year and two years. The muscle charting was done with MRC grading.

Results
We currently have done 18 patients with C5/6 Brachial plexus injury which received double or triple nerve transfers and early results shows the return of biceps function an average of 5 months, the shoulder abduction and external rotation functional recovery is incomplete but functional at 6 months and improved up to 18 months post-operatively. No patient gained full abduction of the shoulder.

Summary Points
- Loss of shoulder abduction, external rotation can be reconstructed as a single stage procedure from the dorsal approach to the spinal accessory & radial nerve, and Oberlin transfer for elbow flexion from volar approach
Bibliography
1: Brachial Plexus
2: Nerve Transfers
3: Spinal accessory transfer via dorsal approach
4: Single Oberlin transfer
5: single stage triple nerve transfer
Images
Poster 347: Peripheral Neuropathy Considered to be Induced by Surgical Stress  
*Category: Pediatrics/Congenital/Nerve*

Evaluation/Diagnosis  
Level 4 Evidence

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Shigeru Kurimoto, MD, PhD  
Hitoshi Hirata, MD

**Hypothesis**
Postoperative peripheral neuropathies are sometimes experienced in daily clinical practice. Although majority of them are attributable to mechanical injuries during surgery, we infrequently encounter those of uncertain cause. Staff et al. reported postoperative neuropathies which are either spatially or temporally segregated from the surgeries as “post-surgical inflammatory neuropathy” (Ref.1). We hypothesized that peripheral neuropathies due to surgical stress but not mechanical stress exist in what are treated as usual postoperative complications.

**Methods**
We sent orthopaedic surgeons working at 68 affiliate hospitals of Nagoya University a questionnaire that asked if they had experienced postoperative neuropathies of uncertain cause in the previous 10 years. Patients who developed a peripheral neuropathy within 30 days of a surgery that can be judged as being unattributable to mechanical injuries during surgery were included to this study. For each case, age, gender, preceding surgery, type of anesthesia, type of neuropathy, pain, sensory loss, time from surgery to onset of neuropathy, image findings (such as MRI and ultrasonography), result of nerve conduction study, presence or absence of surgery for neuropathy, surgical and pathological findings and clinical course of neuropathy were investigated.

**Results**
Forty-two (61.8%) of the 68 institutions responded to the questionnaire, then a total of seven patients were identified (Table 1). Three were male and four were female. The mean age was 58 years (range 39–81 years). Prior to the occurrence of the neuropathies, three patients had upper limb orthopaedic surgeries, one had dermatologic surgery and three had gastroenterological surgeries. The clinical diagnoses were radial nerve palsy (2), median nerve palsy (1), C5 palsy (2),
lumbosacral plexopathy (1) and peroneal nerve palsy (1). The mean time from surgery to onset of neuropathy was 9.3 days (range 1–15 days). Five cases recovered spontaneously in a year. Neurolyses were performed in two patients who did not recover, two hourglass-like constrictions of the radial nerve were found in one of them (Figure 1). No inflammatory cells were seen in the epineurium collected during surgery.

Summary Points
- Seven cases of postoperative neuropathies considered to be induced by surgical stress were found.
- In our cases, no inflammatory cells were seen in the affected nerves.
- Not only to effectively treat but also to avoid medical lawsuits, it is important to spread the recognition that there are postoperative neuropathies not due to mechanical stress.

Bibliography
Images
Poster 349: Plastic changes in the brain in carpal tunnel syndrome

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Basic Science
N/A - not a clinical study

Grant Received from: KAKEN 15K10400

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Hypothesis
The sensory symptoms of carpal tunnel syndrome (CTS) include paresthesia in the median nerve territory, and pain that is sometimes unbearable during the early and chronic stages of the disease. The somatosensory evoked magnetic fields (SEFs) were recorded to investigate the functional changes in the somatosensory cortex of patients with CTS.

Methods
Magnetic fields were measured using 160-channel, whole head magnetoencephalography (MEG). For the SEFs following digit stimulation, the single current dipole model was used to estimate the dipole locations for the initial cortical component of SEF, the N20m. We calculated equivalent current dipoles (ECDs) with a goodness-of-fit value of 75% using the SEF signals obtained from the 75 channels of each hemisphere contralateral to the side stimulated. The ECD location was expressed on a three-dimensional plane, and the distance between the ECD locations for the first and third digits on the vertical axis (z-axis) was calculated. The origin of the coordinate system was the midpoint between the pre-auricular points. The x-axis joined the origin to the nasion, such that the positive value was oriented towards the nasion. The positive y-axis extended from the origin through the left side, and the positive z-axis extended from the origin through the vertex. We then evaluated the functional brain connectivity in patients with CTS using the coherence technique.

Results
The current study cohort comprised of 11 patients and 21 age-matched healthy controls. Eight patients had bilateral CTS. Two patients had CTS on the right side alone, while one had it on the left side alone. We calculated the ECDs using the N20m elicited on stimulation to localize the representation of the first and third digits in the brain. The ECDs for the first and thirds digits were located in primary somatosensory cortex in the hemisphere contralateral to the side
stimulated. The distance on the vertical axis between the ECDs for the first and third digits was significantly less in the patient group, compared to controls. (Fig1) The MEG coherence was also significantly different between the two groups in the areas of S1 and S2, S1 and anterior cingulate cortex, and anterior cingulate cortex and insula. (Fig2)

Summary Points

- The somatotopic representation between two fingers that are innervated by the median nerve becomes unclear in patients with CTS.
- The functional connectivity in the human cortex changed in patients with CTS.
- CTS is accompanied by plastic changes in the brain.
Poster 350: The clinical course of pain after peripheral nerve surgery

Category: Pediatrics/Congenital/Nerve
Evaluation/Diagnosis;Prognosis/Outcomes
Level 4 Evidence

Tetsuro Ohnisi, MD, PhD

Hypothesis
The neuropathic sharp pain is defined as pain associated with damage to or pathological changes in the peripheral nervous system and it is getting familiar generally. The detailed prognosis of pain after nerve injury is not reported so much. So the purpose of this study was to determine the incidence and prognosis of persistent pain after peripheral nerve surgery.

Methods
We reviewed medical charts retrospectively and investigated Patients who underwent peripheral nerve surgery at Nagoya university Department of Hand Surgery between 2008-2015. Data on injury, surgery, Pain VAS score, and pain killer use were analyzed. Binominal logistic regression analysis was done with high pain VAS score as the dependent variables to evaluate the associations of covariates, such as age, gender, preoperative painkiller use, injury, preoperative pain VAS.

Results
There were 71 males and 41 females. Average age was 45.5 years old and average follow up period was 28 months. Average preoperative pain VAS score was 4.91 and average pain VAS score at final follow up was 3.17, that decreased significantly (p<0.05). 59% of patients showed postoperative Pain VAS 3 or less within 1 year, on the other hand 9.8 % patients showed postoperative Pain VAS 7 or more over 1 year. 17.9% patients used painkillers continuously. 75% of patients who showed high pain VAS score 7 or more had had preoperative Pain VAS score 7 or more. Injury sites were divided into three parts like brachial and upper arm, elbow and forearm, distal to the wrist. Average pain VAS scores of each site at final follow up were relatively 4.3, 2.4 and 2.5 and brachial and upper arm part showed significantly higher score (p<0.05). Patients who suffered from pain for more than 6 months before surgery had higher pain VAS score than those within 6 months. The risk of high pain VAS score increased with preoperative high pain VAS score (odds:2.24, 95% odds: 1.42-3.53, P<0.001).
Summary Points

• After intraneural operations, VAS score and the rate of painkiller use decreased in most of cases.
• 9.8% of cases showed Pain VAS 7 or more even after postoperative 1 year, 75% of which had showed preoperative Pain VAS 7 or more.
• Since brachial plexus injury, preoperative high pain VAS score were risk of persistent pain or continuous painkiller use, we should do early aggressive pain control for these patients.
Poster 351: Incidence and Co-Morbidities Associated with Congenital Brachial Plexus Palsy in the United States - Are We Improving?

Category: Pediatrics/Congenital/Nerve

Evaluation/Diagnosis; Prognosis/Outcomes

Level 4 Evidence

Ram Kiran Alluri, MD
Gabriel Bouz, BS
Andrew Sabour
Milan Stevanovic, MD, PHD
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Nina R. Lightdale, MD

Hypothesis
The purpose of this study was to determine the national incidence of congenital brachial plexus palsy (CBPP) and assess whether previously described risk factors have become less associated with CBPP by comparing 1997-2003 and 2006-2012. We hypothesized that with improvements in perinatal awareness and obstetric delivery prevention, known risk factors for CBPP would be less predictive in the later time cohort.

Methods
Datasets from the 1997, 2000, 2003, 2006, 2009, and 2012 Kids’ Inpatient Database (KID) were utilized for this study. Patients with CBPP were identified using International Classification of Diseases, Ninth Revision (ICD-9) codes. We excluded patients who underwent cesarean section. Potential risk factors for CBPP were also identified using ICD-9 codes. Risk factors that were predictive of developing CBPP on univariate analysis were analyzed in a multivariate logistic regression model for years 1997-2012. A subanalysis was performed comparing the odds ratios (OR) of developing CBPP for a particular risk factor in 1997-2003 (Group 1) versus 2006-2012 (Group 2) by creating an interaction term to assess if the risk factor was more or less predictive of developing CBPP based on temporal group.

Results
The nationwide incidence of CBPP was 0.14%, or approximately 1.38 cases per 1,000 live births, from 1997-2012 and progressively decreased by 0.01% every 3 years (P=0.03). In multivariate analysis, shoulder dystocia, large gestational weight (>4.5kg), and gestational diabetes had the highest odds ratio of developing CBPP (Table I). Multiple birth mates during delivery had a protective effect.
In comparing risk factors between 1997-2003 and 2006-2012, diabetic newborns were 73% less likely to have CBPP in the later time period (P=0.01) (Table II). Similarly, the OR for large baby, heavy for dates (large for dates regardless of gestation period), and shoulder dystocia decreased 22%, 14%, and 13%, respectively in the later time period (P=0.10). Multiple birth mates had a 49% greater protective effect on developing CBPP in the later time period (P=0.001).

Summary Points
- The national incidence of CBPP is decreasing, even after exclusion of cesarean section deliveries. This is likely due to improved awareness during perinatal care and prevention efforts during obstetric delivery.
- With respect to developing CBPP, management of neonatal diabetes, shoulder dystocia and large babies improved over time. However, management of gestational diabetes, breech delivery, and assisted vaginal delivery (forceps, vacuum) did not demonstrate similar improvement.

Bibliography
Hypothesis
Contractures following neonatal brachial plexus injury (NBPI) are associated with impaired growth of denervated muscle, a process which in the neonatal period is presumed to require addition of nuclei to the growing myofiber, termed myonuclear accretion. The current study uses an established mouse model of NBPI to determine the role of myonuclear accretion in normal muscle growth and contracture formation.

Methods
Unilateral global (C5-T1) NBPIs were created by surgical extraforaminal nerve root excision in 5-day-old wildtype mice. One and two weeks following NBPI, the myonuclear number per myofiber was immunohistochemically assessed in control and denervated muscles. In additional mice, whole-muscle myonuclear accretion was determined by counting total immunofluorescently labelled mature myonuclei in control and denervated muscles three weeks following NBPI. NBPI was also carried out in transgenic reporter mice with conditional expression of β-galactosidase in muscle stem cells (satellite cells - SCs), the source of nuclei during myonuclear accretion. Tamoxifen was injected following NBPI to induce β-galactosidase expression in SCs and myofibers with which SCs fused following NBPI. Control and denervated muscles were harvested 2 weeks later to assess β-galactosidase expression. Finally, transgenic mice were developed with SC-specific deletion of myomaker, a muscle-specific protein required for myoblast fusion, driven by tamoxifen injection. Unoperated transgenic and control mice were injected with tamoxifen at 0-2 days of age to prevent neonatal myonuclear accretion, and then mice were sacrificed at 4 weeks to assess muscle growth and presence of contractures.
Results
Following NBPI, myonuclear number per myofiber in denervated muscle was normal at one week and higher than normal at two weeks following NBPI. Similarly, whole muscle myonuclear count was normal in denervated muscle three weeks following NBPI, implying normal myonuclear accretion. β-galactosidase expression was identified in a greater than normal proportion of myofibers within denervated muscle two weeks following NBPI, suggesting widespread fusion of SCs to denervated myofibers. Postnatal myomaker deletion effectively reduced myonuclear accretion and led to reduced muscle volume and cross sectional area. However, myomaker deletion did not cause contractures or impair longitudinal muscle growth, as evidenced by normal sarcomere lengths under stretch.

Summary Points
- Myonuclear accretion occurs at normal rates following neonatal brachial plexus injury, despite reductions in muscle growth.
- Postnatal longitudinal muscle growth occurs in the absence of myonuclear accretion.
- Attention must be directed toward protein synthesis, the other major mechanism of muscle growth, in the search for mechanisms and novel therapies for neuromuscular contracture prevention and treatment.
Poster 353: Pneumatic Tourniquet Complications in Hand/Upper-Extremity Surgery: A Case Report and Review of the Pertinent Literature

Category: Miscellaneous

Treatment;Surgical Technique;Prognosis/Outcomes
Level 5 Evidence

Eleni Ntouvali, MD, PhD, FEBOT, FEBHS

Hypothesis
Pneumatic tourniquets are extensively used to ensure a bloodless field for a variety of upper-extremity operative procedures; nevertheless their application can seldom incur severe or even irreversible sequelae.

Methods
We are hereby presenting a case of elbow surgery, complicated by epidermolysis potentially attributable to compression at the site of the tourniquet. In an attempt to find a plausible explanation for this complication, to increase awareness with respect to tourniquet injuries and to promote mindfulness regarding their use, we additionally undertook a meticulous review of the pertinent literature.

Results
A 41-year old, female patient recently underwent operative treatment of post-traumatic arthritis of her left elbow caused by a Mason II radial-head fracture malunion. In terms of our consultation, the patient reported on persistent pain at the extremes of the range of motion of her left elbow; a flexion/extension lag of approximately 10° each; and sensitivity upon pressure on both the lateral and medial aspect of her left elbow joint. The aforementioned patient symptoms agreed with our preoperative clinical findings.

Under general anesthesia and with the aid of an arm tourniquet, the author performed a left-radial-head replacement using a cobalt-chrome, radial-head prosthesis and a titanium-alloy press-fit stem and locking screw. The skin underlying the tourniquet was adequately padded and there was no leakage of antiseptic solution beneath the latter. Intraoperatively, tourniquet pressure was maintained at 250mmHg and the total tourniquet time reached 2h 40min. On the other hand, patient-related, tourniquet-injury predisposing factors included her low blood pressure; sensitive skin; relatively compromised peripheral circulation (smoker; repeated laser hair removal from the affected skin area shortly before the operation); food allergies (nuts); and chronic cortisone use due to allergic asthma. Of note, the patient experienced excessive discomfort during limb reperfusion, at which time point the skin lesion in her left arm was identified. She also developed considerable soft-tissue edema in her left elbow and forearm in
the immediate postoperative period, which quickly subsided after the onset of physical therapy including passive elbow mobilization, pain and edema control. The initial livid appearance of the affected skin area was rapidly replaced by blistering and loss of the epidermis resembling a partial-thickness skin burn, which is currently being treated conservatively based on the invaluable input from regular Plastic Surgery consultations.

Summary Points
- Tourniquet complications (local and systemic) are often underreported.
- Their causes are linked to the practices enforced by the health-care personnel and to patient-related factors.
- Vigilance can prevent cumbersome and costly complication treatment and litigation.

Bibliography

Images

*Category: Miscellaneous*

Treatment;Prognosis/Outcomes;Patient Education

Level 2 Evidence

Neal C. Chen, MD
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Tessa Heinhuis
Emily Lynn Zale

**Hypothesis**
Mindfulness interventions have been found to be feasible, acceptable, and useful in reducing symptoms of pain, anxiety, and fatigue in pain patients, but are resource intensive, lengthy and not amenable to busy orthopedic practices. We tested the primary null-hypotheses that a 60-second Personalized Mindfulness Based Video Exercise (MBVE): 1) is not feasible and acceptable; and 2) does not reduce pain and psychological distress over and above a sham control in patients presenting to a hand surgery practice.

**Methods**
A hundred-twenty-five participants were randomized to MBVE or sham control in the form of Educational Pamphlet (Table 1). Patients completed validated measurement tools for pain and psychological distress before and after the interventions. Post-intervention, patients also completed the Client Satisfaction Questionnaire-3 (CSQ-3) to assess the acceptability. Analysis of covariance (ANCOVA) was used to test comparatively improvement in pain and distress after controlling for baseline scores.

**Results**
93% of patients who were approached agreed to participate in the research study. The intervention was feasible and acceptable, such that 100% of enrolled patients complete the intervention. Both MBVE and sham control had comparable and high acceptability rates (21 out of 32 max). Patients in the MBVE improved significantly more than those in the sham control on self-reported pain intensity, anxiety, state anxiety, depression and anger (P <0.05). There were no significant differences in improvement on distress between the MBVE and sham control. (Table 2).
Summary Points

- MBVE seems feasible for use in busy surgical practices.
- MBVE is effective in improving pain, anger, anxiety and depression outcomes in patients with hand and upper extremity illness.
- MBVE is a cost effective tool for orthopedic surgical practices, which bypasses many barriers associated with typical mindfulness based interventions.
Poster 355: Effecting Change in Postoperative Pain Protocols

Category: Miscellaneous

Treatment; Surgical Technique; Patient Education
N/A - not a clinical study

David L. Nelson, MD

Hypothesis
Providing information about peers’ postoperative pain protocols will result in surgeons changing their own protocols, particularly decreasing the quantity of opioids prescribed.

Methods
Volar plating of a distal radius fracture is an index surgery allowing comparison of postoperative pain management because (1) most surgeons do it in a virtually identical manner, (2) it is moderately painful and therefore a good test of pain management, and (3) it is common enough to allow quick accumulation of data.

Surgeons who perform ORIF of distal radius fractures using a volar plate were interviewed as to their normal perioperative pain management protocol after a volar plating, with specific reference to the choice of opioid and how many were prescribed. Opioid prescriptions were translated into the morphine equivalent of hydrocodone 5 mg (Vicodin 5 mg). Feedback was given to the surgeon how they compared to the study average in terms of number and choice of opioid, supplementary medication, as well as the characteristics of the highest 5 prescribers and the lowest 5 prescribers in the study. A second interview was conducted approximately two weeks later to determine if this feedback prompted the surgeon modify their pain management protocol.

Results
77 surgeons completed the first interview with enough data to allow completion of the analysis. The number of opioids prescribed ranged from 5 pills to 160 pills (equivalent to Vicodin 5 mg), with a mean of 46.1 and a mode of 30. The lowest 5 respondents prescribed an average of 13 pills, usually hydrocodone, reported patients’ pain was well-controlled, and rare refill requests. The highest 5 respondents prescribed an average of 115 pills and used more Dilaudid and Percocet than the group as a whole. Fear of weekend requests for opioid refills was cited as a main reason for prescribing large amounts of opioids. Upon re-interview approximately two weeks after feedback of the results, 41% had already begun, or planned to, decrease their opioid prescription, change to less-addictive opioids, and/or to increase multimodal approaches; 6% saw no need to change, 44% were undecided, and 9% other (retired, already made the change, etc). Further follow-up will be done to determine if the undecided surgeons change.
Summary Points

• Giving feedback to surgeons regarding how they compare to their peers with respect to an index surgery was effective in prompting evaluation of their perioperative pain program and in decreasing the quantity of opioids prescribed for all their surgeries and increasing multimodal programs.
Poster 356: A Treatment Algorithm for Patients with Digital Melanonychia

*Category: Miscellaneous*

**Treatment**

Level 4 Evidence

Jonathan Lans  
Wouter F. van Leeuwen, MD  
Jesse Jupiter, MD  
Kyle Eberlin

**Hypothesis**

Null Hypothesis: Not all patients with digital melanonychia (nail pigmentation) require resection.

**Methods**

We retrospectively reviewed records for all patients above the age of 18 years that underwent biopsy for melanonychia at one of our affiliated hospitals. In 78 patients, a biopsy was performed to rule out melanocytic atypia or neoplasm. We identified 25 patients in whom the pathology reports of the nailbed biopsy described the presence of atypical melanocytes or melanocytic hyperplasia. Five patients were excluded with a follow-up less than two months. The remaining 20 patients had a median age of 62 years (IQR 39-71). The median follow-up was 34.0 months (IQR 13.0-112.3). A bivariate analysis was performed to evaluate treatment choices by surgeon based on melanocytic atypia.

