RF E-POSTER 01: Surgical Outcomes of the Arthroscopic Reduction Association of the Scapholunate (ARASL) Technique

Category: Arthroscopy  
Keyword: Wrist  
Level 4 Evidence

♦ Sara M. Guerra, MD  
♦ Michael R. Hausman, MD  
♦ Steven Koehler, MD

Hypothesis: There are multiple surgical methods used to treat scapholunate interosseous ligament tears however none have been demonstrated as a superior technique. Arthroscopically assisted reduction association of scapholunate (RASL) injuries is an acceptable procedure for patients with scapholunate ligament tears.

Methods: Between 1999 and 2013, a single surgeon treated thirty-three patients with traumatic scapholunate injuries with the arthroscopically assisted RASL technique. This technique was described in a previous publication by Aviles et al. Post operative measurements such as the DASH, range of motion, grip strength, carpal height, scapholunate separation, and follow up time were obtained.

Results: The majority of patients in this study were male with an average age of 57 years. The dominant wrist was involved in the majority of patients. The mean follow up time is 58 months. The average range of motion arc was 105 degrees, a scapholunate gap of 3.8mm, and a carpal height of 1.4. The DASH score was 23 (3.4-70). Removal of hardware was required in two patients. A windshield wiper effect was evident in two patients causing destruction of the remaining scaphoid and lunate.

Summary:  
- This is the largest conducted study exploring the surgical outcomes of the arthroscopically assisted RASL for scapholunate ligament injuries.  
- A follow up time of 58 months is the longest reported.  
- This technique is considered technically challenging however provides a minimally invasive method to repair the scapholunate ligament.  
- The windshield wiper effect and gapping are what lead to symptomatic failure.  
- Most failures are explainable by technical errors however a few have inexplicable reasons for such outcomes.  
- Most patients obtained satisfactory pain relief from this procedure.

References:


Hypothesis: The osteochondral autograft transfer system procedure (OATS) has been described for osteochondral defects. We hypothesize that this procedure can be used for articular defects in the hand and wrist, with adequate functional results.

Methods: We performed a retrospective chart review of four male patients from May 2010 until February 2011 who had an OATS procedure for an articular defect of their hand or wrist. The average age was 30 years old and all had failed months of conservative management. The patients’ injuries consisted of osteochondral defects in two proximal lunates, a proximal scaphoid, and an index metacarpal head. Outcome variables consisted of four month postoperative grip strength, range of motion, time to return to normal activity, and radiographic evidence of osteochondral plug in-growth.

Results: The average time from injury to surgery was 29 months, with an average follow-up of 5 months. Using our technique, we had no significant complications. The average gain of wrist motion was 6°, with grip strength gaining an average of 18 PSI. Radiographic evidence of graft position and an improved articular surface was seen in all the cases by final follow-up. Every patient was happy with their result and would do it over again. All patients returned to their daily activities, including minor league baseball, golfing, and ice hockey.

Summary:
- We recommend using this procedure in young, active patients with osteochondral defects of the hand and wrist.
- The OATS is a technically demanding procedure, but is a good first-line treatment option of focal osteochondral defects in higher demand individuals.
- It incorporates hyaline cartilage into the defect, with capabilities for regrowth and regeneration.
- As opposed to the fibrocartilage regrowth seen in microfracture surgery, hyaline cartilage is biomechanically superior as a tissue for the articular surface.
A successful outcome after maintaining a congruent articular surface may be achieved if the graft incorporates and a motivated patient is able to complete an appropriate course of occupational hand therapy.

References:

Consulting fees: Biomet, Auxilium, SBi, Arthrex
♦ Nothing of financial value to disclose
RF E-POSTER 03: The Effect of Latrogenic Osteochondral Defects of the Scaphoid on Scaphotrapezial Contact Biomechanics

Category: Arthritis
Keyword: Wrist
Not a clinical study

Byung J. Lee, MD
♦ Sarath Koruprolu, BS
♦ Ryan Rich
♦ David Paller, MS
♦ Arnold-Peter C. Weiss, MD

Hypothesis: Long term clinical studies suggest that patients who undergo internal fixation of nondisplaced scaphoid fractures may be at an elevated risk for developing arthritis compared to patients treated nonoperatively. As fracture fixation often requires drilling through the articular surface of the scaphoid to pass the implant, this osteochondral defect may contribute to the development of degenerative changes in the joint. This investigation seeks to evaluate the effect that this surgically created osteochondral defect has on the contact pressures between the scaphoid and trapezium.

Methods: Six fresh frozen cadaveric carpal specimens were utilized for this study. Following dissection, the trapezium and scaphoid were potted to allow for controlled load transfer between the bones. A load cell and displacement transducer was utilized to load 20N of compressive force from the trapezium to the scaphoid. Dynamic data capture using a Tekscan sensor facilitated the analysis of peak pressure, mean pressure and contact area. Following the collection of intact baseline measurements, the process was repeated following the drilling of a 2.5mm, 3.5mm and 4.5mm hole through the distal scaphoid.

Results: The contact area for the intact specimens between the scaphotrapezial joint was 64.7 mm² ± 11.7 mm². The contact area decreased in specimens with 3.5 mm (58.6 ± 12.7 mm², p=0.007) and 4.5 mm (53.7 ± 10.0 mm², p<0.001) holes when compared to intact specimens. The mean contact pressure increased with 3.5 mm (0.35 ± 0.07 MPa, p=0.011) and 4.5 mm (0.39 ± 0.07 MPa, p<0.001) holes when compared to intact specimens (0.32 ± 0.05 MPa). The peak contact pressure was greater in the specimens with 4.5 mm holes (1.54 ± 0.44 MPa, p=0.010) than in the intact (1.11 ± 0.16 MPa) specimens.

Summary:
• There is a decrease in scaphotrapezial contact area and concomitant increase in mean contact pressure with osteochondral defects in the distal scaphoid which are 3.5 mm or greater.
• The scaphotrapezial peak contact pressure is significantly greater with osteochondral defects greater than 4.5 mm in size.
• Increases in contact pressures following the creation of iatrogenic osteochondral defects in the distal scaphoid may contribute to scaphotrapezial arthritis following fixation of scaphoid fractures.

References:

• Contracted research: AFSH Basic Science Grant (Lee); NIH (Weiss)
• Royalties/Honoraria: DePuy, Extremity Medical, Medartis (Weiss)
• Consulting fees: Articulinx (Weiss)
• Intellectual property rights/patent holder: DePuy, Integra LifeSciences, IlluminOss medical, Osteospring Medical, Medartis (Weiss)
♦ Nothing of financial value to disclose
Hypothesis: Disabling joint contractures and painful dorsal ulcers of the proximal interphalangeal (PIP) and metacarpophalangeal (MP) joints are characteristic and major sources of functional impairment for those afflicted with dSSc. This study analyzes the long term results of articular reconstruction, employing both PIP arthrodesis and MP implant arthroplasty, for a select group of scleroderma patients with disabling joint deformity.

Methods: Assessment included eighty patients with scleroderma demonstrating severe PIP flexion deformity and MP extension deformity that required surgical reconstruction. Prerequisites for hand surgery were optimal medical management and a quiescent or stable disease process. The study group included 75 women and 5 men, with an average age of 41 years (range, 26-68 years). Mean duration from disease onset to surgery was 5.7 years; mean follow up period was 7.25 years (range, 3-23 years). 266 joints were reconstructed: 221 by PIP joint arthrodesis, and 45 by MP joint silicone implant arthroplasty. Staged reconstruction with the arthrodeses followed by arthroplasties was used in select cases to enhance digital mobility, grip, and pinch. Dorsal ulcers, when present, were excised and resurfaced with local advancement flaps.

Results: Despite typically compromised microcirculation and a paucity of both bone stock and soft tissues, solid PIP arthrodesis was achieved in 203 (92%) of the cases, with an average time of 8 weeks to union. Following implant arthroplasty, active MP motion averaged 52°, and, on follow up as long as 15 years, radiographs demonstrated a variable degree of implant wear, but no evidence of implant failure. Wound healing was consistently achieved over a period of 4.4 weeks, by either primary or secondary intention.

Summary:
- The results of this study indicate that for select cases of dSSc hand deformity, staged articular reconstruction is a predictable method of alleviating pain, preventing tissue loss, improving function, enhancing aesthetics and achieving patient satisfaction.
- PIP joint arthrodesis is a successful solution for correction of the characteristic flexion deformity of dSSc.
- MP joint arthroplasty, staged after PIP arthrodesis, improves digital motion and hand function.
- Based on the consistent soft tissue and bony healing demonstrated in this series, hand surgery should be considered a key component of treatment for patients with dSSc.

♦ Nothing of financial value to disclose
RF E-POSTER 05: Bicolumnar Intercarpal Arthrodesis: Minimum Two-Year Follow-Up

Category: Arthritis
Keyword: Wrist
Level 4 Evidence

♦ Reid W. Draeger, MD
♦ Donald K. Bynum, Jr., MD
♦ J. Megan Patterson, MD

Hypothesis: Bicolumnar arthrodesis, a modification of traditional scaphoid excision and four-corner arthrodesis, sparing the lunato-triquetral and capito-hamate joints for SNAC-wrist and SLAC-wrist will yield results similar to those previously reported for scaphoid excision with four-corner arthrodesis and is technically easier to perform.

Methods: Bicolumnar fusion was performed on 16 patients by the senior author between 2007-2010. This technical modification greatly simplifies operative technique while preserving normal lunato-triquetral and capito-hamate joint anatomy. These 16 patients were retrospectively identified and contacted. Eleven patients were able to return for a follow-up evaluation, which included measurement of operative and contralateral control wrist flexion, extension, and grip strength, and completion of a patient-reported outcomes questionnaire, visual analog scale (VAS) pain assessment, and Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire. Radiographs of each patient were reviewed for evidence of union. Complications including nonunion and hardware migration were recorded.

Results: The average patient age was 57 years. The average follow-up was 40 months (range 25-59 months). Wrist flexion-extension in the operative wrist was 68% of the contralateral control wrist (p=0.05). No significant difference was found between the operative and contralateral wrist in grip strength, with grip strength of the operative wrist at 97% of the contralateral wrist (p=0.35). Mean current pain at rest on a 10-point VAS scale was 1.8±2.4. Mean DASH score was found to be 16.9±19.8. All patients employed pre-operatively returned to their job post-operatively. All 11 patients had radiographic bicolumnar union (capito-lunate and triquetral-hamate) with eight patients having union of the capito-hamate joint. (Figure 1) One patient required capito-lunate screw removal for migration, though this patient did have evidence of union. Differences between wrist range-of-motion and grip strength in the operative and contralateral control wrist were compared using Student’s t-test. An alpha value of 0.05 was considered significant. Comparison to historic four corner arthrodesis controls showed similar flexion-extension arc range-of-motion and possibly greater grip strength. (Table 1).

Summary:
• Results from scaphoid excision and bicolumnar intercarpal arthrodesis sparing the lunatotriquetral and capito-hamate joints are comparable to those reported for traditional scaphoid excision and four-corner arthrodesis, with a similar loss of wrist range-of-motion and with possible preservation of more grip strength in the operative wrist.

• Advantages of this modification include preservation of the normal anatomic relationships at the lunato-triquetral and capito-hamate joints and simplification of operative technique.

! Nothing of financial value to disclose
RF E-POSTER 06: Arthroscopic Trapeziectomy with Suture Button Suspensioplasty: Moving from an Open to an Arthroscopic Surgery for All Stages of Symptomatic Carpo-metacarpal Arthritis

Category: Arthritis  
Keyword: Hand  
Level 4 Evidence

♦ Genevieve Landes, MD  
♦ Abdo Bachoura, MD  
♦ Sidney M. Jacoby, MD  
♦ A. Lee Osterman, MD  
♦ Randall W. Culp, MD

Hypothesis: Arthroscopic trapeziectomy with button suspensioplasty (ATBS) for all stages of symptomatic thumb osteoarthritis is a safe, minimally invasive technique that achieves acceptable results in terms of pain relief and post-operative pinch strength.

Methods: All charts of patients consecutively treated with partial or complete ATBS at one surgical center, from January 2010 to December 2012, were retrospectively reviewed. One senior hand surgeon performed all cases. Descriptive analyses were computed. Preoperative and postoperative key pinch strength were compared using a paired t-test.

Results: One hundred fifty-seven cases of ATBS were performed in 145 patients; 16 had both thumbs treated. Ninety-seven cases involved arthroscopic hemitrapeziectomies and 60 involved complete arthroscopic trapeziectomies. In 89 cases the right thumb was affected, while the left thumb was affected in 68 cases. There were 41 males and 104 females with a mean age of 60 (range, 43-90 years). Thirty seven percent of the cases were graded as stage IV, 50% as stage III, and 13% as stage II base of thumb arthritis. The median follow-up duration was 14 weeks. One hundred and thirty two cases with pinch strength data more than 8 weeks after surgery were analyzed. The mean preoperative key pinch strength of the affected over the unaffected side was 92 % pre-operatively compared to 95% post-operatively, p=0.77. The median of the delay between the 2 procedures was 6 months (range, 0-29 months). Revision arthroplasty was required in 4 out of 157 cases due to the progression of disease with involvement of the triscaphe joint. All other patients experienced improvements in pain and were satisfied with treatment. No postoperative carpo-metacarpal (CMC) instability was noticed. Two post-operative complications developed (1.3%): one patient presented with osteomyelitis of the 1st and 2nd metacarpal bones and the Tightrope® (TR) was removed 6 weeks post-operatively. In the second case, 10 months post-operatively, the button was found to be too prominent over her 2nd metacarpal dorsally and the TR was removed without any further complications.
Summary:
- ATBS is a promising, novel minimally invasive procedure used to treat symptomatic thumb CMC arthritis of all stages.
- ATBS is associated with maintenance of pinch strength, joint stability, pain relief and satisfaction.
- Longer-term follow up will be necessary to evaluate the longevity of this procedure.
- Ongoing studies are in progress looking at the cost-effectiveness of this procedure as it relates to operative time, recovery period and return to work.

References:
• Contracted research: Auxilium (Osterman)
• Royalties/Honoraria: Elsevier (Osterman)
• Consulting fees: Biomet, Auxilium, SBi, Arthrex (Culp); Medartis, Auxilium, Arthrex (Osterman)
• Intellectual property rights/patent holder: Medartis, Biomet (Osterman)
• Nothing of financial value to disclose
Hypothesis: A relatively novel surgical treatment option for end-stage wrist arthritis is distal radius hemiarthroplasty combined with proximal row carpectomy (PRC). Patients who desire more motion during physical activity but would otherwise undergo total wrist fusion or total wrist arthroplasty may be appropriate candidates for this procedure. Our previous experience using a distal radius component lined with a polyethylene bearing surface revealed high complication rates, in part due to aseptic loosening. In this report, we present our outcomes using an all-metal distal radius component.

Methods: A retrospective chart review was completed for 26 patients who underwent primary wrist hemiarthroplasty combined with PRC or revision hemiarthroplasty using the metallic distal radial component of the Re-Motion prosthesis (Small Bone Innovations, Morrisville, PA). 7 patients were excluded either due to follow up less than 6 months or previous wrist hemiarthroplasty. There were 11 males and 8 females, with a mean age of 63 years (range, 50-81) at the time of surgery. Specific diagnoses included scapholunate advanced collapse n=9, scaphoid non-union advanced collapse n=2, inflammatory arthritis n= 3, post-traumatic arthritis n=5. Preoperative wrist flexion, extension and grip strength were compared to the postoperative values. Radiographic findings and complications were noted. The Patient Rated Wrist Evaluation (PRWE) was obtained. A paired t-test was used and statistical significance was set at p <0.05.

Results: The mean clinical follow up duration was 1.3 years (range, 0.6-2.0). The wrist flexion-extension arc was 71º preoperatively and became 53º post-operatively, p=0.005, n=18. Grip strength of the affected side was 55% of the opposite hand preoperatively and improved to 69% postoperatively, p=0.269, n=11. The mean PRWE after a mean of 2.0 years was 42 (range, 8-81).

Summary:
- Short-term outcomes of the all-metal distal radius hemiarthroplasty combined with PRC reveal the maintenance of a functional arc of wrist motion and a trend towards improved grip strength.
- Various complications occurred including impingement of the prosthesis on the trapezium, capitate or hamate. This was addressed with subsequent partial excision.
- There is a relatively high incidence of unfavorable radiographic findings.
- Several patients had minimal pain and high levels of function.
- Longer follow up for this type of implant is required to fully assess the clinical impact of radiographic changes.
- Subgroup analysis may help to better define the most appropriate candidates for this procedure.

References:

- Contracted research: Auxilium (Osterman)
- Royalties/Honoraria: Elsevier (Osterman)
- Consulting fees: Biomet, Auxilium, SBI, Arthrex (Culp); Medartis, Auxilium, Arthrex (Osterman)
- Intellectual property rights/patent holder: Medartis, Biomet (Osterman)
♦ Nothing of financial value to disclose
RF E-POSTER 08: Nerve Transfers for Lower Brachial Plexus Injury, An Anatomic Study

Category: Basic Science - Anatomy
Keyword: Hand
Not a clinical study

♦ Omar F. Nazir, MD
♦ Naiping M. Xu, MD
♦ Sandeep Mannava, MD, PhD
♦ David Schippert, MD
● Zhongyu J. Li, MD, PhD

Hypothesis: Lower brachial plexus injuries represent the most difficult subset of plexus injuries to treat. Given the unpredictable results of proximal brachial plexus repairs and the time required for axon regeneration, the outcomes are uniformly poor. Distal nerve transfers may be utilized in these injuries. However, there is limited literature illustrating the feasibility of nerve transfers in lower brachial plexus injuries. The purpose of the study is to test our hypothesis that it is possible to use intraneural fascicular transfers for re-animation of the hand function in lower brachial plexus injury patients.

Methods: A human fresh cadaver model was used to test the feasibility of transferring the pronator branch of the median nerve to the anterior interosseous nerve (AIN) and the supinator branches of the radial nerve to the posterior interosseous nerve (PIN). An anatomic study was completed utilizing ten arms from five cadavers. The AIN and pronator branches as well as the PIN and supinator branches were identified and evaluated in all specimens. Distances from branching points, nerve diameters and histology were obtained. The nerve transfers were then attempted to directly assess feasibility based branch pattern, size, length and axon counts.

Results: Our results indicate that Pronator teres receives two major branches from the median nerve and the length and diameter of the pronator branches of the median nerve make it amenable for transfer to the AIN. Similarly, there are two major radial nerve branches innervating the supinator muscle making it possible to transfer one of the supinator branches of the radial nerve to the PIN.

Summary: The findings of this study confirm that both the pronator branch to AIN and supinator branch to PIN nerve transfers are anatomically possible. These transfers may allow for restoration of functional loss following lower brachial plexus injuries.
- Contracted research: Wright Medical (Li)
- Nothing of financial value to disclose
Hypothesis: Adequate exposure of the articular surface of the head of the proximal phalanx is essential for visualization and reduction of articular fractures and for PIP joint arthroplasty. The amount of articular cartilage visible from various surgical exposures has not been quantified. We hypothesize that visualization of the palmar articular cartilage of the head of the proximal phalanx is limited with a variety of commonly used surgical exposures when the collateral ligaments are intact. We quantitatively compare the articular exposure obtained by a dorsal extensor tendon splitting approach, a dorsal extensor tendon reflecting approach (Chamay exposure) or a lateral tendon window approach.

Methods: The PIP joints of twenty-four digits from six fresh-frozen cadaveric specimens were randomized to one of three possible surgical exposures: (1) lateral, (2) extensor tendon splitting, and (3) extensor tendon reflecting. The distal articular surface of the proximal phalanx of each digit was approached as assigned, and the exposed surface was painted with a methylene blue stain. The PIP joints were then completely disarticulated to reveal the entire distal articular surface of the proximal phalanx. Using three-dimensional digital mapping of the dyed and undyed portions of the articular surface, we compared the percentages of exposed surface area (Figure 1).

Results: Mean exposed joint surface area for lateral, extensor tendon splitting, and extensor tendon reflecting approaches was 16%, 41%, and 52%, respectively (Figure 2). Each approach provided a significantly different percentage of articular PIP surface area than the other two (p<0.05 for all comparisons).

Summary:
- Although various dorsal approaches to the PIP joint have been described, the amount of articular surface visualized by different approaches must be weighed against the potential downside of extensor mechanism violation.
- The exposure of the articular surface by the lateral approach to the PIP joint allows nearly a third of the exposure gained by the Chamay exposure.
• Although the Chamay technique revealed the greatest amount of surface area, nearly 50% of the proximal phalanx articular surface still remained inaccessible so long as the collateral ligaments were intact.
• Recession or incision of at least one collateral ligament is required in order to view the palmar 50-80% of the articular surface of the proximal phalanx.
• An understanding of the limitations inherent in dorsal exposure of the PIP joint will help guide the surgical approach for the individual patient.

Figure 1. Three-dimensional digital modeling of dyed and undyed proximal interphalangeal (PIP) joint surface using the

![Articular Surface Area Exposed by 3 Dorsal Approaches to the PIP](image)

Figure 2. Percentages of the articular surface of the proximal phalanx in the PIP joint exposed by the lateral, extensor tendon splitting, and extensor tendon reflecting (Chamay) approaches. Error bars are standard deviations of the mean. Statistical analysis by analysis of variance and independent pair-wise two-tailed comparisons demonstrated all groups to be significantly (p<0.05) different from one another.

♦ Nothing of financial value to disclose
Hypothesis: The creators of the QuickDASH “do not recommend or endorse using the DASH/QuickDASH over the telephone” citing that its characteristics have not been formally tested. Our purpose was to quantify the performance of the verbally administered QuickDASH by assessing its replication of self-administered scores, its test-retest reliability, and its rate of scorable completion compared to its self-administered, written administration.

Methods: 50 patients presenting for initial visits to an orthopedic hand clinic were enrolled regardless of diagnosis. Patients were divided into 2 equal groups. 25 patients completed the QuickDASH verbally the day preceding written administration during their initial office visit. The second group completed the written QuickDASH at their office visit with verbal administration the following day. Intraclass correlation coefficients quantified the verbal questionnaire’s ability to reproduce written scores. Participants verbally completed the questionnaire a final time, 5 months later, to assess test-retest reliability. To quantify the usability of survey data, we compared percentages of scorable surveys between 258 written QuickDASH questionnaires collected as part of an unrelated prior investigation to these verbally administered QuickDASH questionnaires.