**Results**

Melanonychia was often initially diagnosed pathologically as melanocytic hyperplasia 18/20 (90%) and there was one case of melanoma in situ and one case of atypical melanocytic hyperplasia. Melanocytic atypia was present in 9 patients of which one, with severe atypia, ultimately transformed into an acral lentigous melanoma. After initial biopsy 12 patients were monitored (9 without atypia and 3 with mild atypia). Two patients had a secondary biopsy as final treatment. Two patients with severe atypia, 2 with moderate-severe atypia and one patient with mild atypia underwent additional excision as final treatment. One patient with severe atypia that transformed into a melanoma required a digital amputation. There was a trend that melanocytic hyperplasia without atypia was monitored more often (81.8% versus 33.3%), our bivariate analysis was suggestive but not statistically significant (p=0.065).

**Summary Points**

- Surgeons are often inclined to monitor patients with melanonychia without severe atypia.
• This suggests that melanonychia without atypia or mild/moderate atypia can be monitored after biopsy, and resection is recommended for severe atypia.

Bibliography
Poster 357: Donor and Recipient bone marrow-derived stromal cells prolong graft survival in a rat hind limb allotransplantation model

Category: Miscellaneous

Basic Science
N/A - not a clinical study

Ryosuke Ikeguchi
Ryosuke Kakinoki, MD, PhD
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Hypothesis
Recent studies have indicated that bone marrow-derived stromal cells (BMSCs) have immunomodulatory properties that suppress the T cell responses that cause graft rejection. We hypothesized that there would be any difference between donor and recipient BMSCs in immunomodulatory effects in a rat vascularized composite allotransplantation model.

Methods
Orthotopic rat hind limb transplantation was performed using donor Wistar rats and recipient Lewis rats. The recipient rats of the experimental group (donor BMSCs group, n=6) were injected intravenously with 2 × 10^6 donor BMSCs on day 6, and with 0.2 mg/kg/day tacrolimus administered over 7 days. Other experimental group rats (recipient BMSCs group, n=6) were injected with recipient BMSCs. The control group rats were injected with 0.2 mg/kg/day tacrolimus for 7 days. Graft survival was assessed by daily inspection and histology. The immunological reactions of recipients were also evaluated.

Results
The graft survivals of donor BMSCs group (24.0 days) and recipient BMSCs group (24.5 days) were significantly prolonged in comparison with that of control group (18 days) (p < 0.01, respectively). Recipient rats had significantly reduced serum pro-inflammatory cytokine levels. Cytokine expression analysis of the skin of grafted limbs showed significantly decreased pro-inflammatory cytokine mRNA expression. In in vitro study, both donor and recipient BMSCs induce T cell hyporesponsiveness in a mixed lymphocyte reaction.
Summary Points

• Both donor and recipient BMSCs induce T cell hyporesponsiveness and prolong graft survival in the rat vascularized composite allotransplantation model despite their different origins.

• BMSCs exhibit immunomodulatory properties against acute rejection that can be realized without the need for significant recipient immunosuppression.
Hypothesis
Previous studies have evaluated biopsychosocial factors that impact upper extremity musculoskeletal function including anxiety, catastrophization and depression function. However, it is unclear whether or not each of these elements are similarly prevalent in this population. This study was designed to define the relative prevalence of anxiety and depression as assessed by a screening tool, PROMIS, in patients seeking care for upper extremity musculoskeletal disorders and secondarily to determine if those prevalences vary according to the type of musculoskeletal disorder.

Methods
This study enrolled adult patients presenting to a tertiary orthopaedic center for any 1 of 9 common upper extremity conditions from 6/1/2016-11/30/2016. All patients completed the PROMIS Anxiety-v1.0 and Depression v1.0 Computer Adaptive Tests (CATs). Patients were categorized as either affected or unaffected based on PROMIS Anxiety and Depression scores. PROMIS score thresholds were set at >62 and >60 based on established linkage tables with the Generalized Anxiety Disorder 7 (GAD-7) and Patient Health Questionnaire-9 (PHQ-9) Depression scales respectively. Those thresholds mirrored scores on the GAD-7 and PHQ-9 referenced as warranting intervention. Pearson chi-square analysis contrasted the proportion of patients affected with anxiety versus depression. Binary logistic regression determined if the proportion of affected patients varied according to the primary symptomatic condition while accounting for patient age, sex, and race.

Results
Data from 1178 patients were included in final analysis (Table 1). Overall, 16.6% of patients met the anxiety threshold score, while only 9.5% met the depression threshold. The number of
patients affected with anxiety was greater than the number affected by depression for every condition studied. The proportion of patients affected by anxiety varied significantly by diagnosis, even while accounting for age, sex, and race. The highest prevalence occurred in those patients with adhesive capsulitis (27.0%) and peripheral nerve compression syndromes (19.8%)(Figure 1). While patients with these conditions also demonstrated the highest percentage of patients reporting high levels of depressive symptoms (13.5%, 11.3%), the variation in Depression scores between diagnostic groups was not statistically significant.

Summary Points

• Patients with upper extremity conditions more frequently report anxiety to a degree that warrants treatment than depression.
• Patients with adhesive capsulitis and peripheral nerve compression syndromes are the most likely to report both clinically relevant anxiety and depression within an upper extremity specialty practice.
• As part of the general mental health assessment, upper extremity surgeons should screen for anxiety and consider referrals for affected patients to seek treatment.

Bibliography
Poster 359: Early Practice Patterns of Hand Surgeons: an ABOS Database Study

Category: Miscellaneous

Residents/Fellow/Educator Resources
N/A - not a clinical study

F. Thomas D. Kaplan, MD
Tobias Mann, MD
Michelle A. James, MD

HYPOTHESIS
Fellowship trained orthopaedic hand surgeons have sufficiently robust case volumes in upper extremity surgery, during their board collection period, that they will meet minimum case eligibility requirements for subspecialty certification.

Methods
All cases submitted by board eligible orthopaedic surgeons taking part II of their board exam between 2004 - 2013 were obtained from the database of the American Board of Orthopaedic Surgery (ABOS). Each case was then categorized based on the fellowship training of the treating surgeon and based on whether or not it was a hand surgery case. Each hand surgery case was then further categorized into one of the nine categories used by the ABOS to determine eligibility for the Certificate in the Subspecialty of Surgery of the Hand (CSSH)

Results
During our study, 6,854 orthopaedic surgeons submitted 858,146 cases to the ABOS. Fellowship trained hand surgeons made up 13% of all surgeons and 24% of all submitted cases were hand surgery cases. Based on the cases submitted, 44% of hand surgeons were not on track to become eligible for the CSSH. The most common reason for not reaching eligibility was not meeting the minimum requirements in one of either the congenital, skin and wound problems, contracture and joint stiffness, microvascular or tumor categories.

Summary Points
- A large proportion of fellowship trained orthopaedic hand surgeons are not on track to meet minimum eligibility requirements to sit for the Certificate in the Subspecialty of Surgery of the Hand.
- Failure of fellowship trained hand surgeons to become members of the ASSH may be due to the lack of sufficient case diversity in their first few years of practice.
• Newly graduated hand surgery fellows should be educated on case requirements for the CSSH exam and ASSH membership, and encouraged to seek out cases in those areas that are less common.
• The ASSH could create a pathway for membership, allowing additional year(s) of eligibility for those surgeons who have made sufficient progress towards meeting case requirements in the nine required categories, but are delayed in a few.

Bibliography
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Images
Poster 360: Ideal suture construct for early active range of motion rehabilitation in tendon transfer surgery

Category: Miscellaneous

Treatment;Surgical Technique
N/A - not a clinical study

Grant Received from: The Hand Research and Education Endowment Fund

Mike Fitzgerald
Max Hammond
Joseph Wallace
Greg Merrell, MD

Hypothesis
In consideration of 2-0, 3-0, and 4-0 suture with 4,6, and 8 knots of either a krakow or cross stitch, a 4 strand krakow with 3-0 suture will achieve at least 100N of strength to withstand an early active motion protocol in side to side tendon transfer reconstruction

Methods
This was a cadaveric study with two separate limbs including flexor tendons from nine cadaver arms. Based on the literature, it was felt that 100 Newtons (N) was the minimum load to failure required for early active range of motion. In the first limb, 48 tendons were used in 6 total groups. Two separate techniques were chosen based on their reliability in the literature. Three groups were repaired with a locking Krackow stitch with either 4,6,or 8 suture throws and the other 3 groups were repaired with a locking cross stitch with either 4,6, or 8 suture throws. All constructs were tested with load to failure in a tensile testing machine. In the second limb, a construct from the first limb was chosen that met the minimum requirements of the study and then three separate groups were tested with 2-0, 3-0, and 4-0 suture caliber. These were tested to failure to delineate the most efficient and reliable construct.

After the first limb was complete, we chose one of the suture constructs that had obtained at least 100 N and then tested suture caliber. Three more groups were assembled with eight repairs in each using the same repair technique. However, each group was repaired with either 2-0, 3-0, or 4-0 non-absorbable Ethibond suture. A one-way ANOVA model was applied with Tukey post hoc tests in MATLAB.

Results
In the first limb of the study, the cross stitch had a higher yield force in all 3 groups when compared to the Krackow stitch (p<0.001). There was also a significant gain in yield force with
increased suture throws in both groups (p<0.001). All but one of the constructs (a 4-throw Krackow stitch) was able to exceed the 100 N threshold. In the second limb of the study, the average yield force was greatest in the 3-0 caliber group, however, this was not statistically significant (p=0.46).

Summary Points
- 6 throw krakow stitch with 3-0 suture was necessary to achieve 100n of strength
- 3-0 suture caliber was preferred, as 4-0 was weaker and 2-0 cutout from the tissue

Bibliography
Images
Poster 361: The Anesthetic Effectiveness of J-Tip Needle Free Injection System Prior to Trigger Finger Injection: A Double Blinded, Randomized Clinical Trial.

Category: Miscellaneous

Treatment
Level 1 Evidence

Kushal Patel
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Hypothesis
This study aims to evaluate the effectiveness J-Tip Needle Free Injection System (JNFS) to reduce pain associated with corticosteroid injection (CSI) for trigger finger.

Methods
Thirty-four consecutive patients with trigger fingers that met inclusion/exclusion criteria were consented and enrolled into this double blind randomized control study. Patient were randomly assigned into the control (JNFS loaded with sterile normal saline) or treatment group (JNFS loaded with buffered 1% lidocaine). A single blinded fellowship trained hand surgeon performed all of the trigger finger injection after using the JNFS and same technique. 3mL of a 4mL mixture that consisted of 1mL 40mg triamcinolone and 3mL of 1% lidocaine was injected over the A1 pulley using a 27g needle. The presence of a wheal, volume of corticosteroid injected, and pain score using a 10cm (100-point) visual analog scale ranging from “no pain” to “most pain” right after CSI was documented. Fisher exact test was used to analyze demographic data between the two groups. Mann-Whitney U test was utilized to analyze the visual analog score between the two groups with statistical significance set at p= 0.05.

Results
Total of 28 unique subjects and 34 unique digits were enrolled in the study. No difference in patient demographics or pre-intervention pain perception was noted between the two control and treatment group p > 0.05 (Table 1). The mean visual analog score for control group (n=17) and treatment group (n=17) are 49 (std dev 31) and 39 (std dev 36) respectively with p-value > 0.05 (Table 1).
Summary Points

- The use of JNFS loaded with 1% lidocaine did not reduce pain associated with trigger finger injections.
- We hypothesize that the pain from the acidity of lidocaine is the primary driver of pain and discomfort during the injection and the needle stick is secondary.
- As a result, any pain reduction from the JNFS from needlestick is masked by the more painful portion of injection, the deliver of injectate.
- Based on the findings and experience obtained from this study, we recommend that a follow up study that uses buffered lidocaine may be able to reveal the benefit of JNFS
Poster 362: Quality of Surgical Randomized Controlled Trials in Hand Surgery: A Systematic Review

Category: Miscellaneous

Treatment; Surgical Technique
Level 1 Evidence

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Hypothesis
Randomized controlled trials (RCTs) are considered the gold standard in evidence-based medicine. We assessed the quantity, methodological quality, and trends of RCTs that compared hand surgical interventions. We hypothesized an increase in RCTs conducted over time without an improvement in quality.

Methods
We identified RCTs in PubMed, Cochrane, Scopus, Google Scholar, and Clinicaltrials.gov comparing two or more hand surgical interventions. Two independent reviewers assessed manuscripts for inclusion. Study characteristics were collected. We then calculated the Jadad scale (0-5), a validated instrument for assessing RCTs’ methodological quality that incorporates randomization, blinding, and an account of all patients. The Kendall rank correlation was used to assess trends of RCTs over time, and multivariate regression analysis was conducted to determine independent predictors of Jadad score.

Results
Of 2,253 identified studies, 125 unique RCTs were eligible for data extraction (Figure 1). They were published between 1981-2015, with a significant increase over time (p<0.0001), most often in Journal of Hand Surgery (European) (n=34, 27.2%), Journal of Hand Surgery (American) (n=21, 16.8%), or Journal of Bone and Joint Surgery (n=14, 11.2%). The RCTs were most often single-center studies (n=112, 89.6%) conducted in the UK (n=30, 24.0%) or the US (n=20, 16.0%). The majority (n=79, 63.2%) did not mention funding source. They most often studied carpal tunnel syndrome (n=58, 46.4%), osteoarthritis (n=20, 16.0%), or rheumatoid arthritis (n=10, 8.0%). Mean study size was 68.2±50.6 patients.
Mean Jadad score was low at 2.1±1.2. Randomization methods were unspecified in 34 (27.2%) studies; when specified, both appropriate and inappropriate methods were recorded (Figure 2). One-fifth of studies defined primary outcome measure(s) and only 30.4% (n=38) conducted a
power analysis. Of the 53 (42.4%) studies with loss to follow-up, almost two-thirds (n=33, 62.3%) did not provide an explanation for each patient. The large majority did not use intention-to-treat (ITT) analysis (n=115, 92.0%). Studies with a smaller sample size (p=0.003), with a power analysis (p=0.0006), and conducted in the USA (p=0.0002) or the UK (p=0.03) were more likely to have a higher Jadad score. Year published, funding status, and journal were not predictive of Jadad score.

Summary Points
- There has been a significant increase in the number of RCTs over time.
- Methodological quality of RCTs has remained the same over time.
- These findings indicate a need to improve the quality of RCTs in hand surgery literature. Appropriate randomization, blinding, and accounting of all patients are essential to avoiding introduction of bias and ensuring the validity of conclusions drawn.

Bibliography
Poster 363: Traditional Versus Digital Media-Based Hand Therapy After Distal Radius Fracture

Category: Miscellaneous

Treatment;Prognosis/Outcomes
Level 2 Evidence

Grant Received from: 2015 AFSH Fast Track Grant

Taylor Lara

Hypothesis
No clinically significant difference is expected to be found in patient-reported outcomes, wrist range of motion, or strength in patients undergoing face-to-face hand therapy versus a home hand therapy program directed using digital media after volar open reduction internal fixation (ORIF) of distal radius fractures.

Methods
Patients 18 years of age and older were recruited at a level 1 trauma center in Portland, Oregon after undergoing volar ORIF of distal radius fractures under the care of three orthopaedic hand surgeons. Patients were excluded if they were to receive physical therapy for poly-trauma, received physical or hand therapy previously, had a significant cognitive deficit making them unable to participate, or were not proficient in English. At the time of recruitment subjects were randomized to either face-to-face post-operative hand therapy using a twelve-week protocol or an identical protocol presented in digital videos given to the patient on a USB drive and to be watched and performed at home without the aid of a hand therapist. QuickDASH scores were collected as the primary outcome at two-week, six-week, twelve-week, and six-month follow up appointments. Visual Analog Scale (VAS) scores, VR-12 scores, wrist range of motion, wrist circumference, and grip strength were recorded as secondary outcomes. The outcomes data were analyzed using single-tailed T-tests as part of a non-inferiority comparison. An a priori analysis assuming a minimum significant clinical difference of 14 and a standard deviation of 15 estimated that a total of 20 patients per group would be required to produce a statistical power of 80%.

Results
Currently 24 out of 43 eligible subjects have been enrolled in the study, with 15 randomized to the traditional therapy group and 9 randomized to the digital media group. A preliminary analysis of data recorded at six-week follow up shows no difference in QuickDASH scores
(Traditional: 37.3 ± 22.6 versus digital media: 48.85 ± 1.6, P=0.26) or in VAS scores (Traditional: 2.0 ± 1.3 versus digital media: 1.5 ± 0.7, P = 0.29).

Summary Points
- No difference is observed in QuickDASH or VAS scores at six weeks.
- Non-inferiority of digital media-based hand therapy would have implications for reducing the cost of post-operative care and increasing access for patients who have difficulty with travel or who live in communities where hand therapy is not available.
- Patient enrollment and data collection continues with roughly half of the recruitment goal met.

Bibliography
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Images
Poster 364: Preoperative PROMIS Scores Predict Postoperative Success and Failure in Patients Undergoing Hand Surgery for Trauma

Category: Miscellaneous

Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
Preoperative PROMIS (Physical Function [PF], Pain Interference [PI] and Depression) scores can predict who will or will not clinically improve following hand surgery for trauma.

Methods
PROMIS scores for patient visits to a tertiary academic hand clinic between February 2015 and October 2016 were prospectively collected. All patients undergoing hand surgery due to trauma were identified using CPT and ICD-9, 10 codes. Only patients with initial and follow-up (= 6 months) PROMIS scores were included and randomly assigned to a derivation (n=116) or validation cohort (n=115). Receiver operating characteristic (ROC) curves were calculated for the derivation cohort to determine if preoperative PROMIS scores could predict a patient reaching the minimum clinical important difference (MCID). PROMIS PF, PI and Depression cut-off values were determined for: 1) patients who were likely to reach MCID; 2) patients who were likely to fail to reach MCID; or 3) patients who it was unclear whether they would or would not reach MCID. Chi-square analysis was then used to test whether patients categorized using the derived cut off values in the validation cohort were significantly different than chance.

Results
ROC curves demonstrated fair to moderate predictability from preoperative to postoperative PROMIS (PF: Area Under the Curve [AUC] = 0.69, p = 0.001; PI: AUC = 0.69, p = 0.001; Depression: AUC = 0.76, p<0.001). Patients with baseline PF scores below 34.8 and PI and Depression scores above 69.2 and 62.2, respectively, reached MCID with 95% specificity. Patients with baseline PF scores above 52.1 and PI and Depression scores below 46.6 and 44.0, respectively, did not reach MCID with 95%, 94% and 95% sensitivity, respectively. When applied to the validation cohort: Baseline PF predicted (93% accuracy) 22% of patients failing to achieve
MCID (chi square p<0.001). Baseline PI predicted (88% accuracy) 13% of patients that reached MCID (chi square p<0.001) and (92% accuracy) 7.5% of patients failing to achieve MCID (chi square p<0.001). Baseline Depression predicted (82% accuracy) 24% of patients that failed to achieve MCID (chi square p = 0.024).

**Summary Points**

- Preoperative PROMIS scores allow surgeons to predict patients who will or will not clinically improve following hand surgery following trauma
- Many patients have PROMIS values within an ambiguous range, which does not allow for an accurate MCID prediction
- Patient-Reported Outcomes that capture more disease-specific findings or other patient characteristics, like self-efficacy, may clarify or help predict outcomes for patients in the ambiguous range
Poster 365: Simple Assessment of Global Bone Density and Osteoporosis Screening Utilizing Standard Radiographs of the Hand

Category: Miscellaneous

Evaluation/Diagnosis
Level 2 Evidence

Joseph J. Schreiber, MD
Robin Kamal, MD
Jeffrey Yao, MD

Hypothesis
Osteoporosis and resultant fragility fractures have vast consequences at both the individual level and to the overall health care system. Screening rates remain low, and our current system tends to be more reactive than preventative. While dual-energy x-ray absorptiometry (DXA) is the gold standard for assessing bone mineral density (BMD), other simpler tools may be able to provisionally screen bone quality and signal the need for intervention. We hypothesized that the second metacarpal cortical percentage (2MCP) that is calculated from standard radiographs of the hand or wrist would correlate with hip BMD derived from DXA, and could provide a novel simple screening tool for osteoporosis.

Methods
200 consecutive patients who had hand or wrist radiographs and hip DXA scans within one year of another were included in this retrospective diagnostic series. Mid-diaphyseal 2MCP was calculated as a ratio of the cortical diameter to the total diameter (Figure 1). The correlation between 2MCP and total hip BMD was assessed. Subjects were stratified into normal, osteopenic, and osteoporotic cohorts based on hip t-scores, and thresholds were identified to optimize screening sensitivity and specificity.