Results: The intraclass correlation coefficient between the two QuickDASH administration types for the entire sample was 0.91 (95% CI: 0.84-0.95, Figure 1). For the population there was a minimal change in mean score from a patient’s written QuickDASH to that patient’s verbal QuickDASH score (1.1±8.9, P=0.41). Scoring consistency between QuickDASH administrations was similar for each administration sequence (phone followed by written, 0.2±9.6; written followed by phone -1.9±8.2, P=0.41) and by diagnosis (P=0.42, Figure 2). Test-retest reliability between the two verbal administrations demonstrated good reliability (ICC 0.68) and a minimal difference between scores (1.2±16.1, P=0.62). 83% of written questionnaires produced unscorable data compared to 100% of surveys verbally administered (P<0.0001).

Summary:
- Our results indicate that verbal administration of the QuickDASH replicates scores of the written QuickDASH, has good test-retest performance, and minimizes unusable data.
These data allow researchers greater flexibility in gathering patient outcome data in both retrospective and prospective studies.

References:

Ownership interests: OrthoHelix, LLC; Tornier
Consulting fees: OrthoHelix, LLC; Acumed, LLC
Nothing of financial value to disclose
RF E-POSTER 11: A Three-Dimensional Model of the Functional Workspace of the Hand in Normal Adults

Category: Basic Science - Clinical Research
Keyword: Hand
Not a clinical study

♦ Patrick F. Curran, MD

Hypothesis: Reproducible assessment of thumb prehension that is sensitive to change is challenging, due to the complex anatomy and motion of the thumb. We hypothesize that a three-dimensional kinematic model of the hand can assess thumb range of motion and functional workspace in normal adult subjects.

Methods: Ten healthy subjects (9 right-hand dominant; age = 28.7 ± 3.7 years) were studied. Twelve retroreflective markers were placed on bony landmarks of the dorsum of the thumb, fingers, and hand. Motion of the markers was recorded using a twelve-camera motion analysis system using a previously described protocol[1]. Each subject performed three trials of the following range of motion (ROM) tasks: (1) thumb flexion (F), extension (E), opposition, radial abduction-adduction (AA), palmar AA; (2) finger F, E; (3) total thumb ROM; (4) Kapandji score[2]. Functional tasks to simulate activities of daily living were performed including: (1) pick up paperclip, penny, bottle cap, pencil, marker, small ball, medium ball, cup; (2) turn card; (3) grip key; (4) grip toothbrush; (5) open toothpaste; (6) open jar. A 3D model of the hand was generated from marker position for each trial. Relative joint ROM was measured as the distal segment relative to the proximal segment. Functional workspace of the thumb was determined by calculating the volume of intersection between total thumb-tip and fingertip ROM tasks using custom MATLAB software.

Results: The functional workspace of the thumb was 35680 ± 14663 mm³ and the total thumb reach space was 168022 ± 49132 mm³. The average ROM for thumb interphalangeal F-E was 71.9° - 25° and metacarpophalangeal F-E was 58.5° - 0°. There was a positive linear correlation between hand size and thumb reach space. The average total thumb reach space utilized in each activity varied widely (3418 ± 2311 mm³). The selected functional tasks were performed outside of the functional workspace of the thumb (Fig. 1) and required more motion in radial abduction and palmar flexion for completion.

Summary:
- This study describes a kinematic model for measurement of the functional workspace of the thumb.
- The activities performed in this study did not utilize significant portions of the functional workspace of the hand as predicted.
- This model may be used to assess functional workspace and ROM deficits in patients with hand injuries or deficiencies.
- Future investigations will examine the functional ROM and workspace of the thumb in normal children and children with congenital thumb hypoplasia.

References:

Nothing of financial value to disclose
Hypothesis: The purpose of this study was to use the STROBE statement checklist to critically evaluate the change in quality of observational trial reporting in the Journal of Hand Surgery (JHS [Am]) since 2005 (prior to both JHS requiring level of evidence reporting and the publication of the STROBE statement). We tested the null hypothesis that the quality of reporting for observational studies would be unchanged over the study period.

Methods: A cross sectional analysis of observational studies published in JHS [Am] was designed to sample two 6 month periods of publication (March-August 2005, June-November 2011). Fifty-one items were extracted from the STROBE statement for evaluation. Two of three trained reviewers independently scored each article. Discrepant ratings were resolved by consensus. Overall STROBE compliance rates for articles and compliance rates for specific checklist items were determined. Final compliance percentages were compared between the early and current articles by Student t-testing.

Results: Overall compliance with the STROBE guideline was 38% (range,10-54%) in 2005 and 58% (range, 39%-85%) for 2011 manuscripts. This increase in overall compliance represented a statistically significant improvement (p<0.01) for the current articles (Table 1). Areas of excellent compliance with 75% or greater of articles satisfactorily reporting these items at both time points (2005/2011) included explicit reporting of: background (100%/97%), follow-up time (85%/94%), outcome measures (86%/100%), overall interpretation of data (100%/94%), and results of similar studies (95%/89%). Poor compliance areas (25% or less of articles reporting these items) included providing the study design in the abstract (10%/20%), a clear description of the study’s setting (10%/23%), use of a power analysis (0%/17%), handling of missing data (0%/6%), use of a flow diagram (0%, 6%), potential directions of bias (5%/11%) and source of funding (0%/0%). Eighty six percent (44/51) of items were more frequently satisfied in current articles compared to 2005 publications. Absolute increases in compliance rates of =40% were noted in 10 items (20%) (Table 2). Meanwhile, there was no substantial evidence of worsening reporting on any item (maximum deterioration of 6%).
Summary:
- The overall quality of the reporting of observational trials in the hand surgical literature is improving with particular gains seen in areas such as reporting patient characteristics, case selection, and subgroup analyses.
- The reporting of observational trials in hand surgery could still benefit from increased reporting of methodologic details including the use of power analyses, the handling of missing data, and consideration of potential bias.

References:
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<tr>
<th>STROBE Statement Item</th>
<th>2005</th>
<th>2011</th>
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<tbody>
<tr>
<td>1a. Abstract: Study design with specific descriptive term</td>
<td>(2/21) 10%</td>
<td>(7/24) 20%</td>
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<td>1b. Abstract: Balanced summary</td>
<td>(20/21) 95%</td>
<td>(32/35) 91%</td>
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<td>2. Introduction: Background and rationale</td>
<td>(21/21) 100%</td>
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<td>3. Introduction: Objectives: include hypothesis, objective or purpose</td>
<td>(12/21) 57%</td>
<td>(28/35) 80%</td>
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<td>4. Methods: Study design early in paper</td>
<td>(4/21) 19%</td>
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<td>5. Methods: Setting and location</td>
<td>(2/21) 10%</td>
<td>(8/24) 20%</td>
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<td>5. Methods: Recruitment period</td>
<td>(14/21) 67%</td>
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<td>5. Methods: Follow-up time</td>
<td>(17/20) 85%</td>
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<td>(9/21) 43%</td>
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<td>6a. Methods: Sources, Methods of patient or case selection</td>
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<td>(18/28) 62%</td>
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<td>6b. Methods: Case Control: matching criteria</td>
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<td>7. Methods: Define outcomes</td>
<td>(18/21) 86%</td>
<td>(35/40) 87%</td>
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<td>7. Methods: Define exposures</td>
<td>(19/21) 90%</td>
<td>(34/35) 97%</td>
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<td>(0/21) 0%</td>
<td>(2/3) 6%</td>
</tr>
<tr>
<td>7. Methods: Define effect modifiers</td>
<td>(1/21) 5%</td>
<td>(2/3) 6%</td>
</tr>
<tr>
<td>7. Methods: Diagnostic criteria</td>
<td>(16/21) 76%</td>
<td>(33/35) 94%</td>
</tr>
<tr>
<td>8. Methods: Source of data</td>
<td>(10/21) 48%</td>
<td>(26/35) 74%</td>
</tr>
<tr>
<td>8. Methods: Methods of assessment or measurement</td>
<td>(14/21) 67%</td>
<td>(33/35) 94%</td>
</tr>
<tr>
<td>9. Methods: How bias addressed</td>
<td>(0/21) 0%</td>
<td>(1/3) 3%</td>
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<tr>
<td>10. Methods: Power analysis</td>
<td>(0/21) 0%</td>
<td>(6/35) 17%</td>
</tr>
<tr>
<td>11. Methods: How quantitative variables addressed</td>
<td>(4/21) 19%</td>
<td>(21/35) 60%</td>
</tr>
<tr>
<td>12a. Methods: Statistical methods</td>
<td>(10/21) 48%</td>
<td>(25/35) 71%</td>
</tr>
<tr>
<td>12b. Methods: Statistical subgroups/interactions</td>
<td>(3/30) 10%</td>
<td>(13/25) 52%</td>
</tr>
<tr>
<td>12c. Methods: How missing data addressed</td>
<td>(0/21) 0%</td>
<td>(2/3) 6%</td>
</tr>
<tr>
<td>12d. Methods: Cohort: How loss to follow-up addressed</td>
<td>(1/17) 6%</td>
<td>(6/28) 21%</td>
</tr>
<tr>
<td>12d. Methods: Case Control: How matched</td>
<td>(0/4) 0%</td>
<td>(1/4) 25%</td>
</tr>
<tr>
<td>12d. Methods: Cross-Sectional: sampling strategy</td>
<td>(0/1) 0%</td>
<td>(2/3) 67%</td>
</tr>
<tr>
<td>12e. Methods: Sensitivity analyses</td>
<td>(1/10) 10%</td>
<td>(12/25) 48%</td>
</tr>
<tr>
<td>13a. Results: Number at each stage of study</td>
<td>(5/21) 24%</td>
<td>(19/35) 73%</td>
</tr>
<tr>
<td>13a. Results: Reasons for nonparticipation</td>
<td>(0/21) 0%</td>
<td>(1/35) 3%</td>
</tr>
<tr>
<td>13a. Results: Use of a flow diagram</td>
<td>(0/21) 0%</td>
<td>(2/3) 6%</td>
</tr>
<tr>
<td>14a. Results: Characteristics of study participants</td>
<td>(19/21) 90%</td>
<td>(34/35) 97%</td>
</tr>
<tr>
<td>14b. Results: Number with missing data</td>
<td>(1/21) 5%</td>
<td>(3/35) 9%</td>
</tr>
<tr>
<td>14c. Results: Cohort: Follow-up time</td>
<td>(11/17) 63%</td>
<td>(24/29) 89%</td>
</tr>
<tr>
<td>15. Results: Number of events or exposures</td>
<td>(13/21) 62%</td>
<td>(32/32) 100%</td>
</tr>
<tr>
<td>16a. Results: Unadjusted estimates</td>
<td>(4/21) 19%</td>
<td>(23/35) 66%</td>
</tr>
<tr>
<td>16a. Results: Confounder adjusted estimates with reasoning</td>
<td>N/A</td>
<td>(2/2) 100%</td>
</tr>
<tr>
<td>16a. Results: 95% Confidence Interval</td>
<td>(0/21) 0%</td>
<td>(4/35) 11%</td>
</tr>
<tr>
<td>16b. Results: Category boundaries for continuous variables</td>
<td>(2/21) 10%</td>
<td>(21/35) 64%</td>
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<tr>
<td>16c. Results: Translate Relative Risk to Absolute Risk</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>17. Results: Other analyses (subgroups/interactions/sensitivity)</td>
<td>(3/30) 10%</td>
<td>(19/25) 76%</td>
</tr>
<tr>
<td>18. Discussion: Key results with referenced objectives</td>
<td>(16/21) 76%</td>
<td>(31/35) 89%</td>
</tr>
<tr>
<td>19. Discussion: Limitations of study</td>
<td>(8/21) 38%</td>
<td>(23/35) 69%</td>
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<td>19. Discussion: Directions of magnitude of bias</td>
<td>(1/21) 5%</td>
<td>(4/35) 11%</td>
</tr>
<tr>
<td>20. Discussion: Overall interpretation</td>
<td>(21/21) 100%</td>
<td>(33/35) 94%</td>
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<tr>
<td>20. Discussion: Results similar studies</td>
<td>(18/21) 85%</td>
<td>(30/35) 86%</td>
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<tr>
<td>21. Discussion: Generalizability</td>
<td>(20/21) 95%</td>
<td>(31/35) 89%</td>
</tr>
<tr>
<td>22. Funding: Source, role of funders, funding for original study</td>
<td>(6/21) 0%</td>
<td>(6/35) 0%</td>
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<tr>
<td>Overall compliance</td>
<td>39%</td>
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Table 2: Percentage Change in Reporting for STROBE Statement Items