Results
Second metacarpal cortical percentage (2MCP) correlated significantly with BMD and t-scores from the hip (Figure 2, r² = 0.44, P<0.001). A 2MCP threshold of < 60% optimized sensitivity (88%) and specificity (60%) for discerning osteopenic subjects from normal subjects, whereas a threshold of < 50% optimized sensitivity (100%) and specificity (91%) for differentiating osteoporotic from normal subjects.
Summary Points

• By demonstrating that global BMD may be assessed from 2MCP, our data suggests that radiographs of the hand and wrist can play a roll in accurately screening for osteopenia and osteoporosis.

• This simple screening tool that is already ubiquitously utilized for patients with hand or wrist problems may help identify patients at risk for fragility fractures.

• This would thereby prompt additional studies, appropriate referral, or initiation of treatment.

• Routine use could be valuable for decreasing morbidity on an individual level and improving financial efficiency on a systems level.
Poster 367: Biomechanical Analysis of a Novel Flexor Tendon Coupler Versus Suture Repair

Category: Miscellaneous

Treatment; Surgical Technique
N/A - not a clinical study

Grant Received from: Raymond M. Curtis Research Foundation, The Curtis National Hand Center, Baltimore, MD

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Kenneth R. Means, MD

Hypothesis
Flexor tendon repair with a novel tendon coupler produces a faster repair that is equivalent to core suture repair in failure rate during cyclic stress and load-to-failure testing.

Methods
A novel tendon coupler for flexor digitorum profundus tendon repair was compared to core suture repair on non-thumb digits in four matched pair fresh human cadaver hands between the A2 and A4 pulleys in Zone 2 for a total of 16 repairs in each group (32 total). Repair method was randomly assigned to left or right hand for each pair using a random number generator. All repairs were performed by one CAQ-hand surgeon. Both repair methods grasp the tendon up to a distance of 1cm from each cut end. Coupler repair was performed using a novel device comprised of low profile stainless steel staple plates in each tendon stump bridged by a continuous spool of polyethylene thread. Devices were donated by CoNextions Medical (Salt Lake City, UT)*. Suture repair was performed using 4-0 looped Supramid in a locking cruciate fashion. Durability was assessed by repair gapping during simulated gentle active range of motion: 10N load at a rate of 0.2Hz for 2000 cycles. Failure was defined as gapping greater than 2mm or catastrophic failure. Strength was assessed by residual load-to-failure on a servohydraulic loadframe (MTS Systems, Eden Prairie, MN) at a rate of 1 mm/s.

Results
Tendon coupler repair was four times faster than core suture repair (Avg repair time 1:21 min vs 5:32 min, Stdev 48 sec vs 35 sec, p<0.00006). Durability testing showed no significant difference in gapping between coupled and sutured tendons at 2000 cycles (Avg gap 1.35mm vs 0.86mm, Stdev 1.29 vs 0.7, p = 0.19). Residual load-to-failure testing showed coupled tendons are
significantly more resistant to failure than sutured tendons (Avg failure load 77 N vs 54, Stdev 14 vs 15, p <0.0007).

Summary Points
- Tendon repair is faster with a novel coupler than core suture technique
- Tendon coupler repair shows no difference in gapping during simulated early active motion compared to core suture repair
- Tendons repaired with a novel coupler have a significantly greater residual load to failure than tendons repaired with core suture
- The company has no control over the results or any presentations or publications that result from the study.

Bibliography

Images
Poster 369: Moving small hand surgery out of the OR: Evaluation of the cost-savings associated with performing isolated carpal tunnel and trigger finger surgery in a procedure room

Category: Miscellaneous

Treatment;Billing/Coding
Level 4 Evidence

Grant Received from: National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health under award number U01AR067138

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Hypothesis
Carpal tunnel release (CTR) and open A1 pulley release (TFR) are common surgical procedures performed in the operating room (OR). By eliminating need for an anesthesia team and potentially reducing facility utilization, performing these operations in a procedure room (PR) may lead to substantial savings. Furthermore, it remains unclear whether total direct costs or payments differ between open and endoscopic CTR techniques. Our null hypothesis was that total direct costs and payments would not differ for CTR or TFR based upon operative setting (OR versus PR). Our secondary null hypothesis was that costs and payments would not differ between open and endoscopic CTR performed in the OR.

Methods
Consecutive adult patients undergoing isolated CTR and TFR between 5/13/2014 – 10/27/2017 at an academic medical center were identified retrospectively. Patients undergoing endoscopic converted to open CTR, revision surgery, or additional procedures, were excluded. Using our institution’s information technology value tools — allowing for comprehensive cost data collection and analysis on an item-level basis — we calculated total direct costs, total combined payment, hospital payment, surgeon payment, and anesthesia payment for each surgical encounter. We utilized non-parametric Wilcoxon paired-sample signed-rank and Fisher Exact tests to analyze costs and complication rates, respectively.
Results
549 patients were included. Total direct costs, total combined payments, hospital payments, and anesthesia payments were significantly reduced when either open CTR or TFR were performed in a PR when compared to the OR; however surgeon payment did not differ (Table 1). Performing open (versus endoscopic) CTR in the OR significantly reduced total direct costs, total combined payment, hospital payment, and surgeon payment; however anesthesia payment was similar (Table 2). Acute complication rates (infection, wound healing problems, persistent symptoms) were similar between the PR and OR for open CTR (4% and 3% respectively, p = 1.00) and TFR (9% versus 6%, p = 0.72). Complications were similar between open and endoscopic CTR surgeries in the OR (3% versus 5% respectively, p = 0.56).

Summary Points
• Compared to the operating room, both open CTR and TFR done in a procedure room led to 87% and 80% reductions in total direct costs, respectively, and a 27% reduction in total combined payments, without influencing surgeon payment.
• Complication rates were similarly low for the procedure room and OR.
• Open CTR is less costly than endoscopic when performed in the OR, with 18% reductions in total direct costs and total combined payments. Surgeon payment is similarly reduced.

Bibliography
Images
Poster 370: Cost Minimization Analysis of the Treatment Distal Radius Fractures in the Elderly

Category: Miscellaneous

Treatment; Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
Outcomes from nonoperative management of distal radius fractures in those >65 are equivalent to operative management. We present a cost minimization analysis of operative versus closed treatment from the payer perspective testing the null hypothesis that there is no difference in cost from the payer’s perspective between patients >65 years old undergoing open reduction internal fixation (ORIF) vs. closed reduction (CR) of distal radius fractures.

Methods
Data from 2007-2015 was extracted using the Humana and Medicare Advantage Databases. Patients >65 years old with distal radius fractures were identified by International Classification of Disease-9 codes. Treatment was determined by Current Procedural Terminology codes. The primary response variable was the cost associated with each treatment from the payers’ perspective defined as the cumulative cost of the procedure, perioperative services, occupational/physical therapy, and outpatient clinic visits within 1 year of the procedure. Secondary analysis examined the cost associated with common complications and trends in treatment modalities. Cost data was analyzed using a nonparametric t-test. Chi-square test was used to determine differences in frequency of complications. The trend in proportions test was used to evaluate the trend in procedures performed.

Results
Our search yielded 8,924 patients that underwent ORIF and 5,629 patients that were treated with CR. The average cost associated with an uncomplicated ORIF was significantly more than a CR ($7,749 vs $2,161, p<0.05). Overall, there was no difference in the rate of sustaining any complication (p>0.05). However, the average additional cost of a complication in the ORIF group was greater than in the CR group ($1,853 vs $1,362, p 65 year old population
• ORIF as a standard treatment may represent high cost care for an equivalent outcome to
  closed reduction (low value care)

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  2011;93(23).
Images
Poster 371: Reusable versus Single Use Orthopaedic Implant Trays: A Cost Analysis

Category: Miscellaneous

Treatment
Level 4 Evidence

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James Vosseller
Rajendra R. Kadiyala

Hypothesis
Single use orthopaedic implant kits with pre-sterilized implants are available for distal radius and ankle fracture surgeries, two of the most common orthopaedic procedures, which eliminate the reprocessing cost and sterilization time of standard reusable trays. We hypothesize that single use kits will result in significant time and cost savings.

Methods
A model was created to evaluate the time and cost savings associated with single use kits. Costs of implants were obtained from vendors. Time for sterilization of standard trays was obtained from our sterile processing core. The cost of reprocessing implants was calculated using the work of Stockert et al., which includes the costs of labor, detergent, biologic and quality checks, equipment maintenance repair, and instrument depreciation per use to estimate a cost of $0.51 per instrument. Costs of reprocessing reusable trays were extrapolated to estimate national annual savings.

Results
Distal radius and distal fibula surgeries with single use implant kits result in time savings per case of 4 hours and do not incur a higher initial cost. The single use distal radius kit results in reprocessing cost savings of $8.67 - 12.75 (average $10.71) per surgery with estimated national annual savings of $847K - 1.3M (average $1.1M). The single use distal fibula kit results in reprocessing cost savings of $11.20 - 15.81 (average $13.52) per surgery with estimated national annual savings of $2.2M - 3.2M (average $2.7M).

Summary Points

- Four hours of sterilization time per surgery can be eliminated with the single use implant kit
- The average cost of reprocessing a distal radius implant tray is $10.71 per surgery, which would result in an annual $1.1M saved nationally
• The average cost of reprocessing a distal fibula implant tray is $13.52 per surgery, which would result in an annual $2.7M saved nationally

Bibliography

Images
Hypothesis
The purpose of this investigation was to analyze the trends in level of evidence (LOE) in the Journal of Hand Surgery – American (JHS) over the past decade, since their introduction in 2005. Specifically, we aimed to determine if the LOE of published studies increased since adopting this methodology, as well as to determine the effect of LOE, year, author department, and author location on SCOPUS citations per publication.

Methods
All citations from the JHS for 2006, 2008, 2010, 2012, and 2014 were reviewed. Level of evidence, study type, author characteristics (department type and country), and funding sources (none, public, private, or both) were noted, as were the number of SCOPUS citations for each article. Along with descriptive statistics, chi-square and Fisher exact test were used to evaluate differences in factors associated with LOE, and multivariable regression was used to determine the independent variables associated with higher levels of evidence.

Results
The level of evidence published in JHS changed significantly over time, with lower level studies (IV and V) becoming less common in later years (p<0.0001). Studies with a higher LOE (I or II) were more likely to have a source of funding than lower levels (III-V, p<0.0001), and more recent articles were more likely to have funding than older articles (p<0.0001). Level I and II studies had significantly more SCOPUS citations than levels III-V (p<0.0001). Multivariate analysis demonstrated that each higher LOE was associated with an increase in 4.0 citations per level (p<0.0001). Furthermore, earlier year of publication was associated with a higher number of citations (3.0 citations/year). Notably, the authors’ department (Orthopaedic Surgery, Plastic Surgery, or both) did not affect the citation rate. Author demographics stayed
relatively constant, including both department (Orthopaedic versus Plastic Surgery) and location (United States, international, or both).

**Summary Points**

- Implementing the level of evidence methodology has met its goal, as the LOE for articles published in JHS has increased over time.
- Each increase in LOE was associated with an increased number of citations.
- Studies with a higher LOE and published in a more recent year were more likely to have funding than studies with lower LOE.

**Bibliography**


Poster 373: Patient Self-Reported Utility of Hand Surgery Online Patient Education Materials

Category: Miscellaneous

Patient Education
N/A - not a clinical study

Heather Roberts
Dafang Zhang
Brandon E. Earp, MD
Philip Blazar, MD
George Dyer, MD

Hypothesis
Online patient education materials in orthopaedic surgery are consistently written above the recommended grade level; however, no algorithmic measure of readability has been validated in a medical context. The primary objective of our study is to test the null hypothesis that Flesch-Kincaid readability scores correlate with patient self-reported utility of online patient education materials from the American Society for Surgery of the Hand (ASSH).

Methods
An IRB-approved prospective survey study was conducted on new clinic patients with one of five common upper extremity diagnoses at our institution from March 2015 to October 2015. The study cohort included 35 patients, including 14 with carpal tunnel syndrome, 6 with trigger finger, 5 with de Quervain’s tenosynovitis, 5 with lateral epicondylitis, and 5 with distal radius fracture. The primary study outcome was patient self-reported utility of the ASSH online patient education material on a 5-point Likert scale. Secondary study outcomes included patient self-reported understandability, clarity, novelty, and scope of the information used on a 5-point Likert scale. Flesch-Kincaid Grade Level and Flesch Reading Ease were calculated for each of the five ASSH articles and correlated with patient self-reported utility.

Results
The majority of patients found the ASSH online patient education materials useful and understandable, with clear words and clear sentences. Patient self-reported utility was not correlated with Flesch-Kincaid Grade Level (\( \beta = 0.017, p = 0.92 \)) or Flesch Reading Ease (\( \beta = -0.020, p = 0.91 \)). Patients with high school education or below found the articles less useful (\( p = 0.007 \)) and more difficult to understand (\( p = 0.02 \)) than patients with post-secondary education.
Summary Points

- Patients generally found ASSH online patient education materials useful, understandable, and clear.
- Patients without post-secondary education found ASSH online patient education materials less useful and more difficult to understand.
- Flesch-Kincaid readability scores do not correlate with patient self-reported utility of online patient education materials from the American Society for Surgery of the Hand (ASSH).
- There is a need for a validated readability scoring system for health literature and future studies on the readability of online health information should include measures of patient self-reported utility.

Bibliography

Poster 374: Presenter Diversity at the ASSH Annual Meeting Over the Past Seven Years

Category: Miscellaneous

Outreach/Volunteerism; Ethics/Professionalism
N/A - not a clinical study

Brandon E. Earp, MD
Ariana N. Mora, BA
Tamara D. Rozental, MD

Hypothesis
The American Society for Surgery of the Hand (ASSH) annual meeting draws over 2,600 physicians and allied health professionals from the United States and abroad and is considered the primary forum for hand and upper extremity clinical practice and research. We hypothesized that over the last several years the ASSH annual meeting has seen an increase in diversity among its presenters in sex, race, and international presence.

Methods
Records of presentations at the ASSH annual meeting between 2010 and 2016 were reviewed. Data was collected on sex, race, and international oral and poster presentations across the 7-year time period for a total of 3,423 presentations. We removed additional appearances of each presenter so that each presenter was only counted once for distribution analysis of sex, race, and international presence across the 7-year time period.

Results
There was an increase in the number of women presenting from 9.3% to 14.7% female. Presentations by under-represented minorities had a varying distribution across the time period but ranged from 23.0% to 38.2%. International presence also varied throughout the time period from 8.6% to 30.6%. The highest amount of diversity among presenters was in 2016 with 14.7% female, 38.2% racial minority, and 30.6% international presence.

Summary Points
- 2016 had the most diverse representation with 14.7% female, 38.2% minority race, and 30.6% international presenters.
- The ASSH instituted the International Guest Society Program in 2007, which has likely contributed to the increased international presence.
- Continued efforts to increase diversity among ASSH members and presenters are warranted.
Poster 375: Patient Loss to Follow-up After Upper Extremity Surgery: A Review of 2,606 Cases

Category: Miscellaneous

Patient Education; Outreach/Volunteerism; Ethics/Professionalism

Level 3 Evidence

Yoseph A. Rosenbaum, MD
Alex C. Di Bartola
Hannah K. Fox
Xiaolong S. Liu
Yoni Blau
Kanu Goyal, MD

Hypothesis

We hypothesize that demographic variables including patient age, gender, insurance type, length of follow-up period and travel distance are correlated with patient risk of loss to follow-up after upper extremity surgery.

Methods

All surgical cases from July 2014 to June 2015 at a single university hand and upper extremity practice with five surgeons were assessed for inclusion. Exclusion criteria were patients who are prisoners, scheduled to follow up at outside institutions, still in follow-up, died before follow-up was complete, have Veterans Association insurance or unknown insurance status at the time of billed procedure. Charts were reviewed for compliance with post-operative follow-up. Demographic variables including patient age, gender, travel distance, insurance type, and length of follow-up period were analyzed to determine correlation with follow-up. Variables were described with proportions and compared using logistic regression analysis. Odds ratios and confidence intervals were calculated with a p 12 weeks) follow-up patients were lost at 35% and 21% rates respectively (p=0.006, p=0.018). Patients under 30 years of age were lost to follow-up at a 43% rate when compared to patients 30-64 years old (28%, p<0.0001) and 65 and older (16%, p<0.0001). Males had a higher rate of loss to follow-up at 34% compared to females (24%, p<0.0001). Patients living 50 miles or less from the surgery office were lost at a lower rate (27%) when compared to those living greater than 50 miles away (35%, p=0.004).

Summary Points

A large proportion of patients are lost to follow-up after hand and upper extremity surgery. Risk factors include self-pay or Medicaid insurance, young age, male gender, greater travel distance,
and mid-term follow-up. With the information learned in this study, we hope to improve patient follow-up in the clinic and develop new methods of following patients after surgery.

Bibliography

Images
Poster 376: Evaluation of the Acquisition of Ultrasound Proficiency in Hand Surgery Fellows

Category: Miscellaneous

Evaluation/Diagnosis; Treatment; Anatomy
Level 4 Evidence

Grant Received from: Hand Research & Educational Endowment Fund - 2016

Justin Zumsteg, MD  
Gregory A. Merrell, MD

Hypothesis
Hand surgery fellows will be able to attain a functional level of proficiency with ultrasonography following a brief 30 minute instruction session.

Methods
Six hand surgery fellows completed an ultrasound competency assessment as well a survey regarding their attitudes towards the use of ultrasound both before and approximately one month after receiving 30 minutes of instruction from a non-expert ultrasonographer on the use of ultrasound. The competency assessment consisted of three parts: obtaining adequate image quality, identifying a series of anatomic structures in the wrist and hand and performing several clinically relevant tasks such as identifying a flexor tendon gap in a cadaveric model.

Results
Time to obtain an adequate picture significantly decreased from an average of 4 minutes and 42 seconds (4:42; 3:57–7:55), to 0:52 (0:30-1:14). Participants’ performance for structure identification significantly improved from correctly identifying an average of 9.7 (8-13) to 12 (10-13) out of 14 following instruction while the average time to complete the task decreased from an average of 14:06 (12:08-18:30) to 9:34 (4:40-15:54). Following instruction, all 6 participants successfully identified and measured the cross-sectional area of the median nerve, identified and measured a zone 3 flexor tendon gap and identified a simulated FDP avulsion and its level of retraction. Five of 6 successfully administered an ultrasound guided injection to the extensor carpi ulnaris (ECU) subsheath.

Summary Points
- Following a 30-minute instructional session, hand surgery fellows are able to achieve a basic level of ultrasound competency.
Poster 377: Fracture Gap Reduction with Variable Pitch Headless Screws

Category: Miscellaneous

Surgical Technique; Basic Science
N/A - not a clinical study

Austin Roebke, BS
Logan Roebke
Kanu Goyal, MD

Hypothesis
Fully-threaded variable pitch headless screws are used in many different settings in hand and upper extremity surgery. The purpose of this study is to better understand how screw parameters such as diameter, length, and pitch variation as well as technique parameters such as depth of drilling affects the fracture gap closed.

Methods
Acutrak 2 fully-threaded variable pitch headless screws (Acumed, Hillsboro, OR) of various diameters (Standard, Mini and Micro) and lengths (16-28 mm) were inserted into polyurethane blocks of normal and osteoporotic densities (Sawbones, Vashon Island, WA) by the utilization of a custom jig. Three drilling techniques (drill only through first block, 4 mm into second block, or completely through both blocks) were used. During screw insertion, fluoroscopic images were taken and later analyzed to measure fracture gap reduction. The effect of backing the screw out after compression was also evaluated. ANOVA and post-hoc student’s t-test were performed to evaluate statistical significance (p = 0.05).