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<th>2011</th>
<th>Change</th>
</tr>
</thead>
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<tr>
<td>16a. Results: Confounder adjusted estimates with reasoning</td>
<td>N/A</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>14a. Results: Characteristics of study participants</td>
<td>9%</td>
<td>97%</td>
<td>88%</td>
</tr>
<tr>
<td>12d. Methods: Cross-sectional: sampling strategy</td>
<td>0%</td>
<td>67%</td>
<td>67%</td>
</tr>
<tr>
<td>6a. Methods: Sources, methods of patient and case selection</td>
<td>19%</td>
<td>83%</td>
<td>64%</td>
</tr>
<tr>
<td>16b. Results: Category boundaries for continuous variables</td>
<td>10%</td>
<td>64%</td>
<td>54%</td>
</tr>
<tr>
<td>13a. Results: Number at each stage of study</td>
<td>24%</td>
<td>73%</td>
<td>49%</td>
</tr>
<tr>
<td>6a. Methods: Eligibility</td>
<td>43%</td>
<td>91%</td>
<td>48%</td>
</tr>
<tr>
<td>16a. Results: Unadjusted estimates</td>
<td>19%</td>
<td>66%</td>
<td>47%</td>
</tr>
<tr>
<td>17. Results: Other analyses (subgroups/interactions/sensitivity)</td>
<td>33%</td>
<td>76%</td>
<td>43%</td>
</tr>
<tr>
<td>11. Methods: How quantitative variables addressed</td>
<td>19%</td>
<td>60%</td>
<td>41%</td>
</tr>
</tbody>
</table>

♦ Nothing of financial value to disclose
RF E-POSTER 13: Augmentation of Tendon Healing with an Injectable Tendon Hydrogel

Category: Basic Science - Lab Research
Keyword: Hand
Not a clinical study

♦ Maxwell Y. Kim, BS
♦ Simon Farnebo, MD
● Colin W.L. Woon, MD
♦ Taliah Schmitt, MD
♦ Hung Pham, BS
● James Chang, MD

Hypothesis: We hypothesized that tendon healing could be augmented by the addition of a biodegradable scaffold that would guide tissue regeneration. To test this hypothesis, we developed and characterized a tendon-derived hydrogel and applied it in vivo to a novel rat injury model.

Methods: The tendon hydrogel was produced using proprietary methods. We characterized the hydrogel using mass spectrometry and assessed it for its rheological properties. Subcutaneous injection of the gel in a rat model was used to assess biocompatibility and host cell repopulation in vivo, and gel interaction with multipotent adipose-derived stem cells (ASCs) was tested in vitro. Both Achilles tendons of 36 Wistar rats were given full-thickness injuries approximately 5 mm long and 0.5 mm wide from the tendon insertion at the calcaneus to mid-substance (Figure 1). The hydrogel was injected into the injury site of one leg and compared to control saline in the other. The ultimate failure load (UFL), ultimate tensile stress (UTS) and stiffness (STF) were evaluated at 2, 4, and 8 weeks. Tendon cross-sections underwent histological analysis (H&E and Picro-Sirius red) after sacrifice. Statistical analysis of biomechanical data was performed using a paired Student’s T-test.

Results: Mass spectroscopy identified that Collagen I represented more than 55% of the sample. Rheology showed that the gel has storage (G’) and loss (G”) moduli of 213.1±19.9 Pa and 27.1±2.4 Pa respectively at 1 rad/s. It also showed that the gel is thermoresponsive, polymerizing at 37 °C. The in vivo and in vitro experiments showed cell invasion and growth, indicating good biocompatibility. There was no significant difference in strength between gel and saline injections in UFL, UTS, or STF at 2 weeks. However, there was a significant difference in UFL (74.8±11.6 vs. 58.4±14.2 N, p=0.02) at 4 weeks, with the gel-treated tendon reaching near-native strength (76 N). The difference in UTS and STF remained insignificant. There was again no difference in UFL, UTS, or STF at 8 weeks.
Summary:
- The hydrogel is composed of Collagen I and other tendon extracellular matrix proteins, has standard gel properties, and has good biocompatibility in vitro and in vivo.
- Achilles tendons treated with gel are stronger (UFL) than PBS-treated tendons at 4 weeks, with near-native strength.
- In the future, this tendon hydrogel may be used to augment tendon repair at the tendon-bone insertion and in mid-tendon defects.

- Royalties/Honoraria: Grant from VA Rehabilitation Research and Development Merit Review Grant (Woon); Elsevier (Chang)
- Contracted research: Multiple Federal grants (Chang)
- Consulting fees: Tendon Bone Innovations; Zone 2 Surgical (Chang)
- Intellectual property rights/patent holder: Patent for Decellularized Tendon-Bone Constructs (Chang)
- Nothing of financial value to disclose
RF E-POSTER 14: Results of Surgical Treatment of Wrist Flexion Deformity in Patients with Cerebral Palsy

Category: Congenital/Pediatric
Keyword: Wrist
Level 3 Evidence

Christopher J. Dy, MD, MSPH
Morgan Swanstrom, MD
Krystle A. Hearns, MA
Lorene C. Janowski, OTR/L, MS
Michelle G. Carlson, MD

Hypothesis: The selection of surgical procedure for wrist flexion deformity in patients with cerebral palsy (CP) is dependent on the extent of each patient’s deformity and the resultant functional position of the hand. While a number of authors have reported results after FCU to ECRB transfer, there are no series that describe the results of ECU to ECRB transfer or FCU lengthening. We hypothesize that active wrist extension would improve after all of these procedures without clinically significant decreases in active wrist flexion.

Methods: Seventy patients with CP were treated for wrist flexion deformity. Forty-two patients were available for follow-up of at least 12 months. Surgical treatment plans were created based on the extent of preoperative deformity. Twenty patients were treated with FCU to ECRB transfer, 12 patients with ECU to ECRB transfer, and 10 patients with an FCU lengthening. Active and passive wrist ROM was measured at follow-up. Results were compared using paired t-tests.

Results: Mean follow-up after FCU to ECRB transfer was 25.4 months (range, 12-86 months). There was a significant increase in postoperative active extension (p<0.001). Although there was a significant decrease in postoperative active flexion (p=0.008), total active ROM significantly improved (p<.001). Mean follow-up after ECU to ECRB transfer was 20.9 months (range, 12-40 months). There was a significant increase in postoperative active extension (p=0.002), but no change in active flexion. Mean follow-up after FCU lengthening was 24.4 months (range, 12-62 months). There was a significant increase in postoperative active extension (p=0.003), but no change in active flexion. Pre and postoperative active extension and flexion results are depicted in Figures 1 and 2. There was one case each of postoperative extension deformity in the FCU to ECRB and the ECU to ECRB groups.

Summary: Our results indicate improvements in active wrist extension after FCU to ECRB transfer, ECU to ECRB transfer, and FCU lengthening. We demonstrated no loss of active wrist flexion.
flexion after ECU to ECRB transfer or FCU lengthening. Although there was a significant loss of active flexion after FCU to ECRB transfer, there was a significant improvement in total active ROM. While our results corroborate those in the literature for FCU to ECRB transfer, our findings for ECU to ECRB transfer and FCU lengthening represent the first rigorous evaluations of these procedures.

**Figure 1: Active Wrist Extension by Surgical Procedure**

![Graph showing active wrist extension by surgical procedure](image)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Preoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCU to ECRB Transfer (n=21)</td>
<td>-8 (±10)</td>
<td>43 (±27)</td>
</tr>
<tr>
<td>ECU to ECRB Transfer (n=12)</td>
<td>58 (±31)</td>
<td>68 (±34)</td>
</tr>
<tr>
<td>FCU Lengthening (n=10)</td>
<td>33 (±7)</td>
<td>56 (±22)</td>
</tr>
</tbody>
</table>

* p<0.05  
** p<0.01

**Figure 2: Active Wrist Flexion by Surgical Procedure**

![Graph showing active wrist flexion by surgical procedure](image)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Preoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCU to ECRB Transfer (n=21)</td>
<td>60 (±27)</td>
<td>41 (±27)</td>
</tr>
<tr>
<td>ECU to ECRB Transfer (n=12)</td>
<td>75 (±30)</td>
<td>59 (±25)</td>
</tr>
<tr>
<td>FCU Lengthening (n=10)</td>
<td>72 (±22)</td>
<td>70 (±11)</td>
</tr>
</tbody>
</table>

* p<0.05

● Contracted research: NIH/NIAMS T32 Research Fellowship (AR07281); ASSH Resident/Fellow Fast Track Grant; RJOS/Zimmer Research Grant June 2010- June 2011 $30K (Carlson)

♦ Nothing of financial value to disclose
Hypothesis: The long-term sequelae of persistent brachial plexus birth palsy may include glenohumeral joint dysplasia, glenohumeral internal rotation and adduction contractures, and scapular winging, which is particularly evident in tasks that require horizontal adduction at the shoulder, such as bringing the hand to the mouth. This study examined our proposed theory that a glenohumeral horizontal abduction contracture leads to the appearance of scapular winging in children with residual brachial plexus birth palsy.

Methods: Sixteen children with brachial plexus injuries were enrolled in this study. Three-dimensional locations of markers placed on the thorax, scapula and humerus were recorded in the hand to mouth Mallet position (Figure 1) using a motion capture system (Motion Analysis Corporation, Santa Rosa, CA). The unaffected limbs served as a control. Scapulothoracic and glenohumeral horizontal adduction angles were compared between the affected and unaffected limbs. Glenohumeral to scapulothoracic horizontal adduction angle ratios were also compared. Student’s t-tests (a = 0.05) were performed on the glenohumeral and scapulothoracic horizontal adduction angles and ratio.