Results
In the normal bone model, with a 20 mm Mini screw, drilling only through the first block resulted in significantly less fracture gap closure: first block only 1.1 ± 0.2 mm, 4 mm into second block 1.7 ± 0.1 mm, and completely through both blocks 1.8 ± 0.1 mm. In normal bone, the fracture gap closed by a 24 mm long screw was: Standard 1.9 ± 0.3 mm, Mini 2.2 ± 0.1 mm, and Micro 1.5 ± 0.1 mm. In osteoporotic bone, the fracture gap closed by the same screws was a little greater, however to an insignificant degree: Standard 2.2 ± 0.3 mm, Mini 2.3 ± 0.1 mm, and Micro 1.7 ± 0.1 mm. In both models, the Micro screw closed a significantly less fracture gap than the Standard and Mini. All screw sizes demonstrated that with each additional thread passage into the second fragment, more fracture gap is closed (Figure 1). Further, after fragment contact and compression with two subsequent full forward turns, backing the screw out by two full reverse turns led to a mean 0.3 mm fracture gap (Figure 2).
Summary Points

Drilling at least 4 mm past the fracture site reduces screw push off thereby increasing final fracture gap closure. Standard and Mini screws are able to close a larger fracture gap than Micro. The length of screw in the second fragment is the main determinant of fracture gap closure. Finally, backing the screw out after insertion can lead to immediate loss of compression.
Poster 378: Predictive Factors of Poor Health Literacy in Orthopedics: A Multivariate Analysis

Category: Miscellaneous

Evaluation/Diagnosis; Prognosis/Outcomes; Patient Education
Level 4 Evidence

Peter C. Noback, BA
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Direk Tantigate
Robert J. Strauch, MD
Melvin P. Rosenwasser, MD
J. Turner Vosseller

Hypothesis
Evidence shows that patients with limited health literacy (HL) are susceptible to inferior outcomes. By identifying characteristics associated with these poor traits, policy aimed at improving HL could be more efficiently implemented. The Literacy in Musculoskeletal Problems (LiMP) survey is a validated nine-item orthopedic HL questionnaire. The purpose of this study was to assess predictors of orthopedic HL using the LiMP survey through a large patient sample at an urban academic medical center.

Methods
245 patients presenting with chief complaints previously untreated were approached in the clinic of one foot and ankle surgeon and three hand and wrist surgeons. Inclusion criteria required age greater than 18 and English proficiency. Enrolled patients completed the LiMP questionnaire in addition to a demographic form. Clinical history was retrospectively reviewed. The following information was collected: age, gender, BMI, duration of symptoms, number of children living at home, past surgical history, visit type (trauma/non-trauma), smoking status (current/non-smoker), diabetes status (yes/no), history of psychiatric disorder (yes/no), race (white/non-white), education level (more/less than bachelor’s degree), and insurance type (public/private).

Pearson correlation coefficients (PCC) were calculated between LiMP score, demographic data, and medical history data. Based on results of the correlational analysis, variables that were significantly correlated with LiMP score were entered into multivariate regression analysis to assess their effect on HL.
**Results**

231 patients (131 hand/wrist, 100 foot/ankle) were enrolled and fully completed questionnaires. Mean age was 45.6 (±16.8, range 18 – 82), and mean score on the LiMP was 5.40 (±1.8, range 1 – 9). The following variables significantly correlated with LiMP score: race (PCC=0.23), age (PCC=0.16), education (PCC=0.22), past surgical history (SCC=0.18), and insurance type (SCC=-0.16).

Multivariate regression analysis was conducted with LiMP score as the dependent variable, and the factors race, age, education, past surgical history, and insurance type as the independent variables. Results of this analysis can be found in Table 1. The final model significantly accounted for 15.0% of variation in LiMP score. Coefficients that significantly contributed to the final model were those of past surgical history, race, and education level.

**Summary Points**

- Race, past surgical history, and education level all contribute significantly to a patient’s HL. Race significantly increased ability to predict LiMP score. Similarly, the inclusion of education level also significantly added to our model’s ability to predict LiMP score.
- Our results indicate that when designing policy aimed at improving HL, efforts should be focused on lower educated persons and minorities regardless of
Poster 379: Can Patients Forecast Their Postoperative Disability After Elective Hand Surgery?

Category: Miscellaneous

Evaluation/Diagnosis;Treatment;Prognosis/Outcomes
Level 4 Evidence

Aaron Alokozai
Nicole Sheikholeslami
Robin Kamal, MD

Hypothesis
Forecasting is a method of using old data and experiences to anticipate the direction of future trends. Forecasting can be used as a valuable tool in healthcare by predicting future health situations and needs. We tested the primary null hypothesis that patient forecasted dysfunction will not correlate with realized dysfunction. We also tested the secondary null hypotheses that (1) Patients forecasted pain will not correlate with realized pain (2) Catastrophic thinking, self-efficacy, and depression will not correlate with greater difference of forecasted and actual dysfunction and pain levels.

Methods
Upon Institutional Review Board approval, patients undergoing elective hand surgery completed a questionnaire before their procedure/surgery that (1) measured their current hand dysfunction (QuickDASH), (2) recorded pain (Numerical Pain Scale from 0-10), and (3) assessed their forecasted hand dysfunction and pain at 2 weeks postoperatively. The questionnaire also queried the following psychological factors as explanatory variables: Pain Catastrophizing Scale (PCS), General Self Efficacy Scale (GSE-6), and Patient Health Questionnaire Depression Scale (PHQ-2). At the two-week follow-up appointment, patients completed the Quick DASH and Numerical Pain Scale to assess their realized dysfunction and pain levels. Bivariate analyses were performed to determine the associations among psychosocial factors and demographic characteristics with differences in forecasted and realized hand pain and dysfunction. Level 2 Evidence

Results
Twenty patients undergoing elective hand surgery were evaluated. Bivariate analysis using the Pearson correlation coefficient demonstrated that there is a statistically significant correlation (r = .71; p < .05). There was also no correlation between psychosocial factors (catastrophic thinking, self-efficacy, and depression) and difference between forecasted and actual dysfunction and pain levels.
Summary Points

- Patients are able to forecast their postoperative dysfunction.
- Patients are unable to forecast their postoperative pain.
- Psychosocial factors do not affect a patient’s ability to forecast their postoperative dysfunction and pain.
Poster 380: Porcine Tendon Repair Augmented by Intra-Tendinous Insert

Category: Miscellaneous

Treatment; Surgical Technique; Prognosis/Outcomes
N/A - not a clinical study

Jozef Zoldos
Lloyd P. Champagne, MD

Hypothesis
We hypothesize that the rupture strength of the porcine flexor digitorum profundus tendons of the second digit repaired with Krackow technique with an intra-tendinous implant will yield a higher rupture strength when compared to the same tendons repaired with Krackow technique without an intra-tendinous implant.

Methods
Porcine flexor digitorum profundus tendons of the second digit from 80kg porcine were lacerated and subsequently repaired using Krackow technique both with and without an intra-tendinous implant. There were 2 groups including:

1. Krackow repair porcine tendon without implant N = 5
2. Krackow repair porcine tendon with implant N = 5

Tensile force was applied to the tendon repair at 2mm/second using a calibrated Mark 10 force gauge and the force at rupture was recorded (Newtons). Rupture was defined as a 3mm gap between tendon ends. Standard statistical analysis was performed with a Mann-Whitney U-Test using MATLAB (Natlick, MA).

Results
Rupture strength of porcine tendons repaired by Krackow technique with an intra-tendinous implant is greater than the rupture strength of tendons repaired by Krackow technique without an intra-tendinous implant (p<.05). The median repair strength following a Krackow repair without an intra-tendinous was 66N while the median repair strength following a Krackow repair with an intra-tendinous implant was 120N.

Summary Points
- Tendon repair strength, as measured by the force at rupture, is greater with the use of an intra-tendinous ribbon implant.
- Future studies with a larger sample size are needed to validate these findings and determine the clinical outcomes following tendon repair with an intra-tendinous graft.
• These results can be clinically relevant in the treatment of FDP Zone I & II lacerations; improved tendon repair strength using an intra-tendinous implant can lead to early, active range-of-motion protocol, less morbidity and fewer surgical revisions.
Poster 381: Sleep Quality, Pain Catastrophization, and Orthopedic Health Literacy: Are These Factors Correlated to Functional Outcome Scores?

Category: Miscellaneous

Prognosis/Outcomes; Patient Education
Level 4 Evidence

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Mani Seetharaman
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J. Turner Vosseller

Hypothesis
Evidence increasingly indicates the importance of orthopedic health literacy, sleep quality, and a propensity for pain catastrophization in orthopedic patient outcomes. Using previously validated questionnaires including the Literacy in Musculoskeletal Problems (LiMP), Pain Catastrophization Scale (PCS), and the Pittsburgh Sleep Quality Index (PSQI), this study investigated the relationship between these factors and common functional outcome instruments including the Disability of Arm, Shoulder, and Hand (DASH) and the Foot and Ankle Outcome Score (FAOS).

Methods
245 patients in outpatient clinics of one foot and ankle surgeon and three hand surgeons were approached. Inclusion criteria required age greater than 18, English proficiency, and a newly presenting chief complaint. Enrolled patients completed a demographics form, LiMP, PCS, PSQI, and the DASH or FAOS based on extremity. Clinical history was reviewed retrospectively. DASH and FAOS scores were normalized to the same scale (0 – 100, best to worst) and termed “functional survey” (FS). Correlations were calculated between FS scores, subjective questionnaires, and demographic/clinical information. For the variables of race and education level, one-way ANOVA analysis was conducted to determine if FS scores differed based on these variables. Variables that were significantly correlated with FS score were entered into a multivariate linear regression analysis to assess their effect on FS score.

Results
231 patients (131 hand/wrist, 100 foot/ankle) were enrolled and completed all questionnaires. ANOVA analysis found that there were no significant differences in FS scores based on education or race (p > 0.05). Multivariate regression analysis was conducted with FS score as the dependent variable, and factors that were significantly correlated with FS score, including PCS,
PSQI Global Score, visit type (trauma vs. non-trauma), and insurance type (private vs. public) as the independent variables. Health literacy was not significantly correlated with FS score. Results from this analysis can be found in Table 1. The model significantly (p < 0.05) accounted for 19.2% of variation in FS score.

Summary Points
- There is a strong correlation between tendency to catastrophize pain, sleep quality, and FS score. Every 1 unit increase in the PSQI/PCS corresponds with a 1.8/0.38 point increase in FS score; indicating higher functional disability. Given the strong correlation at baseline, such factors as poorly controlled tendency to catastrophize pain may confound functional outcomes.
- No significant correlation was noted between health literacy and FS scores. This suggests that an increased level of orthopedic knowledge does not affect perception of functional disability.
Poster 382: Buried versus Exposed K-wires in Hand and Wrist Fractures: Systematic Review and Meta-Analysis

*Category: Miscellaneous*

Treatment;Surgical Technique;Prognosis/Outcomes
Level 3 Evidence

Andrew Lovy, MD
Aakash Keswani
Debbie Chi
Dong-Han Yao
Michael Hausman

**Hypothesis**
Despite the frequency of K-wire use in hand and wrist fractures, significant controversy exists regarding optimal technique to prevent pin site complications. The purpose of our study was to perform a systematic review and meta-analysis comparing pin-site infection and total complication rates in hand and wrist fractures treated with buried versus exposed K-wire fixation.

**Methods**
Initial database search yielded 537 studies, of which 47 met inclusion criteria for systematic review and 5 for meta-analysis (Figure 1).

**Results**
Among the 14 studies with buried K-wires (658 fractures; 1,547 pins), 9 were of moderate-high quality. For the 35 studies that included exposed K-wires (1,787 fractures, 4,059 pins), 28 were of moderate-high quality. The pooled infection rate for buried K-wire fixation was 3.0% [range: 0-8.0%] with Q value of 5.3 and I² of 0%. The pooled infection rate for exposed K-wire fixation was 6.1% [range: 0-34.5%] with Q value of 51.9 and I² of 34.5%. The pooled total complication rate for buried and exposed K-wire fixation was 24.0% [range: 0-62.0%] and 18.6% [range: 0-57.9%], respectively. In sub-analysis of distal radius fractures (2,397 fractures) buried versus exposed technique yielded pin-site infection rates of 3.9% and 7.5%. In comparison, the pin-site infection rate among metacarpal/phalangeal fractures (198 fractures) was 3.8% for buried and 6.8% for exposed K-wires. Results of meta-analysis using a random-effects model, demonstrated a non-significantly decreased pin-site infection rate in buried versus exposed K-wires (OR 0.40, CI: 0.16-1.01) (Table 1).
Summary Points

- Our findings suggest a non-significant trend towards diminished pin-site infection rates among buried compared to exposed K-wires in hand and wrist fractures.
- Additional high quality studies evaluating pin-site infections and complications of buried versus exposed K-wires are needed.

Bibliography

Poster 383: The Effect of Growth Differentiation Factor 8 (Myostatin) on Bone Marrow Derived Mesenchymal Stem Cell Coated Bioactive Sutures in a Rabbit Tendon Repair Model

Category: Miscellaneous

Treatment; Basic Science
N/A - not a clinical study

Grant received from: AFSH Andrew Weiland Grant

Kunihide Muraoka
Wei Le, MD
Jeffrey Yao, MD

Hypothesis
Accelerating tendon healing by using bone marrow derived mesenchymal stem cells (BMSCs) and/or growth factors is an area of great interest for hand surgeons. We have reported that BMSCs coated bioactive sutures enhance tendon repair strength using an in vivo rat model.(1) We have also shown that growth differentiation factor 8 (GDF-8, also known as myostatin) simulates tenogenesis in BMSCs in vitro.(2) Based on these previous studies, we hypothesized that GDF-8 may stimulate BMSCs to differentiate down a tenocyte lineage providing additional benefit for injured tendons repaired using these bioactive sutures. The purpose of this study was to determine whether BMSCs-coated bioactive sutures treated with GDF-8 would increase tendon repair strength using an in vivo rabbit tendon model.

Methods
Rabbit BMSCs were grown and seeded on to 4-0 Ethibond sutures and treated with GDF-8 in accordance with our previous studies.(2), (3) New Zealand white rabbits’ bilateral Achilles tendons were transected and randomized to experimental (BMSCs-coated bioactive sutures treated with GDF-8) or plain suture control groups. Tendons were harvested at 4 (n = 9) and 7 (n = 9) days and subjected to mechanical assessment. Force at 1 and 2 mm gap formation, stiffness, maximum force, and gap formation at maximum force were recorded. It was determined from preliminary testing that a sample size of nine would be required to show a 30% difference in force at 1 mm of tendon repair site gapping amongst the groups. Comparisons across groups were performed using paired Student’s t-tests with significance set at p < 0.05.

Results
There were no significant differences between the experimental and control groups in all parameters including force at 1 and 2mm gap formation, stiffness, maximum force, and gap
formation at maximum force of the tendon repair site. There was a non-significant trend toward lower strength in the tendons repaired with the myostatin-treated cells.

Summary Points
- GDF-8 does not appear to increase the effect of BMSCs on in vivo rabbit tendon healing in this series.
- Based on these preliminary results, GDF-8 may actually impair the effect of BMSCs on tendon healing.
- To further clarify the effect of GDF-8 on BMSCs used in tendon repair, we are further investigating the strength of the tendon repaired by control and BMSCs coated sutures without myostatin using the same rabbit tendon model.

Bibliography

Images
Poster 384: Prevention of the Postoperative Adhesion Following the Tenorrhaphy in the Hand by Artificial Dermal Matrix

Category: Miscellaneous

Treatment;Surgical Technique;Prognosis/Outcomes
Level 4 Evidence

Hyung-Sup Shim

Hypothesis
Because postoperative adhesion around the tenorrhaphy area is almost inevitable, there have been numerous intraoperative and postoperative methods suggested by the surgeon around the world, including tenorrhaphy methods, suture material itself, anti-adhesion agents or postoperative physical therapy. Among the anti-adhesion agents, artificial dermal matrices were not proven in their efficacies in the prevention of adhesion yet, so we present the long-term follow-up data and their roles.

Methods
The study was performed in single institution, Uijeongbu St. Mary’s Hospital, one of the national emergency headquarter. A total of 87 patients was enrolled in the study. Single tendon rupture cases in Flexor zone I from index finger to little finger were included in the study, and the previous trauma history or underlying disease affecting the motion of the hand were considered as exclusion criteria. The tenorrhaphy was performed by single surgeon, HS Shim, and the bovine dermal matrix was wrapped around the tenorrhaphy site before the skin closure in the study group. The hyaluronic acid based anti-adhesion agents was applied in both group.

Results
The results were assessed by the postoperative range of motion (ROM). All statistical analyses of measurements were conducted using SAS software version 9.3 (SAS institute, Cary, NC, USA); a p-value <0.05 was considered significant. The range of the motion in the distal / proximal interphalangeal joint (DIPJ / PIPJ) was recorded at 6-month postoperative period. In the control group of 46 patients, the average ROM was 78 / 75 degrees respectively. In the study group of 41 patients, the average ROM was 84 / 85 degrees which was significantly greater than control group.

Summary Points
- The surgeon should be aware of multiple strategies for prevention of adhesion in tenorrhaphy of the hand.
• The artificial dermal matrix has a definite role for anti-adhesion by creating barrier from adjacent tissue.

Bibliography
Images
Poster 385: Prevalence of Ulnar Artery Thrombosis in Orthopaedic Surgeons

Category: Miscellaneous

Evaluation/Diagnosis; Anatomy
Level 4 Evidence

Chelsea S. Mathews, MD
Karan Dua
Austin Cole
Eric Siegel
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Theresa Wyrick-Glover, MD

Hypothesis
The prevalence of ulnar artery thrombosis will be higher in orthopaedic surgeons than in the general population. Surgeons who specialize in hip and knee arthroplasty will have a higher incidence of ulnar artery thrombosis than those of other specialties.

Methods
80 current, retired, and resident orthopaedic surgeons at two separate institutions were surveyed for symptoms of UAT. Participants completed surveys indicating symptoms of ulnar artery thrombosis and participation in leisurely activities that may also increase their risk. A timed Allen’s test was performed with the radial artery occluded and the time to reperfusion of the hand was measured. A result of >6 seconds to reperfusion was noted as abnormal. The ulnar artery was also dopplered proximal to the wrist flexor crease to ensure proximal patency and flow. Fisher’s exact test was used to compare UAT incidence between participants and the general population, and between participant subgroups defined by number of years in practice, subspecialty practice, and volume of arthroplasty cases performed per month.

Results
10 participants had an Allen’s test with reperfusion occurring at >6 seconds. One of these was a false positive with increased Allen’s test but no symptoms to indicate pathology. All participants had positive doppler studies proximal to wrist crease. The incidence of UAT in our study population was 11.25% (9/80) in comparison to 1.6% (21/1300) in the general population (P<15 years had a significantly higher rate of UAT (24%) compared to those who had practiced for <15 years (2%)(P=0.0030). The incidence of UAT in adult reconstruction surgeons was 40% (2/5) compared to only 9% (7/75) in other subspecialties, but this was not statistically significant (P=0.095). All 9 UATs occurred among the 62 participants who reported a leisure activity...
compared to 0 among the 18 who didn’t, but this was not significant (P=0.20), and no specific leisure activity appeared to increase the incidence of UAT.

Summary Points
- Orthopaedic surgeons are at a higher likelihood for developing ulnar artery thrombosis
- Risk of UAT is increased with longer years in practice
- Risk may be increased in adult reconstructive surgeons but was not shown to be statistically significant

Bibliography
Images
Poster 386: Fibromyalgia as a Predictor of Complex Regional Pain Syndrome after Distal Radius Fracture

Category: Miscellaneous

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Level 4 Evidence

Daniel E. Hess, MD

Hypothesis
Fibromyalgia can serve as a useful predictor of Complex Regional Pain Syndrome (CRPS) risk in patients with distal radius fractures (DRF), promoting increased vigilance for CRPS symptoms and earlier recognition and treatment to improve patient outcomes.

Methods
The PearlDiver Medicare database was queried using ICD-9 and CPT diagnosis and procedure codes for patients who were diagnosed with distal radius fracture or treated for distal radius fracture either surgically or with closed reduction. The patients identified were queried for a history of fibromyalgia prior to the distal radius fracture, as available within the observation period separating the group into fibromyalgia and control cohorts. The cohorts were then analyzed for the development of CRPS within 3, 6, 9, and 12 months from injury. The two cohorts were analyzed for basic demographics, including age and gender, type of intervention (surgical or closed reduction, if any), and common general comorbidities diagnosed prior to injury. To evaluate for confounding factors, the two cohorts were combined and subsequently analyzed for their association with the development of CRPS within 1 year of distal radius fracture using PearlDiver functions powered by back-end R statistical software to perform both bivariate and multivariable logistic regression, returned as estimated coefficients with calculated probability. Estimated odds ratios (OR) were calculated through exponentiation of model coefficients, and p65, diabetes, and heart failure were negatively associated.

Summary Points
- Higher rates of CRPS were seen in the fibromyalgia group at all time points, suggesting a correlation between the two conditions, potentially allowing for earlier recognition and initiation of treatment. The treatment strategy in CRPS requires quick recognition and early intervention for the best prognosis. Prevention of course yields the best outcome, and studies have shown decreased rates of CRPS with early mobilization and vitamin C supplementation. However, in the event of CRPS development, each progressive stage is associated with a lesser response to therapy, more invasive treatments, and more permanent changes.
• Surgical intervention was also positively correlated with CRPS. Patients should be educated on the risks of surgery.