Results: The mean scapulothoracic horizontal adduction angles were 65.3° for the affected limbs and 39.0° for the unaffected limbs (p = 0.00003). The mean glenohumeral horizontal adduction angles were 12.4° for the affected limbs and 46.7° for the unaffected limbs (p = 0.001). A plot of the glenohumeral adduction angle versus the scapulothoracic adduction angle for each subject is shown in Figure 2. The mean glenohumeral to scapulothoracic horizontal adduction angle ratios were 0.2 for the affected limbs and 1.3 for the unaffected limbs (p = 0.00002).

Summary:
- The results of this study support the theory that brachial plexus injuries can lead to glenohumeral horizontal abduction contractures.
- Affected children demonstrated increased scapulothoracic horizontal adduction that is likely a compensatory mechanism due to decreased glenohumeral horizontal adduction.
- These findings are unique and better define the etiology of scapular winging in children with brachial plexus injuries.
- This information can be relayed to patients and their families when addressing the appearance of scapular winging.

References:

Figure 1. 2D scapular markers were placed while the subjects maintained the hand to mouth position.
Figure 2. Scapulothoracic (X axis) and glenohumeral (Y axis) horizontal adduction angles in the hand to mouth position for both the unaffected and affected limbs. Negative glenohumeral values represent horizontal abduction.

- Royalties/honoraria: Elsevier, Osteomed, Arthrex
- Consulting fees: Osteomed, Arthrex
- Intellectual property rights/patent holder: Osteomed, Arthrex
- Nothing of financial value to disclose
Assessment of the Symmetry of Shoulder Skin Folds: Inter- and Intra-Observer Reliability

Category: Congenital/Pediatric
Keyword: Shoulder
Not a clinical study

Ebrahim Paryavi, MD, MPH
Keya Manshadi, BS
Martin Herman, MD
Scott H. Kozin, MD
Joshua Abzug, MD

Hypothesis: Skin folds are often assessed by pediatricians and orthopaedic surgeons as a screening tool to evaluate for shoulder pathology or brachial plexus palsy. We hypothesized that shoulder skin folds cannot reliably be classified as symmetric or asymmetric by pediatric orthopaedic surgeons.

Methods: Fifty children under 6 months of age were identified as normal after being examined by a pediatric orthopaedic surgeon to ensure there were no signs of shoulder pathology or brachial plexus palsy. Subsequently, the extremities were held in standardized positions and multiple photographs were obtained to assess shoulder skin folds. Three pediatric orthopaedic surgeons reviewed multiple images of each child’s shoulder skin folds to determine whether they were symmetric or asymmetric. Inter- and intra-observer reliabilities were then calculated using Kappa coefficients.

Results: Asymmetry was identified in 26-74% of shoulder skin folds. Low inter-observer reliabilities were present when assessing shoulder skin folds (Kappa coefficient 0.199 [0.038-0.387]). Furthermore, intra-observer reliabilities also demonstrated low values for shoulder skin folds. (Kappa coefficients range 0.186-0.584).

Summary:
- While asymmetry of skin folds has been shown to occur with certain shoulder pathologies, agreement of what “asymmetry” means is not present amongst pediatric orthopaedic surgeons.
- Patient positioning or movement may cause variation in skin fold alignment and therefore the same patient may have symmetry at one moment and asymmetry at the next.
- Utilization of skin folds as a screening tool, in isolation, is unreliable when assessing for shoulder pathology.

Royalties/Honoraria: Springer
Nothing of financial value to disclose
Hypothesis: Thumb duplication type VII is uncommon. The anatomy of the trapezium has been described by Zuidam et al. The purpose of this study is to describe the musculotendinous and bone anatomy in the duplication with two well-formed metacarpals.

Methods: Two twin boys with bilateral thumb duplication type VII with two well-formed metacarpals underwent reconstruction by a single surgeon. The musculotendinous and bone anatomy is meticulously described.

Results: Three of the four hands had radial and ulnar triphalangeal thumbs and one had a triphalangeal ulnar thumb and a biphalangeal radial thumb. All eight thumbs had two fully developed metacarpals. The trapezium was a fused duplicated bone with a minor but visible cleavage plane between the radial and ulnar sides. A saddle-type articulation was noted for the ulnar metacarpal and either a dome shaped or flat articulation for the radial metacarpal. All eight thumbs had a flexor pollicis longus (FPL) tendon. Each hand had a single abductor pollicis longus (APL) inserting on the base of the radial thumb metacarpal. Three of the hands had a single extensor pollicis brevis (EPB) inserting on the base of the radial thumb proximal phalanx. The EPB was absent in the duplication with biphalangeal radial thumb. Each hand had a single extensor pollicis longus (EPL) inserting on the ulnar thumb. The abductor pollicis brevis (APB) for the triphalangeal thumb duplications was duplicated with a head inserting on the radial side of the base of the proximal phalanx of the radial and the ulnar thumbs. The duplicate biphalangeal thumb had a single APB inserting on the radial base of proximal phalanx of the radial thumb. There was an extra dorsal interosseus muscle in all four hands between the two thumb metacarpals. The arterial supply in all four cases was derived from the dorsal branch of the radial artery in the webspace between the two thumbs, with traditional proper digital vessels to both the ulnar and radial thumbs.

Summary: Thumb duplication with two well-formed metacarpals represents approximately 14% of all radial polydactylies. Consistent anatomical features of the triphalangeal duplicates include a duplicate trapezium with separate articular surfaces for the metacarpal bases, a single APL and EPB inserting on the radial thumb and a single EPL inserting on the ulnar thumb. Duplicate FPL
and thenar muscles inserted onto both thumbs. The duplicate biphallangeal thumb had no EPB and single thenar musculature inserting onto the radial thumb.

References:
RF E-POSTER 18: Radiographic Evaluation During Treatment of Pediatric Forearm Fractures: Implications on Clinical Care and Cost

Category: Congenital/Pediatric
Keyword: Forearm
Level 2 Evidence

♦ Gaurav Luther, MD
♦ Patricia E. Miller, MS
● Donald S. Bae, MD

Hypothesis: As up to 30% of displaced pediatric forearm fractures demonstrate loss of reduction (LOR) following closed reduction (CR) and casting, frequent serial radiographic follow-up is advocated to identify redisplacement and guide intervention. We hypothesize there is minimal change in fracture alignment 2 weeks after CR, and thus subsequent radiographs add cost but little value to clinical care.

Methods: 1884 radiographs from 184 patients enrolled in a prospective study of pediatric forearm fractures were evaluated. All patients were treated with CR, casting, and radiographic evaluation at 1, 2, 4, and 6 weeks after injury. Primary endpoint was radiographic LOR. Secondary endpoint was need for any intervention (remanipulation or surgery). A modified number-needed to treat (NNT) analysis estimated the utility of the week 4 x-ray in predicting intervention. Relative value unit (RVU) costing, time derived activity-based costing (TDABC), and billing totals were used for cost analysis. CPT codes 73090, 99212 and 29075 were used for RVU and billing costs. Internally created process maps and capacity cost rates were used for TDABC methodology. Costs were calculated for individual elements and the entire cycle of non-operative fracture care.

Results: 70 patients (38%) demonstrated radiographic LOR. Independent predictors of LOR were initial radius displacement >75% (OR 5.40, CI 2.23-12.60), concomitant ulna fracture (OR 1.71, CI 1.15-2.54), and dominant arm involvement (OR 2.87, CI1.40-5.87). 80% of all LOR occurred within the first 2 weeks. Average change in radius angulation from CR to week one or two was 6.9° (SD 6.1°) on frontal and 11.9° (SD 7.7°) on lateral projections (p2 weeks following CR and casting of forearm fractures.

- Interventions are based on early radiographic follow-up; at most, 1 in 40 patients require intervention >2 weeks after injury
- Elimination of the 4 week x-ray would result in considerable cost savings with little adverse effect in clinical results.

● Contracted research: ASSH, POSNA
● Royalties/honoraria: Lippincott Williams and Wilkins
● Ownership interests: Optimer, Cubist, Osiris
♦ Nothing of financial value to disclose
**Purpose:** Post operative analgesia plays an important role in the management of out-patient hand procedures (1,2,3). Unfortunately, there has been a rise in prescription opioid abuse in North America (4) and as such prescribing practices need to be scrutinized. The goal of this study was to review patterns of opioid prescription in an elective ambulatory hand surgery practice and to identify if patient, anesthetic or surgical factors influenced prescribing patterns.

**Hypothesis:** Current opioid prescribing patterns are not tailored to account for predictive factors of severe post-operative pain in ambulatory hand surgery.

**Method:** Charts of all ambulatory hand surgery patients from 2005 to 2012 were reviewed. Data collected included demographics, medical history, diagnosis, type of surgery, complications, anesthetic type, ASA class, prescription drug and quantity prescribed. For the purpose of data analysis, we calculated odds ratios and conducted frequency analysis using chi-square tests.

**Results:** A total of 298 charts were reviewed of which 163 met inclusion criteria. Procedures were largely soft-tissue relative to bone (58.9% vs 41.1%). The majority of patients were prescribed Tylenol #3 (74%, n=121) or Percocet (23%, n=37). Patients undergoing bone procedures [OR 1.6, 95% CI(0.76, 3.37)], younger patients [OR 3.03, CI(1.37,6.69) (P=0.005, chi-square test)] and those receiving general anesthetic [OR 2.64, 95% CI (0.73, 9.53)] were more likely to be prescribed Percocet. Patients with risk factors for severe post-operative pain, specifically male sex, young age, high BMI, ASA class I and undergoing a bone procedure (5,6), were not all necessarily prescribed of a stronger opioid.

**Summary:**
- In our study, patients were near exclusively prescribed a weak opioid (Tylenol#3) or a strong opioid (Percocet).
- Patients were more likely to receive a prescription for a stronger opioid (Percocet) if they were younger than 44 years old (p=0.005).
- Other anesthetic, surgical and predictive factors of severe post-operative pain did not seem to influence prescribing practice.
Further assessment of patient related outcomes with respect to post operative pain management is necessary to appropriately tailor opioid prescription to patient and surgical factors.

References:

♦ Nothing of financial value to disclose
RF E-POSTER 20: Clinical Outcomes of Endoscopic Carpal Tunnel Release in Patients 65 and Over

Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Wrist
Level 3 Evidence

♦ Nathaniel C. Wingert, MD

Hypothesis: We hypothesized that patients undergoing endoscopic carpal tunnel release (ECTR) who are 65 and older can expect significant relief of pain, night pain, and numbness comparable to open CTR.

Methods: A retrospective review was conducted of all patients 65 years of age and over who underwent ECTR for electromyography confirmed carpal tunnel syndrome from October 2007 to July 2010. The charts were reviewed for demographic data, subjective and objective symptoms and signs at presentation and follow-up, patient satisfaction, as well as three patient reported outcome scores. Pre-operative and post-operative results for pain, night pain and numbness were compared. Logistic regression analysis was used to assess if age had an effect on symptom resolution. Boston carpal tunnel, SF-36 and DASH scores were then compared between patients with mild, moderate or severe CTS.

Results: A total of 78 patients underwent ECTR. Their age ranged from 65 to 93 years with a mean of 73.1 years. Pre-operatively 69% of patients had constant numbness in the median nerve distribution, the remainder had intermittent numbness. Night pain was present in 65 patients prior to surgery, 61 of whom had complete resolution. Following ECTR the average Boston carpal tunnel symptom severity, functional status, and DASH scores were 1.47, 1.50, and 13.2 respectively. At final evaluation 79% of patients were very satisfied or satisfied with their surgical outcome. Patients were found to have a significant improvement in pain, night pain, and numbness following ECTR.

Summary: We have confirmed significant resolution of symptoms of CTS with ECTR in a large population over 65. We found that pre-operative CTS severity, based on nerve conduction study result, does not significantly alter patient outcome following ECTR. Advanced symptoms at presentation do not preclude symptom resolution or functional improvement and should not be a contraindication to ECTR.
<table>
<thead>
<tr>
<th>Pre-Operative Evaluation: Number (%)</th>
<th>Post-Operative Evaluation: Number (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n=78</strong></td>
<td>Relief of pain</td>
</tr>
<tr>
<td>Weakness</td>
<td></td>
</tr>
<tr>
<td>22 (28.2)</td>
<td></td>
</tr>
<tr>
<td>Clumsiness</td>
<td></td>
</tr>
<tr>
<td>17 (21.8)</td>
<td></td>
</tr>
<tr>
<td>Pain</td>
<td></td>
</tr>
<tr>
<td>70 (89.7)</td>
<td>n=65</td>
</tr>
<tr>
<td>Night pain</td>
<td></td>
</tr>
<tr>
<td>65 (83.3)</td>
<td></td>
</tr>
<tr>
<td>Numbness</td>
<td></td>
</tr>
<tr>
<td>75 (96.2)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>Relief of numbness</td>
</tr>
<tr>
<td>54 (69.2)</td>
<td></td>
</tr>
<tr>
<td>Intermittent</td>
<td></td>
</tr>
<tr>
<td>21 (26.9)</td>
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<tr>
<td>Relief with Splints</td>
<td></td>
</tr>
<tr>
<td>32 (55.2), n=58</td>
<td></td>
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<tr>
<td>Relief with Injections</td>
<td>DASH</td>
</tr>
<tr>
<td>20 (66.7), n=30</td>
<td></td>
</tr>
<tr>
<td>Tinnel</td>
<td>13.2 (16.8)</td>
</tr>
<tr>
<td>Durkin</td>
<td>Boston Carpal tunnel</td>
</tr>
<tr>
<td>50 (64.1)</td>
<td></td>
</tr>
<tr>
<td>Phalen</td>
<td>Symptom severity score</td>
</tr>
<tr>
<td>38 (48.7)</td>
<td>Functional status score</td>
</tr>
<tr>
<td>Thenar atrophy</td>
<td></td>
</tr>
<tr>
<td>54 (69.2)</td>
<td></td>
</tr>
<tr>
<td>Weakness</td>
<td>SF-36</td>
</tr>
<tr>
<td>41 (52.6)</td>
<td></td>
</tr>
<tr>
<td>Numbness in median nerve distribution</td>
<td>PCS</td>
</tr>
<tr>
<td>59 (75.6)</td>
<td></td>
</tr>
<tr>
<td>Nerve Conduction Study (distal motor latency at wrist)</td>
<td>MCS</td>
</tr>
<tr>
<td>n=72</td>
<td></td>
</tr>
<tr>
<td>Mild (4-5.4ms)</td>
<td>28 (38.9)</td>
</tr>
<tr>
<td>Mod (5.5-7.2 ms)</td>
<td>18 (25.0)</td>
</tr>
<tr>
<td>Severe (&gt;7.2 ms)</td>
<td>26 (36.1)</td>
</tr>
</tbody>
</table>
Table 2: Comparison of Pre- to Post-Operative Symptoms and Post-Operative Symptoms Stratified by Pre-Operative NCS Value

<table>
<thead>
<tr>
<th></th>
<th>Pre-Op</th>
<th>Post-Op</th>
<th>p-value*</th>
</tr>
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<tbody>
<tr>
<td>Pain</td>
<td>70 (89.7)</td>
<td>0</td>
<td>---</td>
</tr>
<tr>
<td>Night pain</td>
<td>65 (84.4)</td>
<td>4 (5.2)</td>
<td>&lt;0.001</td>
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<tr>
<td>Numbness</td>
<td>75 (96.2)</td>
<td>10 (12.8)</td>
<td>&lt;0.001</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Mild NCS N (%)</th>
<th>Moderate NCS N (%)</th>
<th>Severe NCS N (%)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief of Pain</td>
<td>28/28 (100)</td>
<td>18/18 (100)</td>
<td>26/26 (100)</td>
<td>---</td>
</tr>
<tr>
<td>Relief Night Pain</td>
<td>19/21 (90.5)</td>
<td>12/13 (92.3)</td>
<td>26/26 (100)</td>
<td>0.31</td>
</tr>
<tr>
<td>Relief Numbness</td>
<td>21/27 (77.8)</td>
<td>15/16 (93.8)</td>
<td>25/26 (96.2)</td>
<td>0.09</td>
</tr>
<tr>
<td>Boston Carpal tunnel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptom Severity Score</td>
<td>1.27 (1.00-1.90)</td>
<td>1.05 (1.00-1.63)</td>
<td>1.09 (1.00-1.64)</td>
<td>0.67</td>
</tr>
<tr>
<td>Functional Status Score</td>
<td>1.25 (1.00-1.63)</td>
<td>1.21 (1.00-1.50)</td>
<td>1.13 (1.00-1.63)</td>
<td>0.61</td>
</tr>
<tr>
<td>SF-36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCS</td>
<td>40.4 (28.5-50.3)</td>
<td>33.0 (26.3-52.4)</td>
<td>46.2 (39.4-51.0)</td>
<td>0.43</td>
</tr>
<tr>
<td>MCS</td>
<td>56.4 (49.5-61.6)</td>
<td>56.2 (55.8-62.9)</td>
<td>60.2 (56.4-62.4)</td>
<td>0.07</td>
</tr>
</tbody>
</table>

* Fisher’s Exact test for categorical values, and Wilcoxon rank sum test for continuous variables

♦ Nothing of financial value to disclose
RF E-POSTER 21: Hand Shape as a Valuable Screening Tool in the Diagnosis of Carpal Tunnel Syndrome

Category: Evaluation/Diagnosis/Clinical Treatment  
Keyword: Wrist  
Level 4 Evidence

Mithun Neral, BS  
Margaret Tilson, RN  
Joseph E. Imbriglia, MD  
Ronit Wollstein, MD

Hypothesis: The relationship between hand dimensions and the incidence of carpal tunnel syndrome (CTS) has been studied based on the impression that “square” hands have an increased tendency to develop CTS. Our hypothesis was that we would find a significant relationship between ratios comparing palmar width and palmar length and the occurrence of CTS.

Methods: A retrospective case-control study of 138 hands was performed. Inclusion criteria: all patients presenting with signs or symptoms of CTS. Exclusion criteria: previous trauma, deformity, major hand surgery procedures, and patients with incomplete information. Controls were hands with normal nerve conduction tests (NCT). Cases were hands with any severity of CTS by NCT. Historical information and exam findings were collected. The measurement of palm width (PW) (along proximal palmar crease), palm length (PL) (distal wrist crease to proximal finger crease), and middle finger length (ML) (proximal middle finger crease to middle finger tip) were performed and documented. The hand index described by Chroni et al, \([PL+ML]/[PW]\), as well two additional indices: \([ML]/[PL]\) and \([PL]/[PW]\) were calculated for each hand and ROC curve analysis using a Generalized Estimating Equations model (GEE) was performed to identify the hand index that correlated best with NCT (as the gold standard to objectively identify CTS).

Results: With a significance of \(p=0.024\), sensitivity=70.8\%, and specificity=53.4\% below a cutoff of 1.2, the \([PL]/[PW]\) index had the strongest correlation with CTS as well as the greatest sensitivity and specificity to detect CTS compared to the other hand indices. Chroni et al’s ratio also showed significance with \(p=0.021\), sensitivity=67.7\%, and specificity=52.1\% for ratio values below 2.1. The \([ML]/[PL]\) ratio did not show a significant correlation with CTS.

Summary:

- Hands with greater palm widths or shorter palm lengths (i.e. more square in shape) had a significantly greater tendency to be diagnosed with CTS.
- The high sensitivity and specificity along with the ease of administering this test make it an excellent, quick, and economical screening test for CTS.
• It may also help identify patients who have a greater likelihood of developing CTS in the future for early preventative treatment.

References:

Table 1: Hand Index Screening

<table>
<thead>
<tr>
<th></th>
<th>Chroni</th>
<th>PL/PW</th>
<th>ML/PL</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEE p-value</td>
<td>0.039*</td>
<td>0.024*</td>
<td>0.742</td>
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<tr>
<td>cutoff</td>
<td>2.1</td>
<td>1.2</td>
<td></td>
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<tr>
<td>sensitivity (%)</td>
<td>67.7%</td>
<td>70.8%</td>
<td></td>
</tr>
<tr>
<td>specificity (%)</td>
<td>52.1%</td>
<td>53.4%</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td>2.3</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>OR p-value</td>
<td>0.021*</td>
<td>0.009*</td>
<td></td>
</tr>
<tr>
<td>OR lower CI</td>
<td>1.1</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>OR upper CI</td>
<td>4.5</td>
<td>4.8</td>
<td></td>
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<tr>
<td>PPV</td>
<td>55.7%</td>
<td>57.5%</td>
<td></td>
</tr>
<tr>
<td>PV</td>
<td>64.4%</td>
<td>67.3%</td>
<td></td>
</tr>
</tbody>
</table>

*Statistically significant
Figure 1: Receiver operating characteristic (ROC) curve analysis results for the different hand indices. The PL/PW and [PL+ML]/PW indices proved highly sensitive and specific for carpal tunnel syndrome whereas the ML/PL index did not.

- Royalties/honoraria: Auxilium (Xiaflex Presentations)
- Consulting fees: Auxilium - Xiaflex, Acumed
- Nothing of financial value to disclose
Hypothesis: The purpose was to evaluate functional outcome scores following removal of digital intra-cutaneous or sub-cutaneous calcinosis lesions using a high-speed burr. We hypothesized that there would be significant objective and subjective functional improvement in patient satisfaction after surgical removal of calcium deposits in the hand using a high-speed burr in patients with localized disease.

Methods: A retrospective analysis of nine consecutively enrolled scleroderma patients was performed at our institution by the senior author from 2009-2011. A debulking procedure was performed using a micro-burr to soften and express calcinosis material in digits. Demographics, complications, recurrence, and post-operative functional outcome measurements including the Disabilities of the Arm Shoulder and Hand (DASH), Michigan Hand Questionnaire (MHQ), a Study Specific Questionnaire (SSQ), Visual Analog Scale (VAS), and the Short Form-12 (SF-12) were collected. Ethics Board approval was obtained prior to commencement.

Results: Mean follow up time was two years. Four of nine patients were satisfied with the procedure, and five would recommend surgery. Complications included two reports of each of the following: weakness, decreased motion, numbness, and superficial wound infections that resolved with oral antibiotics. The mean DASH in those who would have surgery again was 27.2 (4/9) versus 54.0 (5/9) for those that would not. Mean MHQ for the operated hand was 48.03 versus the non-operated hand 53.20. Patient satisfaction appeared to be correlated with location and extent of calcinosis load (R²=0.56, p=0.02). Those that had discreet involvement (two fingers or less) or involvement of the pulp were correlated with better patient satisfaction versus in those with more extensive digital involvement.