**Bibliography**


Poster 387: Factors Associated with Leech Therapy in Digit Revascularization and Replantation

*Category: Miscellaneous*

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Level 4 Evidence

Z-Hye Lee
Joshua Cohen
John Stranix
Vishal Thanik, MD

**Hypothesis**

While leech therapy is an important adjunct for salvaging in the treatment venous congestion in digit replantation, it carries significant morbidities including need for blood transfusions, increased length of stay and patient discomfort. We hypothesize that there are certain patient factors and intraoperative variables associated with increased rates of leech therapy.

**Methods**

Between August 2007 and June 2015, a retrospective review examined all patients who underwent medicinal leech therapy for digit revascularization. 22.1% (38 of 172) of all digits that were revascularized required leech therapy.

**Results**

36.8% of digits (14 of 38) that were leached survived compared to 88.9% of digits that underwent revascularization without leech therapy (p < 0.0001). Patients with complete amputations were more likely to undergo leech therapy compared to incomplete amputations (p < 0.0001). Significant contamination of wounds was associated with increased rates of leeching (p < 0.04). 50% of all avulsion injuries required leeching compared to only 20% of lacerations and 8% of crush injuries with the lowest rates of leeching (p < 0.01). The presence of concomitant bone fractures was associated with higher rates of leeching compared to devascularized digits with no bone fractures (p < 0.001). Smoking status and diabetes mellitus was not associated with increased rates of leeching (p = 0.61 and p = 0.74 respectively). The average number of transfusions was significantly higher in patients receiving leech therapy (3.0 ± 3.87 units) compared to patients who were not leached (p < 0.0001). Similarly, patients receiving leech therapy after revascularization had longer length of stay compared to patients without leeching (13.7 ± 5.74 vs. 9.3 ± 3.29 days, p < 0.0001).
Summary Points

- Several factors were associated with increased rates of leech therapy including complete amputations, significant contamination of wounds, avulsion injuries and the presence of bony fractures.
- Patient with one or more of these factors can be counseled prior to replantation regarding the higher likelihood of leech therapy post-operatively.

Bibliography


Images
Poster 388: Changes in Arterial Flow across the Palm with Wrist Position

Category: Miscellaneous

Basic Science
N/A - not a clinical study

Elizabeth A. Newman, MD
Fiesky A. Nunez, Jr., MD, PhD
Wayne A. Chen, MD
Linda H. Chao, MD
Megan E. Friend, MD
Zhongyu Li, MD, PhD

Hypothesis
We hypothesize that flow across the radial and ulnar arteries will change with varying wrist positions. We hypothesize that flow across the radial and ulnar arteries will increase with release of the first dorsal extensor compartment and Guyon’s canal respectively.

Methods
The ulnar and radial arteries of a cadaveric arm were dissected approximately 3 cm proximal to the wrist joint. The radial and ulnar arteries where cannulated with PE205 polyethylene tubing. An arthroscopic fluid pump was used to create flow at a constant pressure of 80 mmHg. Flow across the ulnar artery was measured using a 3 mm vessel ultrasound flowprobe. The arthroscopic pump was connected to the cannulated radial artery to create inflow across the radial artery. The fluid traveled through the radial artery, palmar arch and out the cannulated ulnar artery. Changes in outflow were measured at the cannulated ulnar artery. Flow in various wrist positions (flexion, extension, ulnar and radial deviation) was measured for ten seconds each, recording flow every second.

Results
Preliminary data show peak flow with the wrist between 10 degrees of flexion and extension. It also demonstrates progressive decrease in flow with increases in flexion and extension with approximately 30% decrease in flow at 40 degrees and negligible flow at 50 degrees. Maximal flow in the coronal plane was in neutral position with progressive decrease with ulnar and radial deviation and negligible flow at 15 degrees of radial deviation and 25 degrees of ulnar deviation.

Summary Points
- We present a cadaveric pilot model for measuring flow across the palm. We demonstrate that flow varies with wrist position.
Our efforts continue at the moment to measure flow across the radial artery before and after release of the first dorsal extensor compartment and, flow across the ulnar artery before and after release of Guyon’s canal in varying wrist positions.

Changes in flow with these releases may have clinical implications for Scleroderma in which arterial flow is decreased at these compartments.

Bibliography

Images
Poster 390: Preemptive Analgesia in Hand Surgery: Immediate Post-Operative Pain with Pre-Incision vs. Post-Incision Local Analgesia

Category: Miscellaneous

Treatment; Surgical Technique; Patient Education

Level 4 Evidence

Asif Ilyas, MD
Joseph Labrum

COI
Royalty: Jaypee Medical Publishers
Consulting Fee: Globus
Speakers Bureau: DePuy Synthes

Hypothesis
Local anesthetics are often used in the management of post-operative pain in hand surgery. Currently no guidelines exist for the timing of the injection of anesthetics in surgeries performed under general anesthesia to minimize post-operative pain. Preemptive, or pre-incisional, injection has been purported to provide better post-operative pain relief. In order to better understand the role of timing of the injection of local anesthesia in hand surgery performed under general anesthesia, we evaluated the effect of pre-incisional local analgesic injection vs. post-incisional local analgesic injection on immediate post-operative pain experience in hand surgery, using a thumb basal joint arthroplasty surgery model. We hypothesized that the pre-incision (preemptive) injection of local anesthetic will result in decreased immediate post-operative pain experience and analgesic use when compared to after incision placement (post-closure) of the injection.

Methods
Consecutive cases of thumb basal joint arthroplasty performed over a four-year period were retrospectively reviewed. During the first half of the study period, the surgical site was infiltrated with 20cc of 0.5% Bupivacaine at the completion of surgery following closure (post-closure group). During the second half of the study period, the surgical site was infiltrated with 20cc of 0.5% Bupivacaine prior to skin incision (pre-incision group). All cases were performed under general anesthesia with no cases receiving any regional anesthesia. Data collected included patient demographics, immediate post-operative recovery room (PACU) pain scores, and post-operative opioid consumption in morphine equivalents. Descriptive statistics were subsequently performed.
Results
Two-tailed t-test identified there was no statistically significant difference between the pre-incision and post-closure cohorts relative to PACU entrance pain scores ($p = 0.74$) and time spent in the PACU ($p = 0.91$). However, PACU exit pain scores were significantly lower in the pre-incision cohort ($p = 0.04$). Also, the mean PACU pain score was also significantly lower in the pre-incision cohort ($p = 0.009$). PACU opioid consumption, converted into morphine equivalents, was found to be 211mg in the pre-incision versus 299mg in the post-incision cohort ($p=0.25$).

Summary Points
- The pre-incision (preemptive) injection of local anesthesia was found to result in lower pain scores during and upon exit of the PACU compared to the post-closure group.
- The pre-incision (preemptive) cohort also trended towards lower opioid consumption while in the PACU.
- Surgeons should consider giving the routine use of preemptive injection of local anesthesia to maximize pain relief in a multimodal pain strategy in hand surgical patients.
Poster 391: Design and Use of a Novel Tendon Coupling Device for Tendon Repair

*Category: Miscellaneous*

Treatment; Surgical Technique; Prognosis/Outcomes
N/A - not a clinical study

Grant received from: Raymond M. Curtis Research Foundation, The Curtis National Hand Center

Sam Fuller, MD
Brent G. Parks, MSc.
Kenneth R. Means, MD

**Hypothesis**
We hypothesized that a novel tendon coupling device would be non-inferior and more consistent than traditional flexor tendon suture repair in a load-to-failure study.

**Methods**
Fresh frozen cadaver flexor digitorum profundus (FDP) tendons were used to test ultimate failure load (UFL) after application of the Nitinol coupling device to the tendon. Matched cadaver FDP tendons were used to compare UFL to a locking 8-strand core cruciate technique using 4-0 Fiberloop and a 6-0 Prolene running locking epitendinous suture repair. Specimens were secured in a servohydraulic loadframe via cryogenic soft tissue grips and loaded to failure at a rate of 1 mm/s. Load and displacement data were collected continuously at a rate of 20 Hz.

**Results**
Average UFL for 5 sutured tendon repairs was 99.40N (range 65-126N), all failing secondary to suture pull-through. Average UFL for 5 tendons repaired using the coupling prototype with was 84.80N (range 77-92N), all failing secondary to bottom plate breakage. The 95% confidence interval (CI) on the mean was 6.991 for the tendon coupler and 29.154 for the sutured repair. The difference in load-to-failure was not statistically significant (P = 0.21).

**Summary Points**
- Study validated proof of concept and initial required UFL testing that Nitinol tendon coupler is strong and reliable.
- Sutureless, novel coupling device for tendon repair can successfully and reproducibly reach at least 77N of force prior to failure and obtained a narrower standard deviation and 95% CI on the mean than a sutured repair.
• Device may remove surgeon experience and skill as potential limitations and variability in tendon repair outcomes.
Poster 392: The Effect of Seasonal and Weather Variations in the Presentation of Common Orthopaedic Upper Extremity Disorders

Category: Miscellaneous

Evaluation/Diagnosis; Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
The goal of this study is to characterize the effect of seasonal and weather variations in common upper extremity orthopedic conditions. Our hypothesis is that seasonal and weather variation exists among these disorders.

Methods
We reviewed 68,943 consecutive, new patient visits from January 2010 to September 2015 for the following conditions: carpal tunnel syndrome (CTS), trigger finger (TF), DeQuervain’s tenosynovitis (DeQ), lateral epicondylitis (LE), hand arthritis (OA), and distal radius fractures (DRF). Temperature, precipitation, barometric pressure and humidity were obtained from the National Oceanic and Atmospheric Association. Diagnoses were compared across months and seasons using Holm-Bonferroni adjustment for multiple pairwise tests. Associations between weather parameters and diagnosis rates were determined using Spearman's rho.

Results
DRF, OA, CTS and LE had a higher rate of presentation in the winter (P<0.001). Higher average monthly humidity levels were associated with significantly lower rates of CTS, TF, DeQ, LE, and DRF (P<0.001). Higher average barometric pressures were associated with higher rates of all of the diagnoses evaluated. There was no significant association between temperature levels or amount of precipitation and rates for any the above diagnoses.

Summary Points
- There are seasonal and weather variations that affect the presentation of upper extremity conditions.
• Although the precise mechanism remains unclear, there does appear to be a physiologic impact specifically of colder temperatures, increased barometric pressure and higher humidity.
• Further studies may help determine more conclusively why this occurs, as well as help to assess the economic impact of the variability of diagnoses and its burden on health care resources.
Poster 393: Outcomes according to Surgical Methods for Digital Glomus Tumor

Category: Miscellaneous

Treatment;Surgical Technique;Prognosis/Outcomes
Level 4 Evidence

Jong Hun Baek
Jae Hoon Lee
Duke Whan Chung, MD
Kyu Jin Kim
Chung Hwan Lee
Hyun Ho Lee

Hypothesis
Authors hypothesized that we would find different clinical outcomes of glomus tumor of finger according to anatomical location, surgical method and approach.

Methods
From 2001 to 2016, outcomes of 50 cases of surgical excision of glomus tumor by 2 surgeons were retrospectively studied by telephone interview and clinical chart-review. Mean follow-up period was 80.1 months (range, 10-324) and mean age was 40.7 years old (range, 19-80) and 8 cases were male, 42 cases were female. 9 cases were at volar pulp, 3 cases were at nail matrix and 38 cases were at nail bed. Preoperatively, bony erosion in 23 cases, nail deformity in 4 cases and subungual discoloration in 14 cases was found. 22 cases were operated with surgical microscope, 28 cases were operated with loupe. 3 different surgical approach was applied according to tumor's location. Volar approach was applied to mass located at volar pulp, 32 transungual approach and 9 partial nail-sparing approach was applied to subungual mass.

Results
There were recurrence of 6 cases (12%), numbness of 2 cases (4%), nail change of 7 cases (14%). 2 of 9 cases of volar mass were recurred and 4 of 41 cases of subungual mass were recurred (p=0.293). 1 of 22 case by microscope was recurred and 5 of 28 cases by loupe were recurred (p=0.211). 9 cases of partial nail-sparing approach showed no recurrence, and 4 of 32 cases of transungual approach was recurred (p=0.559). Volar mass most recurred (22%), but there was no statistical significance. No statistical significant differences were found on complications. Age, gender, duration of symptom, preoperative bony erosion, subungual discoloration did not influenced to surgical outcomes.
Summary Points
Recurrence rate after surgical excision of glomus tumor of finger was 12%. There were no statistical difference of recurrence and complication rate according to location and surgical approach.
Hypothesis
The purpose of this study was to analyze and compare the wrist motion during four selected tasks using a new desktop motion analysis system developed with the motion controller for a home video game console.

Methods
Eighteen healthy, right-handed subjects performed 15 trials of selective tasks (dart throwing, hammering, circumduction, and winding thread on a reel) with both wrists. The signals of light-emitting diode markers attached to the hand and forearm were detected by the optic receptor in the motion controller. We compared the results between both wrists and between motions with similar motion paths.

Results
Between both wrists, the ranges of flexion-extension and radioulnar deviation for dart throwing and hammering were not significantly different, except for radioulnar deviation of hammering ($p = 0.005$). Couplings for dart throwing and hammering were not significantly different between both wrists. The ranges and offsets for circumduction and thread winding were not significantly different between both wrists. The orientations of the oblique plane for circumduction were not significantly different between both wrists, but the orientation for thread winding in the left was larger ($p = 0.005$). In each wrist, the ranges for hammering were larger than those of dart.
throwing. The offsets and the orientations of the oblique plane were not significantly different between circumduction and thread winding.

Summary Points

- A desktop motion analysis system was developed with Wii remote motion controller.
- Dart throwing, hammering, circumduction, and thread winding were analyzed.
- The four tasks showed similar motion paths between both wrists.
- The ranges of motion for hammering were larger than those of dart throwing.
- Our system may be a cost-effective and simple method for wrist motion analysis.

Bibliography


Images
Hypothesis
Fractures in children with an immature skeleton rarely give problems in adulthood due to remodeling of the growing forearm shaft. However, diaphyseal radius fractures in adolescents that heal with a rotational deformity may later cause an instability of the DRUJ. In these cases a corrective osteotomy may be performed. Traditionally this has been prepared using X-rays and/or computed tomography scans (CT) and executed freehand with or without a reconstruction of the TFCC. A recently developed method is to perform the correction aided by 3D printed guides. This technique gives a higher precision when mapping the deformity and planning the surgery, enabling a safer and more rapid surgery and a more predictable radiographic and clinical outcome compared to the traditional procedure. We present our clinical experience using this technique in three cases where all sustained diaphyseal radius fractures when teenagers and as adults suffered from instability and subluxation of the DRUJ on supination.

Methods
At our clinic we have performed corrective osteotomies on three patients with the aid of patient-specific drill and cutting guides. A 3D reconstruction was made from CT data acquired using a specific high resolution scan protocol. The healthy contralateral side was mirrored and used as a template for the correction. The surgery was planned to match the template. Patient-specific drill and cutting guides and plastic models of the bones were printed. During surgery, the screw holes were pre-drilled using the guides before performing the osteotomy and applying the selected plate, which had been pre-bent on the bone model. No ligament surgery was performed.
The guides and bone models were provided by the company Materialise (Leuven, Belgium).
Results
All patients gained a satisfactory radiographic correction of the malunion and stability of the DRUJ, comparable to the uninjured side.
Range of motion was normal as compared to the uninjured arm.
All osteotomies healed.

Summary Points
• Preoperative planning using only X-ray and/or CT scans for a corrective osteotomy of a malunion of the radius with instability of the DRUJ can be venturesous when a rotational deformity co-exists.
• Virtual 3D planning facilitates the preoperative planning of a corrective osteotomy.
• Mapping the rotational and angular deformity gives a high precision and thereby a safe and less time-consuming operation with a more predictable outcome compared to traditional methods.
Poster 398: Dog Leash Injuries of the Hand and Upper Extremity

Category: Miscellaneous

Patient Education
Level 4 Evidence

Yan Chen
Peter M. Murray, MD
Shane Ashapiro
Kazmerchak Shari

Hypothesis
The purpose of this study was to describe dog leash injuries of the upper limb including injury type and demographic trends among patients and canines. We hypothesize that certain injury trends will be uniquely attributable to handling a dog on a leash.

Methods
Between 2005 and 2016 a consecutive series of patients presenting with upper extremity injuries relating to walking a dog on a leash were prospectively reviewed. Patients were either Emergency Department follow-ups or new consultations. Age, gender, body mass index (BMI), injury history, past medical history, dog size, injury mechanism, injury patterns, and treatment were all recorded. Patients who were attacked by the dog or tried to stop a dog fight were excluded. Data were descriptively summarized using median (range) for numeric variables and n (%) for categorical variables. Wilcoxon rank sum tests and Fisher’s exact tests were used to explore associations between variables.

Results
28 cases were included in the study. Three patients were male, 25 patients were female. Median patient age was 56 years (range, 21 to 80) and median BMI was 24.1 (range, 19.0-38.3). There were 20 fractures (71%) and 8 soft-tissue injuries (29%). Treatment included surgery (N=12, 43%), splint (N=10, 36%), cast (N=1, 4%), and immediate motion (N=5, 18%). Injury sites were the wrist (N=14, 50%) and the finger (N=10, 36%). The dominant side was injured more frequently (N=16, 57%) than the non-dominant side (N=12, 43%). Injuries occurred from falling (N=15, 53%), from the leash wrapped around the arm, wrist, or a finger (N=10, 36%), or from the patient being suddenly pulled by the dog (N=3, 11%). The median BMI was 30.6 among those who did not have a fracture and 23.1 among those who did have a fracture. Among the 20 patients with a fracture, 15 (75%) had a history of osteoporosis (N=11) or osteopenia (N=4). Among the 13 patients with a small or mid-sized dog, 11 (85%) had a fracture and 6 (55%) required surgery. Among the 13 patients with a large dog, 9 (69%) had a fracture and 4 (31%)
had surgery. Among the 2 patients had surgery because of soft tissue injury. Dog size could not be specifically determined in 2 cases. There were no significant correlations with dog size.

Summary Points

- Fractures requiring operative intervention should be suspected following injuries occurring from females walking dogs on a leash.
- Wrapping the leash around the fingers, hand or wrist of the dominant hand should be avoided.

Bibliography

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4: Kurrle SE, Day R, Cameron ID. The Perils of Pet Ownership: A New Fall-Injury Risk Factor. MJA 2004; 682-683
Poster 399: Palmaris Longus Muscle Rupture After Tendon Harvest - An Unusual Complication

Category: Miscellaneous

Hypothesis
The Palmaris Longus tendon is often used as a tendon graft in hand reconstructive procedures. This report highlights a new complication that is not well described in the literature.

Methods
A 40 year old man underwent A2 pulley reconstruction using an ipsilateral palmaris tendon graft. The harvest was performed using a standard technique with 3 forearm incisions. Immediate post procedure recovery was uneventful however 3 weeks post surgery he hyperextended his wrist and felt immediate sharp pain in the forearm.

Results
Ultrasound as well as MRI scans were performed confirming a high grade partial tear of the palmaris muscle 11 cm proximal to the wrist joint. The patient was managed with an extension blocking wrist splint for 6 weeks which improved his symptoms marginally. The literature reports on median nerve injury as the most frequent major complication of palmaris tendon harvest. There is little written about palmaris muscle damage as a result of tendon harvesting, though there are reports of plantaris muscle injury with compartment syndrome post harvest.

Summary Points
- To our knowledge there are no reports of muscle damage or injury as a result of palmaris tendon harvesting.
- This report presents a unique complication which can have a significant impact on wrist and hand function and rehabilitation post surgery.
- Patients should exercise caution when carrying or supporting loads to prevent excessive wrist hyperextension post tendon harvest.

Bibliography
Images
Poster 400: Clinical Management Guidelines for Mycobacterium Marinum Infection of the Hand and Wrist

Category: Miscellaneous

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Level 5 Evidence

Amy Yao
Haoming Xu
Tiffany Y. Sia, MD
Danny Fong, MD

Hypothesis
Infection with Mycobacterium marinum often affects the structures of the hand and wrist following exposure to aquaria. However, treatment of infection involving the deep tissue structures is controversial in the literature.

Methods
Records of 16 patients aged 52 to 91 (mean age 68.3) seen by a single hand surgeon with suspected or confirmed infection with M. marinum were reviewed. Infection was associated with an outbreak in New York City’s Chinatown.