Summary:
- Patients with calcinosis limited to the pulp or with fewer sites of involvement appeared to be more satisfied.
- Patients should be counselled that the benefit might be more limited than previously reported.
Further research involving a prospective study would be beneficial as our study suggests that recurrence may occur between the one to two year post-operative periods, and results may not be as promising as previously reported.

References:
<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Affected Finger(s)</th>
<th>Location of Surgical Treatment</th>
<th>Scleroderma Type / Diagnosis Date</th>
<th>Patient Reported Indication for Surgery</th>
<th>Patient Reported Post-Operative Limitations</th>
<th>SF 12 Physical</th>
<th>SF 12 Mental</th>
<th>VAS (cm)</th>
<th>DASH</th>
<th>MHO Total Operated Side</th>
<th>MHO Total Unoperated Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>63</td>
<td>T / I / L / R / S</td>
<td>I – pulp radial &amp; MP radial</td>
<td>Limited / 1995</td>
<td>Function / Pain</td>
<td>VU / Function Pain</td>
<td>19.3</td>
<td>68.5</td>
<td>7.0</td>
<td>60.8</td>
<td>29.8</td>
<td>28.6</td>
</tr>
<tr>
<td>2*</td>
<td>66</td>
<td>T / I / L</td>
<td>L – pulp &amp; PIP</td>
<td>Limited / 1990</td>
<td>Pain / Risk of infection</td>
<td>SS / Sensation</td>
<td>27.7</td>
<td>56.5</td>
<td>0.8</td>
<td>48.3</td>
<td>4.8 / 48.4</td>
<td>58.2</td>
</tr>
<tr>
<td>3</td>
<td>81</td>
<td>T / I / L</td>
<td>R – PIP</td>
<td>Limited / 1992</td>
<td>Pain / VU</td>
<td>Pain / VU</td>
<td>27.3</td>
<td>42.1</td>
<td>4.7</td>
<td>64.7</td>
<td>36.0</td>
<td>44.3</td>
</tr>
<tr>
<td>4*</td>
<td>53</td>
<td>T / I</td>
<td>S – pulp &amp; volar MP</td>
<td>Diffuse / 1999</td>
<td>Pain / VS</td>
<td>N/A / VS</td>
<td>34.9</td>
<td>63.6</td>
<td>5.5</td>
<td>20.8</td>
<td>72.9 / 80.0</td>
<td></td>
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<tr>
<td>5*</td>
<td>65</td>
<td>I</td>
<td>I – pulp / tip</td>
<td>Limited / 2009</td>
<td>Cosmetic / VS</td>
<td>N/A / VS</td>
<td>51.1</td>
<td>54.7</td>
<td>0.0</td>
<td>5.0</td>
<td>78.3</td>
<td>82.0</td>
</tr>
<tr>
<td>6</td>
<td>27</td>
<td>T / I / L</td>
<td>T – pulp</td>
<td>Limited / 2001</td>
<td>Pain / VU</td>
<td>N/A / VS</td>
<td>47.3</td>
<td>50.6</td>
<td>1.8</td>
<td>18.3</td>
<td>53.8</td>
<td>52.9</td>
</tr>
<tr>
<td>7*</td>
<td>50</td>
<td>T</td>
<td>I – volar radial aspect of P1 &amp; volar ulnar P2 &amp; pulp radial</td>
<td>Limited / 2003</td>
<td>Pain / SS</td>
<td>Pain Function</td>
<td>31.0</td>
<td>59.4</td>
<td>7.5</td>
<td>34.7</td>
<td>45.9</td>
<td>33.1</td>
</tr>
<tr>
<td>8</td>
<td>82</td>
<td>T / I / L</td>
<td>T – pulp</td>
<td>Limited / 1985</td>
<td>Function / SU</td>
<td>Function</td>
<td>30.0</td>
<td>28.9</td>
<td>4.7</td>
<td>71.7</td>
<td>36.0</td>
<td>49.9</td>
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<tr>
<td>9</td>
<td>63</td>
<td>I / I / L</td>
<td>I – mid P2 / pulp</td>
<td>Limited / 1994</td>
<td>Function / Stiffness</td>
<td>Function Stiffness</td>
<td>32.0</td>
<td>39.0</td>
<td>5.0</td>
<td>55.2</td>
<td>31.3</td>
<td>40.8</td>
</tr>
</tbody>
</table>

Table 1. Patient outcomes.
VU = Very Unsatisfied, SU = Somewhat Unsatisfied, SS = Somewhat Satisfied, VS = Very Satisfied
T = Thumb, I = Index, L = Long, R = Ring, S = Small
(*) and bold indicates patients that would have surgery again.

Figure 1. AP radiograph and intraoperative photo of a patient with calcinosis cutis of the tip of the thumb, Index DIP joint of long and small fingers and base of thumb.

♦ Nothing of financial value to disclose
Hypothesis: High-level musicians, such as music performance majors and professional musicians spend many hours practicing and performing. Such activity involves highly coordinated, repetitive use of the hands to master complex patterns of finger motion necessary to produce rapid musical passages. We hypothesized that such musicians have more sensitive, stronger, and flexible hands than non-musicians.

Methods: One hundred musicians and one hundred age matched control subjects were included and assessed for two-point discrimination, Semmes-Weinstein monofilament light touch, grip and pinch strength, and laxity using the Beighton modification of the Carter Wilkinson laxity scoring system. Musicians were included if enrolled as instrumental performance majors at a four-year accredited conservatory of music (aged 18-28). Non-musician controls were age-matched university students who never or rarely engaged in playing an instrument. Exclusion criteria were history of any hand condition, trauma, surgery, or diabetes. Statistical analysis, as reviewed by a statistician, was carried out using t-test and ANOVA.

Results: High-level musicians in our cohort show the same handedness as the general population (Table 1). All strength measurements were weaker in musicians. Male musicians were significantly weaker in pinch (mean 8.09 vs 9.45 kg, musicians vs non-musicians, p=0.007) and grip (37.0 vs 41.9 kg, p=0.02) than non-musicians whereas female musicians were only significantly weaker in grip on the right (24.0 vs 26.5 kg, p=0.03). Two-point discrimination was significantly smaller in musicians for all digits except thumbs bilaterally (2.91 vs 3.13 mm, p=0.02) as was sensitivity to Semmes-Weinstein testing on the right digits, including thumb (2.46 vs 2.61, p=0.003), but not the left digits with the exception of the ring (2.48 vs 2.55, p=0.2 for all digits, 2.43 vs 2.53, p=0.037 for ring). There was no difference in laxity between the two groups.

Summary:
- Musicians hands are significantly more sensitive in spatial discrimination.
- The right hands of musicians have a significantly lower detection threshold for light touch.
- Male musicians are significantly weaker in pinch and grip than non-musicians as are female musicians in right hand grip.
- High-level musicians have, in general, more sensitive but weaker hands than non-musicians but the differences seem clinically small.

References:
5. Dellon, AL; Mackinnon, SE; Crosby, PM. Reliability of two-point discrimination measurements. J Hand Surg [Am], 1987, 12, 5 Pt 1, 693-696.

<table>
<thead>
<tr>
<th></th>
<th>Musicians</th>
<th>Non-musicians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total subjects</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Age, average (range)</td>
<td>20.05 (18-28)</td>
<td>20.25 (18-27)</td>
</tr>
<tr>
<td>Female</td>
<td>52</td>
<td>61</td>
</tr>
<tr>
<td>Male</td>
<td>48</td>
<td>39</td>
</tr>
<tr>
<td>Right handed</td>
<td>93</td>
<td>91</td>
</tr>
<tr>
<td>Left handed</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Instrument
- Flute  | 5
- Oboe   | 8
- Clarinet | 5
- Bassoon | 5
Saxophone 2
Violin 10
Viola 9
Cello 5
Bass 7
Trumpet 1
French horn 1
Trombone 6
Euphonium 2
Tuba 1
Percussion 8
Harp 5
Guitar 2
Piano 17
Organ 1

Years played (range) 11.1 (4-22)
Hours per day practicing (range) 3.26 (0.5-7)
Years at current level of practice (range) 4.11 (1-20)

Table 1. Subject characteristics

<table>
<thead>
<tr>
<th></th>
<th>Musicians</th>
<th>Non-musicians</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 point discrimination, mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(range 2-6 for musicians, 2-9 for non-musicians)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left thumb</td>
<td>3.11</td>
<td>3.04</td>
</tr>
<tr>
<td>Left index</td>
<td>2.63</td>
<td>2.82</td>
</tr>
<tr>
<td>Left middle</td>
<td>2.86</td>
<td>3.01</td>
</tr>
<tr>
<td>Left ring</td>
<td>2.96</td>
<td>3.24</td>
</tr>
<tr>
<td>Left small</td>
<td>3.33</td>
<td>3.64</td>
</tr>
<tr>
<td>Right thumb</td>
<td>2.88</td>
<td>2.91</td>
</tr>
<tr>
<td>Right index</td>
<td>2.53</td>
<td>2.68</td>
</tr>
<tr>
<td>Right middle</td>
<td>2.77</td>
<td>2.94</td>
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<tr>
<td>Right ring</td>
<td>3.03</td>
<td>3.22</td>
</tr>
<tr>
<td>Right small</td>
<td>3.18</td>
<td>3.52</td>
</tr>
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</table>

Semmes Weinstein,
common log of force measured in tenths of
a milligram (range 1.65-2.83 for both groups)

<table>
<thead>
<tr>
<th></th>
<th>Left thumb</th>
<th>Left index</th>
<th>Left middle</th>
<th>Left ring</th>
<th>Left small</th>
<th>Right thumb</th>
<th>Right index</th>
<th>Right middle</th>
<th>Right ring</th>
<th>Right small</th>
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<tbody>
<tr>
<td></td>
<td>2.57</td>
<td>2.48</td>
<td>2.47</td>
<td>2.43</td>
<td>2.49</td>
<td>2.51</td>
<td>2.46</td>
<td>2.50</td>
<td>2.40</td>
<td>2.44</td>
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<td>2.67</td>
<td>2.61</td>
<td>2.60</td>
<td>2.58</td>
<td>2.59</td>
</tr>
<tr>
<td></td>
<td>p = 0.71</td>
<td>p = 0.068</td>
<td>p = 0.078</td>
<td>p = 0.037</td>
<td>p = 0.23</td>
<td>p = 0.0023</td>
<td>p = 0.0056</td>
<td>p = 0.0065</td>
<td>p = 0.000067</td>
<td>p = 0.00019</td>
</tr>
</tbody>
</table>

Grip/pinch, female, kg (range)

<table>
<thead>
<tr>
<th></th>
<th>Grip left</th>
<th>Grip right</th>
<th>Pinch left</th>
<th>Pinch right</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22.4 (12-42)</td>
<td>24.4 (10-40)</td>
<td>5.68 (2.5-8.5)</td>
<td>5.69 (2-9)</td>
</tr>
<tr>
<td></td>
<td>24.0 (12-46)</td>
<td>26.5 (12-38)</td>
<td>5.95 (2-10)</td>
<td>6.39 (2-11.5)</td>
</tr>
<tr>
<td>p</td>
<td>0.081</td>
<td>0.030</td>
<td>0.25</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Grip/pinch, male, kg (range)

<table>
<thead>
<tr>
<th></th>
<th>Grip left</th>
<th>Grip right</th>
<th>Pinch left</th>
<th>Pinch right</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35.7 (12-66)</td>
<td>40.1 (20-65)</td>
<td>8.15 (3-12)</td>
<td>8.02 (4-13.5)</td>
</tr>
<tr>
<td></td>
<td>38.3 (18-65)</td>
<td>43.6 (22-64)</td>
<td>9.18 (6-15)</td>
<td>9.71 (6-12.5)</td>
</tr>
<tr>
<td>p</td>
<td>0.020</td>
<td>0.0092</td>
<td>0.013</td>
<td>0.0000071</td>
</tr>
</tbody>
</table>

Laxity, can touch thumb to wrist/bend small finger >90°, percent positive

<table>
<thead>
<tr>
<th></th>
<th>Left wrist</th>
<th>Left small</th>
<th>Right wrist</th>
<th>Right small</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>34</td>
<td>16</td>
<td>28</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>21</td>
<td>39</td>
<td>18</td>
</tr>
<tr>
<td>p</td>
<td>0.23</td>
<td>0.35</td>
<td>0.091</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Table 2. Two point discrimination, Semmes Weinstein, grip/pinch, and laxity data. Significant p values are bolded.