Results
The mean delay in presentation was 3.81 months (range: 1-9 months). 87.5% of patients had a positive history of fishbone exposure. Cultures were positive for M. marinum in only 43.5% of cases. All patients underwent combined surgical and medical treatment with nontuberculous mycobacterial antibiotics due to high clinical suspicion for M. marinum. 100% of patients experienced complete symptom resolution.

Summary Points
- Clinical suspicion for M. marinum infection should be raised for insidious onset tenosynovitis worsened by corticosteroid therapy, negative routine bacterial cultures, and positive history of exposure to fish
- Clinicians should be alert that steroid injections in the setting of a possible infectious process can greatly worsen the disease course
- Management of M. marinum infection involving the deep structures of the hand should be managed surgically with a prolonged course of antibiotics to restore hand function
Bibliography

Images
Poster 401: Hand20 for elderly people and its norm

Category: Miscellaneous

Evaluation/Diagnosis; Prognosis/Outcomes
Level 4 Evidence

Tetsuro Ohnisi, MD, PhD

Hypothesis
In most of developed countries, we evaluate outcomes of treatment on elder people more frequently than ever because of the graying of society. Patient-rated assessment is an inevitable part of treatment outcome evaluation. However it can be difficult to apply it to elder people because of the difficulty in understanding contents. And few questionnaires have their norm for elder people. The purpose of this study was to evaluate the norm of Hand20(1) in elder people for future assessment.

Methods
We had elder people (over 65 years old) who didn’t have any treatment on their upper extremities answer Hand20 questionnaire. We investigated Hand20 score, Hasegawa’s Dementia Scale revised (HDS-R), medical history, questionnaire (understandability of Hand20, quantity of Hand20 items, whether subjects have purpose of life, whom subjects live together with). We assessed invalid cases, deficits of items, the average of hand20, comparison between sexes, age groups, relation between Hand20 score and whether subjects have purpose of life, single life, and medical history. The Binominal logistic regression analysis was performed to estimate the risk factors of high Hand20 score (Hand20 score>12).

Results
There were 184 responders and invalid cases that had more than 3 deficits of items were 5 (3%). We assessed 179 cases excluding 5 invalid cases. There were 64 men and 115 women. Average age was 77.6 years old. The average of Hand20 score was 8.3±12.3 (male: 6.8±10.1, female: 9.2±13.4). There were not statistically significant differences between sexes (p=0.138). Age group more than 85 was significantly higher than other groups (Fig.1). The average of HDS-R was 25.5±4.2. 90.5% of participants told they could understand Hand20 easily, and 77.1% of participants answered that quantity of Hand20 items was not too many. The average hand20 score of participants who had purpose of life was lower than that of others (7.5±11.7, 12.8±15.0 p=0.04). The average Hand20 score of persons who live single was significantly higher than that of persons who live together with someone (12.2±16.8, 7.6±11.2, p=0.03). The average Hand20 score of group that had more than 3 medical histories was higher than that of group that had 2...
or below (13.9±17.4, 6.7±9.9, p<0.01). The risk of high Hand20 score increased with group that
didn’t have purpose of life and increasing age.

**Summary Points**
- The average Hand20 score was 8.3±12.3 in elder people over 65 years old.
- Hand20 score might be influenced by purpose of life, resident status, age and medical
  history.

**Bibliography**
1: Suzuki M. et al. Development and validation of an illustrated questionnaire to evaluate
Hypothesis
The Internet is a widely used resource by patients. Although physicians aim to provide information online that is reliable and accurate, patient awareness and usage of these websites is unknown. In the current study, we surveyed patients from hand surgery practices to describe patient preferences and utilization patterns for online resources. Our hypothesis is patients utilize resources that are not reliable or published by physicians, potentially complicating their understanding of their diagnosis and treatment options.

Methods
From October 2015 to June 2016, we enrolled patients presenting to four orthopaedic hand surgeons at Rush University and Washington University in St. Louis. Patients completed a survey, with questions related to their preference for learning about their diagnosis and internet utilization both before and after the visit. Descriptive statistics were tabulated after compilation of the survey data. Due to the exploratory nature of the study design with a lack of data to allow a more formal analysis, we did not conduct any comparative/inferential statistical analysis.

Results
A total of 226 patients were enrolled in the study. 45% of the patients had done online research prior to the office visit. 81% preferred to learn about their diagnosis through verbal communication, as opposed to only 8% who listed website information. 50% indicated that there was a greater than 50% chance or they would definitely seek additional information on the Internet after the office visit. When asked to choose from a list of websites to visit, the most popular website was WebMD, followed by the Mayo Clinic website. Specialty society websites (ASSH and AAOS) were less popular.
Summary Points

- This survey-based study found that a majority of patients utilize the Internet both before and after the office visit, however they often utilize unregulated sites for information.
- Over 80% of patients in our survey indicated that their preferred means of learning about their diagnosis is from a physician, with less than 10% selecting a website as their preferred method, suggesting that patients are more likely to rely on the information given to them by their physician and use online resources as a supplement.
- Information gained from this research and can help physicians guide patients to high quality websites for information on their clinical diagnosis and treatment, improving the doctor-patient shared decision making and ultimate satisfaction and outcomes.

Bibliography

Poster 404: The Touch Surgery™ App: Analysis of Surgical Simulation Validity and Training Potential

Category: Miscellaneous

Surgical Technique; Residents/Fellow/Educator Resources
N/A - not a clinical study

Asif Ilyas, MD
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Drew Park
Joseph Labrum

COI
Royalty: Jaypee Medical Publishers
Consulting Fee: Globus
Speakers Bureau: Depuy Synthes

Hypothesis
Surgical training has been historically built upon extensive patient-based exposure in the operating room under the apprenticeship model. With recent limitations in post-graduate training hours as well as heightened focus on operating room efficiency and patient safety, there exists a need to supplement surgical education with surgical simulation. Touch Surgery™ is an interactive, smart device application (app) that aims to provide a realistic, cognitive motor skill simulation and surgical step rehearsal based on technique and sequential steps that are hallmarks of a given surgical intervention. The primary aim of this study was to assess program validity, content authenticity, training potential, and user satisfaction of the Carpal Tunnel Surgery Phase 2: Carpal Tunnel Release Touch Surgery™ (CTR) module and the Tension Band Wire for Olecranon Fracture Touch Surgery™ (TBW) module.

Methods
Eighteen novices, twelve intermediates and five experts were recruited to complete two separate simulation modules: CTR and TBW. All participants with prior experience with Touch Surgery™ were excluded. All participants then carried out Touch Surgery module learn and test simulations in a standardized fashion. Participants completed the CTR and TBW modules 3 consecutive times. All study participants carried out the study modules on standard iPad™ tablets to ensure a similar operating interface. A performance score was generated after completing each module attempt. Analysis of Variance (ANOVA) was used to evaluate for significant differences in the simulation module performance.
Results
All participants demonstrated improvement in all attempts for both modules (p< 0.05). Experts outperformed both intermediates and novices in both modules. These results were significant for all modules (p< 0.05) except for the final two attempts of the TBW module. When combining novice and intermediate, expert results were significant for all attempts at the TBW module (p <0.05). All participants agreed on the utility for surgical training and learning new operations. Both intermediates and experts agreed that the procedural steps were realistic. All participants agreed that the simulation module should be made available to all surgical trainees.

Summary Points
All participants demonstrated improvement with their simulation module scores over all attempts. Comparatively, all experts demonstrated higher scores in all attempted modules for CTR and TBW. The results of this study demonstrate that Touch Surgery™ is a valid simulation for surgical procedures that may benefit in the surgical training of medical students and residents in hand surgery.
Poster 405: Choice and proper dose of anesthetic agents for ultrasound-guided supraclavicular brachial plexus block for upper extremity surgery

Category: Miscellaneous

Surgical Technique
Level 4 Evidence

Masanori Nakayama, MD, PhD
Yu Sakuma, MD
Katsunori Ikari, MD, PhD

Hypothesis
Ultrasound-guided supraclavicular brachial plexus block is now popular and effective analgesia for upper extremity surgery but there is no specific consensus about choice and dose of anesthetic agents. The aim of this study was to investigate an appropriate choice and dose of anesthetic agents for supraclavicular brachial plexus block for upper extremity surgery.

Methods
We reviewed our cases that underwent upper extremity (hand, wrist, forearm and elbow) surgery under only ultrasound-guided supraclavicular brachial plexus block in our hospital between 2011 and 2016. Adverse events during surgery were evaluated including the addition of local anesthesia on the surgical site, the incidence of tourniquet pain, the administration of intraoperative opioid and the incidence of low SpO2 or local anesthetic poisoning. Additionally, we constructed receiver operating characteristic (ROC) curves to investigate the relationship between the time from block onset to skin incision and the addition of local anesthesia on the surgical site.

Results
There were 225 patients included who received 1% lidocaine (L) and 0.75% ropivacaine (R) in combination. Patients were divided into three groups according to their anesthetic agents: group 1) n=62, L10ml+R20ml; group 2) n=93, L20ml+R10ml; and group 3) n=70, L10ml+R15ml. There was no statistic deviation about age, sex, body weight, surgical site and operation time (Table 1). The incidence of the addition of local anesthesia on the surgical site was significantly higher in group 3 than in the other two groups, but there was no significant difference between groups 1 and 2. There were no significant differences in the other evaluated items among the three groups; however, low SpO2 and local anesthetic poisoning were slightly more frequent in group 2 (Table 2). ROC curve analysis indicated that 24 or more minutes from block onset to skin incision might reduce the incidence of the addition of local anesthesia.
Summary Points

- According to our result, the total volume of anesthetic agents had an important influence on the incidence of the addition of local anesthesia for surgical pain.
- The combined dose of agents did not influence the evaluation items, but less lidocaine seemed to be better because some adverse events were slightly frequent in group 2.
- For effective analgesia, 24 or more minutes should elapse from block onset to skin incision.

Bibliography


Images
Poster 406: Physical and Occupational Therapy Use and Cost Among Common Upper Limb Procedures

Category: Miscellaneous

Evaluation/Diagnosis; Treatment; Surgical Technique

Level 3 Evidence

Steven Zhang, BA
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Kevin Li

Hypothesis
Use of physical (PT) and occupational therapy (OT) depends on evidentiary support, surgeon preference, and availability. Various rehabilitation techniques can be used following hand surgery, including range-of-motion exercises, heat and cold treatments, and strengthening exercises. Effectiveness of these interventions continues to be studied and high-level evidence supporting their use is limited. We conducted a retrospective review of PT and OT use for post-surgical treatment of carpal tunnel syndrome, DeQuervain’s release, trigger finger release, carpometacarpal (CMC) arthritis surgery, wrist ganglion excision, and fixation of distal radius fractures. We describe the use of postoperative PT and OT for four common hand pathologies and their costs, and geographic and temporal variation.

Methods
We conducted a retrospective review using a private-payer database of 16 million payers examining data on demographic distribution, diagnoses, procedures, and reimbursement fees from years 2007 to 2014. Patients were identified by records with CPT and ICD-9 codes referring to procedures and diagnoses of interest. To determine whether patients underwent therapy evaluation, patients must have received PT or OT within three months after undergoing a hand procedure as indicated by their respective codes. We further analyzed regional differences of average per patient cost. Within each region, cohort data were secondarily analyzed by age, sex, and year of operation.

Results
PT and OT utilization increased consistently each year. The greatest increase was in CMC arthritis, increasing 360% during the study period. There was large variation in the use of post-operative therapy. Patients who suffered distal radius fractures were most likely to enter occupational and physical therapy after surgery (15.3%) while only 5.8% of patients undergoing ganglion excision required occupational and physical therapy. Further analysis of cost revealed that these patients undergoing distal radius fractures also had the highest average PT and OT
costs at $467.54 per patient. Overall, there was variation in cost per patient undergoing PT and OT illustrated by heat map by state within the United States. Average cost of total occupational and physical therapy use revealed high levels of variation in cost by state.

Summary Points

• Patients are increasingly undergoing common upper limb procedures.
• A significant percentage of these patients will undergo PT/OT despite limited evidentiary support of their benefit in post-operative rehabilitation.
• Post-operative occupational and physical therapy use and cost of these procedures are highly varied between states by cost and may be unnecessary variation in care.

Bibliography


Images
Poster 407: Influence of Body Mass Index on Initial Patient-Reported Health Measures Using PROMIS

*Category: Miscellaneous*

Evaluation/Diagnosis
Level 2 Evidence

Jason Guattery, MS
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**Hypothesis**
Obesity is understood to independently predict postoperative complications and impair orthopaedic surgical outcomes1-5. However, it is unclear if obesity influences initial patient reported health measures at presentation for treatment. This study tested the null hypothesis that patient-reported physical function, pain interference, and mental health, quantified by PROMIS assessments, would remain consistent across BMI categories.

**Methods**
This study analyzed PROMIS Physical Function (v1.2), Pain Interference (v1.0), Depression (v1.0), and Anxiety (v1.0) scores collected at a tertiary orthopaedic surgery clinic from 4/1/2016 – 12/31/2016. PROMIS assessments are all scored to a population mean of 50 (range 0-100) with higher scores indicating more of that domain (e.g., higher scores indicate more pain interference, more depressive symptoms, but also more physical function). Only new patient visits were eligible for inclusion. Patients were categorized by BMI: Normal (BMI 18.5 – 25.0), Overweight (BMI 25.1 – 30.0), and Obese (BMI 30.1+). ANOVA analysis determined if there was a significant difference in the mean PROMIS assessment scores between BMI groups with subsequent post hoc pairwise comparisons.

**Results**
PROMIS scores were analyzed from 1598 patients. Between BMI categories, there were significant (p<0.01) differences between the average initial score for Physical Function, Pain Interference, and Depression assessments. Compared to normal and overweight BMI patients, obese patients demonstrated significantly greater pain interference and depression scores. All three groups had significantly different Physical Function scores with normal BMI patients reporting the highest perceived functioning and overweight and obese patients the lowest(Table 1). There was no significant difference in Anxiety scores between patient groups.
Summary Points

• When stratified by BMI, PROMIS scores indicate that obese patients presenting for orthopedic care experience greater pain interference, more depressive symptoms, and perceive poorer physical function than normal and overweight groups.
• While statistically significant, further study of these PROMIS assessments is necessary to determine the clinical relevance of the differences noted across BMI classes.

Bibliography
4: Werner BC, Burrus MT, Browne JA, Brockmeier SF. Superobesity (body mass index >50 kg/m2) and complications after total shoulder arthroplasty: an incremental effect of increasing body mass index. J Shoulder Elbow Surg 24(12) 2015.

Images
Hypothesis
A single pass bidirectional barbed suture repair with a running epitendinous stitch would provide adequate strength for early active range of motion protocols in zone II flexor tendon repairs1,2.

Methods
Three groups of ten flexor digitorum profundus tendons in zone II were harvested from the index, middle and ring fingers of fresh frozen cadaver specimens. Each tendon was then sectioned with a scalpel.
Group one (control): Kessler repair with horizontal mattress technique – four core strand repair.
Group two: four core strand barbed suture repair using the single pass technique with a running epitendinous suture.
Group three: six core strand barbed suture repair using the single pass technique with a running epitendinous suture.
First, using a double-armed bidirectional barbed suture, one needle is passed through the core of the distal tendon stump, exiting 10 mm from the cut edge of the tendon. The suture is pulled through just until the mid point of the suture when the barbs change direction and begin to engage the tendon. Second, the other needle is placed in a similar fashion in the proximal tendon, but it is not pulled all the way through, but allowed to remain gapped so there is sufficient space to place additional sutures. Third, the remaining sutures are placed in a similar fashion, taking care to place each suture through a different portion of the tendon to space them evenly. Fourth, while holding the suture strands exiting the proximal tendon stump, a toothless Adson forceps is used to gently bring the proximal tendon stump adjacent to the distal tendon stump for approximation of the contiguous ends. Fifth, the barbed suture ends are cut at the surface of the tendon. Sixth, a running epitendinous stitch is placed.
Dynamic tensile strength testing was performed to determine force to 2mm gap formation and force to failure, which was then recorded.
All data was compared across conditions using an ANOVA test. A Tukey post-hoc analysis was also performed where appropriate.
Results
Mean force to 2mm gap formation:
Group one (control): 48.04N (36.19-64.21)
Group two: 23.32 (16.25-34.29)
Group three: 36.81 (32.15-43.04)
Mean force to failure:
Group one (control): 51.03 (39.2-66.69)
Group two: 34.67 (27.73-48.54)
Group three: 37.02 (32.33-43.51)

Summary Points
• Single pass barbed suture technique with a running epitendinous stitch can provide sufficient strength for early active range of motion protocols after flexor tendon repair.

Bibliography
Poster 410: A Modular Approach to Designing Complex Operations: Bilateral Hand Transplantation  
*Category: Miscellaneous*

Surgical Technique; Prognosis/Outcomes; Anatomy  
Level 5 Evidence

Benjamin Chang  
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**Hypothesis**  
Bilateral hand transplantations are complex operations dependent upon well-orchestrated logistical coordination between multiple synchronous teams. Surgical checklists have been utilized to improve the culture of safe surgery. We have adopted checklists as iterative tools to streamline the procedure for bilateral hand transplantation. We present our experience combining pre-transplant surgical rehearsals with surgical checklists for bilateral hand transplantation.

**Methods**  
An interdisciplinary team consisting of plastic, orthopedic, and transplantation surgeons designed a stepwise, multifaceted checklist for all hand transplant operations performed by our team. By applying a Kaizen approach during surgical rehearsals, coordination between team members was optimized. Our checklist has been designed to incorporate all procedural elements. Separate checklists for procurement, donor preparation, recipient residual limb preparation, and transplantation were created with individual team members assigned to specific tasks. The procedures were rehearsed on fresh frozen cadavers, and the checklists modified based on lessons learned from rehearsal. During the transplants, a team-member was assigned to record the time when each task was completed, which allowed for post-surgical analysis. After each transplant, the checklist was modified to incorporate deviations from the protocol during the actual surgery to improve efficiency.

**Results**  
We have successfully performed 3 bilateral hand transplants to-date using these checklists. The operative times improved with each surgery from 11.5 hours to 10.6 to 8.5 hours.
Summary Points

- The use of checklists in VCA is essential for team success and optimal functional outcomes.
- As we gain more experience, surgical technique can become standardized for each level of hand and arm transplantation.
Poster 411: Cortical Bone Tissue Properties and the Assessment of Fracture Risk

Category: Miscellaneous

Evaluation/Diagnosis; Basic Science
Level 2 Evidence

Grant Received from: NIH/NIA 1R03AG047861

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Hypothesis
Measurement of bone mineral density (BMD) by dual-energy X-ray absorptiometry (DXA) is currently the standard for the diagnosis of osteoporosis, yet BMD does not always accurately reflect fracture risk. Recently introduced impact microindentation allows in vivo measurement of cortical bone material properties via the ‘bone material strength index’ (BMSi). The ability to use a clinical test which, in conjunction with DXA, would improve the identification of women at risk for fragility fractures would have a major impact on clinical management of osteoporosis. We hypothesize that postmenopausal women with fractures will have worse BMSi compared to non-fracture controls even after adjustment for BMD and other potential confounders.

Methods
In this cross-sectional study, postmenopausal women with recent distal radius fractures (DRF, n=49) or hip fracture (HF, n=31) were prospectively recruited and compared to non-fracture controls (CONT_DRF, n=60 and CONT_HF, n=60) of similar age. Primary outcome variables were BMD at the femoral neck (FN), total hip (TH) and lumbar spine (LS), FRAX score and BMSi measurements from the anterior tibia (Osteoprobe, ActiveLife Scientific, Santa Barbara, CA). Differences between groups were assessed by student t-test and logistic regression (odds ratio (OR) per 1 SD and 95% CI), while relationships among outcome variables were assessed using Pearson correlation coefficients.

Results
BMSi was weakly correlated with age (r=-0.17, p=0.03), femoral BMD (r=0.2, p=0.01) and FRAX (r=-0.16, p=0.03). DRF and CONT_DRF were similar in age, BMI, calcium intake, serum 1,25(OH)2 Vit D and activity level. HF were older (p=0.01), had lower BMI (p=0.02) and were less active...
(p<0.001) than CONT_HF, though calcium intake and serum 1,25(OH)2 Vit D levels were similar. Both DRF and HF had lower BMD at the LS, FN and TH than their respective control groups (p<0.05 for all) and higher FRAX score (p<0.001). Low BMD and high FRAX score were strong predictors of DRF and HF adjusting for age and BMI (THBMD: DRF OR=2.8 [1.58, 4.96] per SD decrease, p<0.001; HF OR=5.34 [1.92, 14.81], p=0.0012; FRAX: DRF OR=2.29 [1.11, 4.70], p=0.02; HF OR=4.73 [2.01, 11.15], p<0.001). BMSi adjusted for age and BMI trended toward significance (DRF OR=1.45 [0.97, 2.18], p=0.07; HF OR=1.72 [0.93, 3.19], p=0.08).

**Summary Points**

- Low BMD at the lumbar spine, femoral neck and hip are strong predictor of DRF and HF.
- High FRAX scores are strong predictors of DRF and HF.
- BMSi may be helpful in predicting DRF and HF independent of BMD.
Poster 412: Physiologic Hand Swelling Peaks in the Morning

Category: Miscellaneous

Evaluation/Diagnosis
Level 4 Evidence

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Michael Rivlin, MD

Hypothesis
The goal of the study is to quantify the amount of nocturnal hand swelling that is expected in patients without hand pathology. Our hypothesis is that hand swelling occurs at night in subjects with no known hand pathology.

Methods
We performed an evaluation of 22 volunteers with no active hand pathology. Hand volume measurements were taken daily at 8a, 2p, 8p over a three day period using the Baseline Volumetric Measuring Device. Demographic information and any previous hand pathology was recorded for each subject. Subjects were blinded to the objectives of the study. P-values were calculated using ANOVA followed by a Tukey test at a 95% confidence interval.

Results
Twenty-two volunteer subjects were enrolled. Subjects had a mean age of 38 years old (range 7-60). None of the subjects had any previously diagnosed hand pathology. Hand volume is significantly larger in the morning compared to the afternoon and evening (p<0.05). There is no significant difference between afternoon or evening.

Summary Points
- Physiologic hand swelling peaks in morning which may contradict current teaching that swelling worsens overnight.
- Further investigation is needed to elucidate the etiology of these findings and how this translates to disease processes that peak overnight.
Hypothesis
The purpose of this investigation is to examine a nationwide legal database to describe the most common reasons for malpractice litigation following carpal tunnel surgery and to assess factors contributing to a plaintiff ruling. Our hypothesis is that technical complications have a higher physician loss rate compared to litigation aimed at a non-technical complication.

Methods
This study is a retrospective analysis of the VerdictSearch (ALM Media Properties, LLC, New York, NY) database. VerdictSearch is a large legal claims database encompassing over 180,000 legal cases, catalogued from February 1988 to May 2015 (27 years). Of the 180,000 claims indexed in VerdictSearch, 22,074 represent cases of medical malpractice. The database was queried utilizing the term “carpal tunnel surgery.” All malpractice claims that occurred following carpal tunnel surgery were included. Patients of all ages were included. Cases were excluded if there was missing or incomplete information, or if they occurred following a revision carpal tunnel surgery.

Results
In total, 46 cases met inclusion criteria, representing 15 (32.6%) male and 31 (67.4%) female patients with an average age of 46.4 years (±14.7). Four cases (8.7%) resulted in settlement. Of the 42 cases that went to trial, 14 (33.3%) ended in decision in favor of the plaintiff (physician loss) and 28 (66.7%) ended in a decision in favor of the physician. The average payment for all lawsuits was $637,140.97. There was no significant difference in the average payment for cases lost in court ($329,690 ± 233,910) compared to cases that ended in settlement ($422,286 ± 388,973) (P= 0.662). The three most common causes of malpractice litigation after carpal tunnel surgery were nerve injury (n=18, 39.1%), persistent pain and numbness (n=15, 32.6%), and
regional sympathetic dystrophy (n=9, 19.6%) (Figure 1). Of the 20 cases that reported surgical technique (i.e. open vs. endoscopic), there was no difference in physician loss rate (P=0.6).

Summary Points

- The three most common causes of malpractice litigation after carpal tunnel surgery were nerve injury, persistent pain and numbness, and regional sympathetic dystrophy.
- There was no significant difference in the average payment for cases lost in court compared to cases that ended in settlement.
- Common complications of carpal tunnel release should be emphasized during the consent process in an effort to lessen the financial burden resulting from the malpractice litigation in carpal tunnel surgery.

Bibliography


Images
Hypothesis
One of the most frequent fracture types encountered are those of the distal radius. Treatment with open reduction and internal fixation (ORIF) is increasing in frequency, which represents a significant cost for the healthcare system. Using a value-driven outcomes tool, we aim to identify which treatment-, injury-, and demographic-specific factors influence surgical encounter costs for distal radius ORIF. Our null hypothesis is that no factors influence treatment cost variation.

Methods
We retrospectively reviewed all adult patients treated by orthopaedic surgeons who underwent ORIF of the distal radius between 1/1/2015 – 7/31/2016 at a single academic medical center. Those with additional injuries were excluded. Using our institution’s information technology value tools — which allow for comprehensive cost data collection and analysis on an item level basis — we calculated basic descriptive statistics and determined relative costs (RC) for the operative treatment of distal radius fractures using gamma regression analysis.

Results
Based upon 86 included patients, we determined that total cost was most influenced by implants (31%), facility utilization (24%), surgeon costs (23%), and anesthesia costs (14%) (Table 1). Factors responsible for driving variation in total direct costs are depicted in Table 2. Treatment-specific factors influencing cost variation include plate manufacturer (RC 1.60 for the most versus least expensive manufacturer), number of non-locking screws used (RC 1.09), and surgery setting (RC 1.42 for inpatient versus outpatient). Anesthesia type (general versus regional) and treating service (trauma versus hand) did not affect costs. Significant injury-specific factors include open fracture (RC 1.58 versus closed fracture) but not number of distal
radius fracture parts, simultaneous carpal tunnel release, or simultaneous treatment of distal ulna fractures. Studied demographic factors did not affect costs (age, sex, race).

Summary Points

- The cost of distal radius ORIF was most influenced by implant costs (31% of total cost, and 60% of variation in total direct costs depending on the manufacturer): this nearly equals the combined costs for the orthopaedic surgeon plus anesthesia provider.
- Open fracture, which may be confounded with inpatient status, was associated with increased costs; however other estimates of fracture severity did not affect costs.
- Cost savings for distal radius ORIF may be expected if hospital systems utilize bargaining power to reduce implant costs, by performing surgeries on an outpatient basis when medically appropriate, and by efficiently completing surgeries (every 10 minutes of additional anesthesia time increased costs by 4%).

Bibliography
Images
Poster 415: Mini C-arm Fluoroscopy: Does Its Configuration Matter for Radiation Exposure?

Category: Miscellaneous

Surgical Technique;Basic Science;Residents/Fellow/Educator Resources
N/A - not a clinical study

Talia Chapman, MD
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Hypothesis
Radiation exposure from standard large-c-arm fluoroscopy during various orthopaedic procedures has been well studied, however there is less of a consensus regarding the risk of radiation exposure from using a mini c-arm. Fluoroscopy using a mini C-arm is routinely used in Hand Surgery. Using a distal radial fracture surgery model, we examined the radiation exposure from a mini c-arm in three beam configurations and how radiation exposure varies to different body parts.

Methods
An anthropomorphic mannequin (representing the upper body of a 60” male surgeon) was seated at a hand table as if operating on a volar-plated wrist sawbone model. Thermoluminescent dosimeters measured radiation exposure to the surgeon’s eyes, thyroid, chest, hand, and groin from a mini C-arm fluoroscopy unit in three commonly-used configurations: vertical (source above table), inverted (source below table), and horizontal (with beam parallel to table surface). The fluoroscope scanned the wrist model for fifteen continuous minutes in triplicate for each orientation.

Results
Radiation to the hand was significantly greatest in all mini C-arm positions compared to all other anatomic sites irrespective of C-arm position. Hand radiation exposure was greatest in the horizontal position (2887.09 mrem), versus the vertical and inverted positions (59.79 mrem, 31.10 mrem, p<0.001). Eye radiation exposure was significantly greater in the inverted position (2.33 mrem) compared to the vertical (0.67 mrem, p=0.024), and horizontal positions (0.33 mrem, p=0.012). No significant difference in radiation exposure was found at the thyroid, chest, and groin sites, at each of the three C-arm configurations.
Summary Points

- Surgeons’ hands received on average almost 1000 times more radiation exposure, than all other sites.
- Radiation exposure of the hand was maximized in the sideways position.
- There was a small increase in eye radiation exposure with the c-arm in the inverted position compared to the vertical position.
- Surgeons should consider wearing protective equipment especially for the eyes and hands, and also consider avoiding the sideways position to minimize radiation exposure.
Poster 416: Radiation Exposure Safety Patterns Amongst Members of the American Society for Surgery of the Hand

Category: Miscellaneous

Residents/Fellow/Educator Resources
N/A - not a clinical study

Amar A. Patel
Arpan A. Patel
F. Thomas D. Kaplan, MD

Hypothesis
We hypothesize that members of the American Society for Surgery of the Hand poorly monitor their radiation exposure. Women, orthopaedic surgeons, and those with less than 10 years of experience likely best comply with radiation safety recommendations.

Methods
An online survey was sent to members of the ASSH and included 18 questions on fluoroscopy practice patterns as well as demographic information, including gender, years of experience, specialty, and geographic region. Multivariate logistic and multinomial regressions were used to determine predictors for fluoroscopy practice patterns while adjusting for these demographic factors.

Results
904 surgeons (27%) responded to the study (Table 1). The majority of surgeons preferred the mini C-arm for hand (91%) and elbow (70%) surgeries. Most did not use a personal dosimeter (70%). Forty-two percent of surgeons while using the mini C-arm did not use protective devices while only 5% of surgeons did not while using the standard C-arm. Women, surgeons with less than 10 years of experience, and responders in the western United States were the most likely to use protective devices (Table 2).

Summary Points
- Most surveyed surgeons do not properly monitor their radiation exposure, but the majority of surgeons utilize protective devices.
- Female gender, orthopaedic surgery training, less than 10 years of experience, and western United States region were identified as groups to best correlate with proper radiation safety practice.
- There has been a shift in the increased use of protective devices over the past five years.
Bibliography

Images
Poster 417: Are Opioids Necessary to Manage Post-Operative Pain after Carpal Tunnel Release Surgery? A Prospective Cohort Evaluation

Category: Miscellaneous

Treatment;Surgical Technique;Prognosis/Outcomes
Level 2 Evidence

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COI
Royalty: Jaypee Medical Publishers
Consulting Fee: Globus
Speakers Bureau: DePuy Synthes

Hypothesis
Managing postoperative pain in hand surgery is important for both patients and surgeons. However, there is growing concern over prescription opioid abuse. We hypothesized (1) that pain medications after carpal tunnel release (CTR) surgery are over-prescribed and (2) that opioids are unnecessary in the majority of patients.

Methods
We prospectively studied two demographically similar patient cohorts receiving either opioid or tramadol for CTR performed by two hand surgery fellowship-trained orthopaedic surgeons over a 1 year period. The first cohort of patients undergoing CTR received opioids pills postoperatively. The second cohort of patients received a standard prescription of 10 tramadol pills postoperatively. Student t-tests were performed to evaluate statistically significant differences between the tramadol and opioid cohorts in total pill consumption and number of postoperative days the medication was used.

Results
The opioid cohort consisted of 159 patients with a mean opioid consumption of 4.9 pills for 2.3 days. Eleven of these patients declined the use of opioids postoperatively and instead substituted for NSAIDs and/or acetaminophen. The tramadol cohort consisted of 110 patients with a mean tramadol consumption of 3.3 pills for 1.8 days. Seven of these patients requested opioids postoperatively, and 14 substituted for NSAIDs and/or acetaminophen. When comparing the postoperative consumption of opioids and tramadol for CTR, there was a statistically significant difference in total pill consumption based on both intention to treat as well as the
medication ultimately prescribed. There was no difference in the duration of postoperative utilization.

Summary Points

- Following CTR, pain medications are being over-prescribed, with patients receiving more than double the amount of pills than they consume.
- Tramadol appears to be equally effective in managing post-operative pain compared to opioids.
- We recommend prescribing less than 10 pills of either tramadol or an opioid to manage post-operative pain after primary CTR.
Patient definitions of high quality care in hand surgery: a qualitative analysis

Category: Miscellaneous

Evaluation/Diagnosis; Prognosis/Outcomes; Patient Education

N/A - not a clinical study

Nicole Sheikholeslami
Robin Kamal, MD

Hypothesis
We studied definitions of high quality care from post-operative hand patients using a grounded theory approach with the goal of identifying themes of quality that are important to patients.

Methods
We assembled a patient focus group to guide the creation of an open ended survey to study themes in high quality care. Ninety-nine patients receiving upper limb surgery at two tertiary care institutions completed the survey during their six to eight week post-operative clinic visit with an orthopedic surgeon. Two reviewers independently analyzed the open-ended survey responses using thematic analysis in a 3-step schematic: open coding, axial coding, and selective coding. We then completed a latent content analysis on the open codes.

Results
Survey responses were categorized into three overarching themes (selective codes): patient education, challenges and barriers, and goals and expectations. Within "patient education", five axial codes were identified: financial logistics, injury and surgical procedure, post-operative discomfort, functional concerns, and recovery. Within "challenges and barriers", 3 axial codes were identified: financial and logistics, function concerns, and recovery. Within "goals and expectations", another 2 axial codes were identified: functional goals and aesthetic goals.

Summary Points
- Within patient education, highest priorities were to better explain: surgical procedure, recovery timeline, and expected post-operative pain. Within challenges and barriers, greatest post-operative concerns were hindrance to daily activity and pain. Within goals and expectations, improved functionality and reduced pain were the most important factors.
- Recognizing these primary concerns allows for greater understanding of patient-defined definitions of quality which may guide patient-centered care.
Advantages of early management of P2 chondroma-related pathologic fractures by curettage and filling protected by dynamic external fixation — discussion of a case with over 3 years long term follow-up

Category: Miscellaneous

Treatment; Surgical Technique; Prognosis/Outcomes
Level 5 Evidence

Xavier Gueffier

Hypothesis
Phalangeal pathologic fractures due to chondromas are particularly unstable. Treatment involves curettage and bone grafting after consolidation of the fracture. We are reporting on a case of early management with curettage and filling protected by a dynamic external fixator subsequent to a fracture of the base of the second phalanx. The object of the study is to report on the outcome of this treatment allowing for early rehabilitation.

Methods
We were treating a chondroma-related pathologic fracture on the second phalanx base of the index finger. Pre-operative assessment included X-ray and CT scan. Curettage and cancellous bone graft filling as well as the application of a dynamic external fixator were part of the same surgical procedure. Post-operative follow-up included clinical, radiological and functional evaluation.

Results
Results of the pre-operative scan led to preferring an anterior cortical window approach for curettage and cancellous bone grafting harvested from the iliac crest. The dynamic external fixator was placed in the course of the same surgical procedure and was then retained for 33 days. Rehabilitation began immediately after the operation. Full mobility was achieved. The fracture was pronounced to be consolidated at 3 months. There
were no major complications, such as nonunion, malunion, infection or tumour recurrence.

Summary
The study demonstrates the advantages of surgical management with curettage and filling protected by a dynamic external fixator in the event of osseous chondroma fracture at the base of the second phalanx. With the placement of a dynamic external fixator, the fracture is stabilised so that early rehabilitation can prevent the tendon adhesions causing stiffness

Bibliography
Poster 420: Applying a dynamic external fixator to improve functional prognosis in chondroma-related pathologic fractures of the base of the second phalanx - Cases reports

Category: Miscellaneous

Treatment;Surgical Technique;Prognosis/Outcomes

Level 5 Evidence

Xavier Gueffier

Hypothesis
Chondroma management is complicated in the fracture or pre-fracture stages and the common procedure is to await fracture consolidation before surgical management of the chondroma. Applying a dynamic external fixator could it improve functional prognosis in chondroma-related pathologic fractures of the base of the second phalanx?

Methods
Between January 2011 and February 2013, we treated 2 patients with pathologic chondroma-related fractures of the second phalanx of long digits. Pre-operative assessment to select therapeutic action systematically included X-ray and CT scans. Post-operative follow-up included clinical examination and X-ray.

Results
Follow-up covered 13 months and 39 months. One case involved cancellous bone grafting by anterior approach together with placement of the dynamic external fixator as part of the same surgical procedure. The external fixator was removed on day 35. Full mobility was achieved at 3 months. In the other case, the dynamic external fixator was applied early so that rehabilitation could begin without delay. The bone graft (harvested from the anterior iliac crest) was performed on day 54 at the same time as the external fixator was removed. Full mobility was complete at 3 months. There were no major complications, such as nonunion, malunion, infection or tumour recurrence.

Summary Points
These cases demonstrate the possibility of using a dynamic external finger fixator for the management of second phalanx chondroma at the fracture stage. With early rehabilitation, prolonged immobilisation and resulting stiffness can be avoided.
Bibliography
Images
Poster 422: Effectiveness of a Self-Directed Microvascular Training Curriculum Utilizing Synthetic Microvessels

Category: Miscellaneous

Surgical Technique; Anatomy; Residents/Fellow/Educator Resources
N/A - not a clinical study

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Hypothesis
Acquisition of microvascular surgical skills remains a challenge for orthopedic residency programs. Hands-on experience is limited by variable exposure, a steep learning curve, and potential complications caused by failed anastomoses. Furthermore, utilization of live-animal training models can be difficult due to lack of access and high maintenance costs. The purpose of this study was to determine the effectiveness and cost of a self-directed microvascular training curriculum utilizing synthetic microvessels and non-living training models in our orthopedic residents.

Methods
Twenty-five orthopedic residents were prospectively enrolled in the study. The curriculum consisted of initially learning the basics of microsurgery on nonliving models and progressed to performing anastomoses on a synthetic 1 mm microvessel. Outcome measures included global rating scale score, patency, anastomosis time, resident comfort level with anastomoses (1-10 scale), time to complete the curriculum and utility of the curriculum (1-10 scale). Blinded qualitative assessments of pre- and post-curriculum anastomoses were made by four hand surgery faculty members (1-10 scale). Each outcome measure was obtained at baseline and post-curriculum. Cost of the curriculum was calculated as initial setup cost plus yearly maintenance cost per resident. A paired t-test was used to compare the pre- and post-intervention outcome measures.

Results
All enrolled residents (n=25) successfully completed the curriculum, ranging from PGY 1 to PGY 4 training year. Average anastomosis time significantly decreased from 40 ± 3 minutes at baseline to 22 ± 4 minutes (P<0.0001) post-curriculum. Global rating scale scores improved from 12.1±2 to 18.9±2 (P< 0.01). Patency was achieved by 36% at baseline evaluation and 96% at post-
curriculum evaluation (P < 0.0001). Resident comfort level improved from 3.1 ± 1.2 to 6.1 ± 1.7 (P < 0.0001) out of 10. Blinded qualitative anastomoses scores significantly improved (P < 0.0001) from 4.5 ± 2.2 (poor) to 8.0 ± 1.1 (good) out of 10. Average time to complete the curriculum was 5.5 ± 1.4 hours, and average utility of the curriculum was graded as 7.8 ± 1.8 out of 10. Cost of initial setup was $1700 with a yearly utilization cost per resident of $42.

Summary Points

- A self-directed curriculum utilizing synthetic microvessels and non-living models was implemented
- Orthopedic residents demonstrated significant improvements in patency, anastomosis time, GRS scores, comfort level, and anastomosis quality
- This curriculum represents minimal startup cost ($1700) and yearly cost/resident ($42) compared to traditional live animal models
- Level of Evidence: Level 2 (Prospective Cohort Study)

Bibliography
Poster 423: Postoperative Pain Control and Length of Stay with Peripheral Nerve Block Prior to Distal Radius Repair

Category: Miscellaneous

Surgical Technique; Prognosis/Outcomes
Level 4 Evidence

Pierce Johnson
Joshua William Hustedt, MD, MHS
Evan Lederman, MD
Thomas Matiski

Hypothesis
We hypothesize that peripheral nerve blocks will provide improved post operative pain control as well as shorter length of stay following distal radius repair surgery.

Methods
We performed a prospective evaluation of 82 patients undergoing distal radius fracture fixation from March to August of 2016. Other than two excluded patients, all other patients were consecutive. Patients were given either peripheral nerve block or general anesthesia. All brachial plexus nerve blocks were performed using either 0.5% Bupivacaine with or without epinephrine, or 0.5% Ropivacaine with or without epinephrine. The primary outcome measures of the study were postoperative pain scores and time to discharge from an outpatient surgical center. The effect of anesthesia type was compared with student t-tests.

Results
Patients in the nerve block group showed a statistically significant decrease in postoperative pain at discharge as well as decreased phase I and total length of stay (LOS). Postoperative pain scores in the block group showed a mean of 0.932 ± 1.981 vs no block group 3.93 ± 2.780 (mean difference of 3.0024, p < .00001). Phase I LOS showed a mean time of 37.27 ± 12.79 minutes in the block group vs 71.21 ± 33.12 minutes in the no block group (mean difference of 33.938, p < .0001). Total LOS differed between the two groups as well with a mean LOS of 72.12 ± 23.45 minutes in the nerve block group vs 109.18 ± 59.48 minutes in the no block group (mean difference of 37.068, p < .0001).

Summary Points
The group of patients that received a peripheral nerve block prior to distal radius repair showed statistically significant lower pain scores at discharge as well as shorter length of stay. Based on
these results we recommend the use of peripheral nerve blocks prior to distal radius repair for improved postoperative pain and decreased Length of stay.
Poster 424: Single-Use Sets for Volar Distal Radius Plating are Currently Less Cost Effective than Conventional Sets

Category: Miscellaneous

Level 4 Evidence

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Hypothesis
Pre-sterilized, single-use volar plate fixation sets have been purported to increase operating room efficiency and decrease the cost of plating distal radius fractures. The purpose of this study was to compare the actual cost of using a conventional set versus the projected cost of using its single-use counterpart; we hypothesized that use of single-use sets is more cost effective than conventional sets.

Methods
We retrospectively analyzed 30 consecutive cases of volar plate fixation in which conventional instruments sets were used. The actual cost of using the conventional set (including instrument processing fees) versus the projected cost of using the single-use set was calculated. Student’s t-test was used for statistical analysis with statistical significance set at p < 0.05.

Results
The mean total cost per case for the conventional set was $2,728. The sticker price for the single-use set is $2,650, which corresponds to an initial $78 cost savings. However, additional hardware was needed to supplement the single-use sets in 23 of the 30 (77%) cases. The mean cost of hardware supplementation was $282 per case. When additional hardware was included in total cost of utilizing single-use sets, the mean cost rose to $2,868, resulting in a $140 increase in cost compared to conventional sets (p < 0.05, Figure 1). In all cases requiring additional hardware, appropriate length screws were unavailable and thus necessitated the use of individually sterilized/wrapped screws. The most commonly needed supplemental screws were 18 mm locking screws followed by multi-directional screws (Table 1).

Summary Points
- As the health care agenda continues to strive for cost effectiveness, the implementation of single-use systems have begun to emerge as a means to improve operative efficiency.
• Even though a number of investigators have quantified the health care burden of distal radius fractures, implant cost in conventional versus the single-use volar plating systems for distal radius fracture management has not been studied.
• We identified that implant cost of the single-use system for volar plating of distal radius fractures of a single company is currently a less cost effective alternative to their conventional sets.
• While the sticker price of the single-use set is less than the mean charge for using a conventional set, additional screws not available in the single-use set were required in 77% of cases and consequently rendered the conventional set cheaper in 83.3% of cases.
Poster 425: Does the use of live video evaluations as part of a novel telemedicine program alter the need for transfer for management of acute hand trauma?

Category: Miscellaneous

Hypothesis
The use of video evaluation as part of the Arkansas Hand Trauma Telemedicine Program (AHTTP) will not significantly impact the need for transfer for management of acute hand injuries.

Methods
The AHTTP began on January 1, 2014 and provides continuous availability of a fellowship trained hand surgeon for telemedicine consultation of acute hand injuries. Evaluations occur in real time utilizing a tablet computer and live video from emergency rooms across Arkansas. In some cases, live video is not available and consultation occurs via telephone. Radiographs are also available for review. On call physicians make recommendations for patient care including local management, transfer for general orthopedic care, or transfer for hand specialty care.

We collected data from 2014 on the use of video evaluation versus telephone consultation. We recorded the need for transfer and the type of transfer (orthopaedic or hand surgery). A chi-squared test was used to compare the rate of transfer for video encounters and telephone consultations. Additionally, we used the chi-squared test to compare the rates of transfer for orthopaedic versus hand surgery care.

Results
A total of 298 telemedicine consultations occurred in 2014. Local care was recommended in 164 (55%) cases and transfer in 134 (45%) cases. 195 (65%) evaluations utilized video, while 103 (35%) consultation occurred via telephone. Of the 195 video evaluations, 104 (53%) were recommended for local care. The remaining 91 (47%) cases required transfer including 39 for orthopaedic and 52 for hand specialist care. 60 (58%) cases of telephone evaluation were recommended for local care, while the remaining 43 (42%) cases required transfer. 20 consults were transferred to a hand specialist, and 23 were transferred to an orthopaedist. The use of video evaluation did not significantly impact the need for transfer (p=0.42). Additionally, there
was not a significant effect on the rate of transfer for general orthopaedic or hand specialist care (p=0.25).

Summary Points

- The use of a telemedicine program can minimize unnecessary transfer for care of traumatic hand injuries. Local care was recommended for the majority of consultations.
- Communication with a fellowship trained hand surgeon by telephone or live video are both successful means at preventing unneeded transfers.
- The use of video evaluations did not alter the rate of transfer to a higher level of care for the management of acute hand injuries. Additionally, the use of live video evaluations did not decrease the rate of transfer to a hand specialist for care.
Poster 426: Preoperative PROMIS Scores Predict Postoperative Success and Failure in Patients Undergoing Elective Hand Surgery

Category: Miscellaneous

Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
Preoperative PROMIS (Physical Function [PF], Pain Interference [PI] and Depression) scores can predict who will or will not clinically improve following elective hand surgery.

Methods
PROMIS scores for patient visits to a tertiary academic hand clinic between February 2015 and October 2016 were prospectively collected. All patients undergoing elective hand surgery were identified using CPT and ICD-9, 10 codes. Only patients with initial and follow-up (= 6 months) PROMIS scores were included and randomly assigned to a derivation (n=79) or validation cohort (n=78). Receiver operating characteristic (ROC) curves were calculated for the derivation cohort to determine if preoperative PROMIS scores could predict a patient reaching the minimum clinical important difference (MCID). PROMIS PF, PI and Depression cut-off values were determined for: 1) patients who were likely to reach MCID; 2) patients who were likely to fail to reach MCID; or 3) patients who it was unclear whether they would or would not reach MCID. Chi-square analysis was then used to test whether patients categorized using the derived cut offs in the validation cohort were significantly different than chance.

Results
ROC curves demonstrated fair to moderate predictability from preoperative to postoperative PROMIS (PF: Area Under the Curve [AUC] = 0.73, p = 0.007; PI: AUC = 0.69, p = 0.004; Depression: AUC = 0.63, p = 0.049). Patients with baseline PF scores below 31.0 and PI and Depression scores above 68.2 and 62.2, respectively, reached MCID with 95%, 96% and 94% specificity, respectively. Patients with baseline PF scores above 52.1 and PI and Depression scores below 49.5 and 39.5 did not reach MCID with 94%, 93% and 96% sensitivity, respectively. When applied to the validation cohort: Baseline PF predicted (100% accuracy) 22% of patients
failing to achieve MCID (chi square p = 0.031). Baseline PI predicted (100% accuracy) 10% of patients that reached MCID (chi square p = 0.007). Baseline Depression predicted (88% accuracy) 18% of patients that failed to achieve MCID (chi square p = 0.013).

**Summary Points**

- Preoperative PROMIS scores allow surgeons to predict patients who will or will not clinically improve following elective hand surgery
- Many patients have PROMIS values within an ambiguous range, which does not allow for an accurate MCID prediction
- Patient-Reported Outcomes that capture more disease-specific findings or other patient characteristics, like self-efficacy, may clarify or help predict outcomes for patients in the ambiguous range
Poster 427: Characteristics of Patients Admitted to the Hospital for Cat Bite Injury to the Hand and Wrist

Category: Miscellaneous

Prognosis/Outcomes
Level 4 Evidence

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Hypothesis
The purpose of this study is to identify the characteristics of patients who require admission to the hospital following a cat bite injury to the hand or wrist that present to the emergency department.

Methods
We performed a retrospective chart review of one-hundred and forty-five patients who presented to the emergency department (ED) for cat bite injuries to the hand or wrist. Patient demographics, medical and social history, day of presentation, physical exam, route of antibiotic therapy, whether or not irrigation and debridement (I & D) was performed in the ED, examination findings, laboratory values, and length of stay were collected. The data was analyzed to evaluate differences between patient’s admitted to the hospital versus discharged home.

Results
Seventy-five of the one-hundred and forty-five patients (51.7%) were admitted to the hospital. Of patients admitted to the hospital 36% had failed oral antibiotics compared to just 6% of patients that were discharged to home (p 0.001). Admitted patients were found to be significantly older and presented to the hospital in a delayed fashion. Physical exam findings including swelling and lymphangitis were found to increase a patient’s risk of hospitalization, 3.6 and 1.7 times respectively (Figure 1). Similarly, admitted patients had significantly higher WBC count. No differences between admitted and discharged patients were found in regards to location of bite, history of smoking, or diabetes mellitus (Table 1).

Fourty-five of the 75 patients admitted (60%) underwent I & D. Forty percent (n=30) of patients underwent I & D in the emergency department, whereas the remaining 20% (n= 15) were performed in the operating room. Five patients (n=5) that underwent a procedure in the emergency department required an additional intervention in the operating room. Patients
undergoing an I & D prior to admission were found to be significantly older than patients admitted for antibiotic therapy alone (p=0.039). There was a trend for increased length of stay for patients undergoing an I & D, however this was not found to be statistically significant (p=0.07).

Summary Points
- Cat bites to the upper extremity are serious injuries with roughly 50% of patients presenting to the ED requiring admission.
- Older age, delayed presentation and physical exam findings increase a patient’s need for hospital admission.
- There are certain patient characteristics associated with admission, however, these characteristics do not appear to influence the decision to perform an I & D in the ED.
Poster 428: Patient Perceptions of Fluoroscopy in the Outpatient Hand Clinic Setting

Category: Miscellaneous

Evaluation/Diagnosis; Patient Education
N/A - not a clinical study

Patrick K. O'Callaghan

Hypothesis
Fluoroscopy has become a commonly used imaging modality in clinics, especially with advancements in technology providing improved image quality. The hypothesis of this study is that patient perceptions of live fluoroscopy are more positive than traditional radiographs, when comparing efficiency, time, radiation and patient understanding.

Methods
A short survey was prepared and given to patients that had undergone both traditional radiographs and in-room fluoroscopy as part of their care to assess their perceptions of the two different type of imaging modalities.

Results
There was an overwhelming trend to patients preferring fluoroscopy in clinic over formal radiographs. Patients enjoyed seeing their radiographs more on the live fluoroscopy 80% of the time, compared to 4.4% of formal radiographs. Patients understood their diagnosis better after fluoroscopy 73.3% of the time, compared to 6.7% of radiograph patients. The perceived wait time was less with fluoroscopy, with 86.6% saying they waited under 5 minutes, compared to 72.7% of patients with radiographs waiting longer than 5 minutes, including 13.6% who waited longer than 20 minutes. Patients felt care was more efficient with fluoroscopy 79.5% of the time, compared to 4.5% of radiograph patients. Patients thought they were exposed to more radiation with radiographs 56.8%, of the time compared to 11.4% of fluoroscopy patients. Finally, 84.4% of patients said they would prefer fluoroscopy for future imaging, and 2.2% patients preferring future radiographs.

Summary Points
- Our data shows that given the choice, patients prefer in-room fluoroscopy over radiographs.
- Patients felt the clinic ran more efficiently, understood their diagnosis better, and spent less time waiting.
- Given our results in combination with recent research on cost effectiveness, efficiency and patient safety of fluoroscopy, we would recommend using live fluoroscopy when possible for patient imaging.

**Bibliography**

1: Gieroba, T; Bain, G; Cundy, P; Review of the Clinical Use of Fluoroscopy in Hand Surgery. Hand Surg. 20, 228 (2015). DOI


Images
Poster 429: The Effectiveness of Cryotherapy over Plaster Splints after Hand and Wrist Surgery on Reducing Pain and Skin Temperature

Category: Miscellaneous

Hypothesis
The objective is to evaluate the effect of cryotherapy on postoperative pain as measured by the visual analog scale (VAS) and narcotic requirement as well as skin temperature changes under plaster splints after hand and wrist surgery. We hypothesize that applying ice packs over splints postoperatively will not have a significant difference in patient pain and skin heat exposure.

Methods
This is a prospective, randomized, controlled clinical study. Eligible patients undergo hand and wrist surgery with this study’s attending surgeons and will subsequently recover in a wrist or thumb spica splint. Temperature probes are placed on the volar and dorsal wrist near the incision. Skin temperature is recorded every minute for 60 minutes. Two initial readings are recorded before splinting. Then a standardized splint is applied, and ice is placed over the splint per subject randomization into control and experimental groups. VAS rating is obtained every 15 minutes with narcotics administration as indicated. Total energy exposure is calculated for each group. Simple t-test is used for statistical analysis.

Results
The cryotherapy group had a lower skin temperature during the study period compared to the controls. Before splinting, the side of wrist to be splinted had average temperatures of 32.40°C and 34.13°C and reached maximum temperatures of 38.98°C and 36.38°C in the control and experimental groups, respectively. The control group’s temperature did not return to baseline within 60 minutes. The cryotherapy group reached baseline temperatures 33 minutes after splinting and decreased to an average minimum of 31.88°C. The control wrist was exposed to 48.24 calories of heat while the experimental group lost -3.57 calories for a difference of 51.81 calories. The ice group had a mean VAS of 5 and mean oral morphine equivalent dose of 3.92mg while the control group had a mean VAS of 1 and no narcotic was administered in PACU.
Summary Points

- The cryotherapy group experienced lower minimum and maximum temperatures after splinting than the control group.
- Although not statistically significant given the study groups’ small size, the overall temperature difference between the groups is reflected by their large heat exposure difference.
- Interpretation of pain parameters requires more data due to an outlier in the experimental group that may have skewed preliminary results.
- Information regarding cryotherapy’s effect on skin temperature under splints and postoperative outcomes will help establish an evidence-based protocol that specifies cryotherapy delivery modes and application duration to maximize its benefits as a treatment modality.

Bibliography

Hypothesis
Although carpal tunnel release (CTR) has routinely excellent outcomes, complications from this procedure can be devastating and litigation is a likely outcome in some of these cases. The purpose of this study was to investigate malpractice suits following carpal tunnel release and to examine factors related to legal outcomes.

Methods
The WestLaw legal database was searched for malpractice litigation related to CTR. Only suits directly related to elective CTR were included in this study. Jury verdicts and settlement reports were reviewed to determine geographic and yearly trends, case liability, plaintiff and defendant demographics, defendant training, alleged injury and cause, case outcomes, awards and settlements.

Results
The search identified 92 cases between 1986 and 2016; only 7 suits were related to endoscopic CTR. Cases were distributed with greater frequency in more populous states. Plaintiffs were predominantly female (71%) with a mean age of 45, which is consistent with reported epidemiology. Orthopaedic surgeons were the most common defendants (73%); only 27% of all defendants were fellowship-trained in hand surgery. The majority of cases were found in favor of the defendant (66%). Monetary awards were granted in 25 cases (27%). Plaintiff awards averaged $305,923 (range = $12,000 - 1,338,147). Liability was most commonly attributed to surgeon negligence (80%) with damages suffered from median nerve injury (60%).

Summary Points
• Although median nerve injury is a rare, known complication of CTR, it is the most common reason for litigation against surgeons in this procedure.
• Successful plaintiffs were able to demonstrate breach in standard of care resulting from surgeon negligence.
- Plaintiff damages following median nerve injury are significant, and the resulting awards from jury verdicts are substantial.
- The large majority of defendants in CTR litigation did not have hand surgery fellowship training.
- The sample of cases in this series reflects demographic and epidemiological trends for carpal tunnel syndrome and CTR procedures.
Poster 431: Effects of Intra versus Extra-articular Corticosteroid Injections on Blood Glucose in Diabetic Patients

*Category: Miscellaneous*

Evaluation/Diagnosis; Treatment; Patient Education

Level 3 Evidence

Jonathan Twu, MD
Neil Patel
Megan Conti Mica, MD

**Hypothesis**

Literature has shown significant elevation in the blood glucose of diabetic patients after corticosteroid injections in the first one to four days post-injection creating a bias in treatment algorithms for diabetics. However, there is a paucity of literature comparing the effect of intra-articular and extra-articular injections on glucose elevation. We hypothesize that intra-articular and extra-articular corticosteroid injections will not affect the length or amount of glucose elevation in diabetics.

**Methods**

49 diabetic patients that required single corticosteroid injections were enrolled from orthopaedic clinics at our center. Injection mixtures included triamcinolone in a standardized formula. After obtaining consent, patients were provided with a standardized glucometer and educated on how to measure one fasting and one post-prandial blood glucose for 14 days following their injection. Blood glucose measurements were obtained through telephone calls from a research assistant. The control blood glucose was measured using the median fasting and post-prandial blood glucose days 10 through 14. Median blood glucose from days 1 through 7 were compared to controls. Intra-articular and extra-articular injections were separated into groups. Intra-articular injections (Group 1) included shoulder glenohumeral injections and knee injections. Extra-articular injections (Group 2) included trigger finger, tendon sheath injections, elbow injections and subacromial shoulder injections. Data was analyzed utilizing T-Test statistics.

**Results**

Group 1 consisted of 24 patients undergoing single intra-articular injections consisting of 40 mg of triamcinolone. Group 2 consisted of 25 patients who received a single extra-articular corticosteroid injection with an average of 16 mg of triamcinolone. Injection details and patient demographics are summarized in table 1. A significant elevation was seen in the fasting blood glucose on post injection day 1 (59.5 mg/dL +/- 70.0, p = .0003) and 2 (24.1 mg/dL +/- 33.8,
p=.002) of intra-articular injections compared to baseline. A significant elevation was seen in the post-prandial blood glucose on post injection day 1 (31.6 mg/dL ± 57.9, p = .01) and 2 (16.9 mg/dL ± 39.1, p=.04) of intra-articular injections compared to baseline. There was no significant increase in extra-articular fasting or post-prandial blood glucose on any post injection day. (Figure 1).

**Summary Points**

- Intra-articular corticosteroid injections showed significant elevations in fasting and post-prandial blood glucose on post injection day 1 and 2
- Extra-articular corticosteroid injections did not cause significant elevations in fasting or post-prandial blood glucose.
- When counseling diabetic patients following corticosteroid injections, patients given intra-articular injections should be counseled regarding short term blood glucose elevation.

**Bibliography**


Images
Poster 432: The Effect of Multiple Corticosteroid Injections on Blood Glucose in Diabetic Patients

Category: Miscellaneous

Treatment; Prognosis/Outcomes; Patient Education

Level 4 Evidence

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Megan Conti Mica, MD

Hypothesis

Studies have shown elevation of blood glucose levels after corticosteroid injections in diabetic patients. However, there are no data about the effects of multiple corticosteroid injections on blood glucose levels. We hypothesized that multiple corticosteroid injections would not affect the length or amplitude of increase in blood glucose following corticosteroid injections.

Methods

Eleven diabetic patients that required multiple corticosteroid injections during a single clinic visit were recruited from hand and upper extremity clinics at our institution. Injection mixtures included triamcinolone in a standardized formula. Consented patients were provided with a standardized glucometer and educated on how to measure one fasting and one post-prandial blood glucose for 14 days following their injection. Blood glucose measurements were obtained through telephone calls from a research assistant. The control blood glucose was measured using the median fasting and post-prandial blood glucose days 10 through 14. Median blood glucose from days 1 through 7 were compared to the control. Data was analyzed utilizing T-tests statistics.

Results

The cohort included 11 type II diabetics, made up of 4 men and 7 women, the mean patient age was 66. The mean BMI of patients was 33.8. Patients were predominantly black (73%). 100% of patients were type 2 diabetics. The mean hemoglobin A1C was 7.58. Patient’s predominant control method was with medications (64%). Metformin was the most common medication used. All patients had type 2 diabetes. 9 patients had 2 injections and 2 patients had 3 injections. The median triamcinolone received was 50 mg with amounts ranging from 10-80 mg. A significant elevation was not seen in fasting blood glucose on any post injection day. (Figure 1). A significant increase (33.4 mg/dL +/- 43.9, p=.03) was seen in post-prandial blood glucose on post injection day 1 but then became insignificant. (Figure 1) The total amount of triamcinolone given and location of injection did not affect the elevation in blood glucose significantly.
Summary Points

- Multiple corticosteroid injections resulted in significant elevations in post-prandial glucose on post injection day 1 but was insignificant on post injection days 2-7.
- Multiple corticosteroid injections did not cause a significant increase in fasting blood glucose.
- There is no difference on the effect of blood glucose in giving one versus multiple corticosteroid injections in a single clinical encounter.

Bibliography