♦ Nothing of financial value to disclose
Hypothesis: Traumatic upper extremity amputations cause significant morbidity and replantations comprise one of the most difficult challenges to the hand surgeon. Current clinical practice is largely dictated by surgeon training, experience and case-load.

Methods: We conducted a multinational 32-question survey of ASSH members that were involved in replantation surgery. The survey looked at surgeon demographics, training, case loads, perioperative practices and clinical outcomes.

Results: 234 surgeons, who currently perform replantations, responded and consented to the survey. The participants practiced in the US, Canada, UK, Israel and Saudi Arabia. Orthopedic surgeons comprised 67% of the respondents, while plastic surgeons accounted for 29% and general surgeons were 4%. Almost 99% of the surgeons said they had Microsurgery, Hand Surgery or other related fellowship training. Most surgeons reported performing replantation surgeries for more than 5 years (72%) but the vast majority had a yearly caseload of 10 replantations or less (88%) and worked at institutions with yearly caseloads of 20 or less (77%). Type of amputation (avulsed, crush or clean cut) and ischemia time were ranked as the most important preoperative factors with respect to a successful outcome. Single digit or thumb replantations were the most performed (99%) and had the highest success rates (86% of respondents reported a success rate greater than 50% and 30% of respondents reported a greater than 80% success rate). Conversely, proximal forearm and elbow replantations were only performed by 52% of all respondents with lower success rates (62% of respondents had a success rate of 50% or more). The most common postoperative regimen included antibiotics (93%), warming blanket (79%), aspirin or Plavix (75%), continuous IV hydration (77%) and bed rest with limb elevation for 1-3 days (63%). 91% of the surgeons reported that patients needed 1 or more additional surgeries (after the replantation) to achieve an acceptable outcome.

Summary:
- The survey outlines the current practices and reported outcomes of ASSH replantation surgeons.
- The practice patterns and outcomes will be discussed.
• More outcome and evidence bases studies are needed to standardize replantation practices across varied surgical training, hospital settings and countries.

<table>
<thead>
<tr>
<th>Intervention (n= total number of surgeons using this intervention in post-operative care)</th>
<th>Post-operative Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coumadin (n=1)</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Anticoag (other) (n=15)</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Bed Rest / Elevation &gt; 3 days (n=34)</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Anticoag w/Heparin (n=45)</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Dextran (n=46)</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Bed Rest / Elevation ≤ 3 days (n=77)</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Continuous IV fluids (n=89)</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Aspirin/Plavix (n=91)</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Warming Blanket (n=92)</td>
<td>![Bar Chart]</td>
</tr>
<tr>
<td>Antibiotics (n=113)</td>
<td>![Bar Chart]</td>
</tr>
</tbody>
</table>

% within each intervention of Surgeons who used it

♦ Nothing of financial value to disclose
RF E-POSTER 26: Outcomes of Treatment of Carpal Tunnel Syndrome Secondary to Atypical Flexor Tenosynovitis Infection

Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Hand
Level 4 Evidence

♦ Dalibel Bravo, BS
♦ Eric Wagner, BS
♦ Bassem T. Elhassan, MD

Hypothesis: The purpose of this study was to identify patients who presented to our institution with signs and symptoms of carpal tunnel syndrome (CTS) secondary to atypical flexor tenosynovitis infection at the wrist, and to determine the outcomes of treatment.

Methods: We identified 141 patients who presented at our institution with symptoms of CTS secondary to infection. Fourteen of these cases were determined to be secondary to atypical infections of the flexor tenosynovium at the wrist. Collection of data included type of microbial infection, duration of antibiotic therapy, type and number of procedures, comorbidities, and final outcome.

Results: There were equal numbers of men and women, with an average age of 58 years (±11.72). The most commonly presenting symptoms included swelling at the wrist with painful limited range of motion of the fingers. The most commonly isolated type of organisms included: mycobacterium avium intracellulare (MAI) in 5 patients (36%), and histoplasma capsulatum in 2 (14%). The remaining patients had isolated single cases of streptococcus pyogenes, streptococcus pneumoniae, gram negative bacillus, pasturella multocida, propionibacterium, candida parapsilosis, and polymicrobial infection. Treatment included single or multiple surgical débridements of the flexor tenosynovium, with an average number of 2.4 (±1.5) procedures combined with long-term antimicrobial therapy with an average duration of 5.9 months (±5.8). MAI required the longest medical treatment with an average duration of 12.3 months (±4.9). Among the isolated microbes no specific cause of the infection was noted except for one patient who had a cat bite prior to the development of symptoms. Comorbidities associated with these atypical infections include: immunosuppression in patients with rheumatoid arthritis (2), dermatomyositis (1), renal transplant (1), and knee septic joint (1). Among those with at least 24 months (±40.2) of follow up, 7 (78%) patients had resolution of symptoms with no recurrence, while one patient with candida parapsilosis had recurrence of infection which occurred after 33 months, and another patient with streptococcus pyogenes necessitated amputation of the index finger because his infection was complicated by sepsis.
**Summary:** Development of carpal tunnel syndrome as a result of atypical infection of the flexor tenosynovium at the wrist is rare. The treating physician should keep it in the diagnostic differentials in immune compromised patients who present with signs and symptoms of CTS associated with wrist swelling and limited range of motion of the fingers. Débridement and long-term antibiotics are the mainstay of treatment with good expected outcomes.

**References:**

♦ Nothing of financial value to disclose
RF E-POSTER 27: Internal Fixation of Distal Metacarpal Fractures: “New” Uses for an Old Plate

Category: Fractures and Dislocations
Keyword: Hand
Level 4 Evidence

♦ Paul Sibley, DO
♦ Sidney Jacoby, MD
● Joshua Abzug, MD
♦ Michael Rivlin, MD
● John M. Bednar, MD

Hypothesis: The purpose of this study was to examine our outcomes following utilization of a mini-condylar blade plate for the treatment of distal metacarpal fractures. We hypothesized that we would obtain functional results with minimal complications.

Methods: Twenty-two distal metacarpal fractures in 20 patients treated with a mini-condylar blade plate were retrospectively reviewed. Outcome measures collected included postoperative grip strength, range of motion, return to work, and radiographic evidence of osseous union.

Results: The average arc of motion of the metacarpal-phalangeal (MCP) joint was 62 degrees post-operatively. 82% (18 of 22 fractures) were able to flex their digits to their distal palmar crease. 71% (12 of 17 patients) had at least 75% return to grip strength compared to the contralateral side. The average return to full activity (17 patients) was 2.5 months (range 1-3 months) after surgery. There were no major complications.

Summary:
- Certain metacarpal fracture patterns require operative fixation to restore anatomy and optimize results.
- Compared to dorsal plating, the width of the mini-condylar blade plate buttresses the deforming volar pull of the intrinsics and provides a stronger construct.
- The implant provides firm fixation in the juxta-articular fragment with minimal space requirements.
- The mini-condylar blade plate is a safe and effective technique for stabilizing unstable peri-articular metacarpal fractures.
- Stable fixation allows for early range of motion, rapid return to strength, and a relatively quick return to full work duty.
- We have shown a low complication rate, however stiffness and residual pain can occur.
- The utilization of this technique should be considered when treating distal metacarpal fractures with open reduction and internal fixation.

- Royalties/honoraria: Springer (Abzug)
- Ownership interest: Philadelphia Hand Center (Bednar)
- Nothing of financial value to disclose
RF E-POSTER 28: Distal Radius Traction Views: Inter- and Intra-observer Reliability with Comparison to Computed Tomography

Category: Fractures and Dislocations
Keyword: Wrist
Not a clinical study

Daniel M. Avery, MD
Kristofer S. Matullo, MD

Hypothesis: Our goal was to compare five traction view images to CT images to evaluate the interobserver and intraobserver reliability of individual fracture fragment identification, the correct identification of fracture fragments on CT imaging versus traction views, and consistency of treatment recommendations.

Methods: Eleven observers were asked to evaluate two blinded presentations of either traction images or CT images displaying seventeen different intra-articular distal radius fractures. Each observer was then asked to identify the presence or absence of six specific fracture fragments (radial column, dorsal wall, dorsal ulnar corner, volar ulnar corner, volar rim, and central impaction) and recommend treatment (nonoperative, open reduction internal fixation, external fixation/distraction plating). Analysis were then conducted to evaluate the interobserver reliability of traction view images and CT images for fracture fragment identification, intraobserver variability for fragment identification, correct fracture fragment identification with traction views versus a CT gold standard, and assess the consistency in treatment selection.

Results: Interobserver reliability for traction view images and CT images were both fair to poor. Intraobserver variability for fragment identification was similar for each fragment without statistical significance. Correct identification of fracture fragments was significantly better with the radial column on CT imaging (71.8%) and the volar rim fragment with traction view imaging (72.7%). Treatment recommendation was similar for each imaging modality agreeing in 80.9% of situations for ORIF and 67.9% for external fixation.

Summary: Traction view images are a suitable alternative to CT imaging for distal radius fractures. Our data shows similar interobserver reliability as compared to CT imaging, no significant difference with regard to intraobserver variability, consistent correct identification in 4 of 6 major fracture fragments, and little difference with regard treatment recommendations. Level of Evidence: Level II
Correct fracture fragment identification averages for each imaging modality with and without residents

<table>
<thead>
<tr>
<th>Surgeon</th>
<th>Radial Column</th>
<th>Dorsal Wall</th>
<th>Dorsal Ulnar Corner</th>
<th>Volar Ulnar Corner</th>
<th>Volar Rim</th>
<th>Central Impaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traction Views with residents CT imaging with residents</td>
<td>65.8</td>
<td>61.5</td>
<td>66.3</td>
<td>55.1</td>
<td>72.7</td>
<td>73.8</td>
</tr>
<tr>
<td>p Value</td>
<td>0.04</td>
<td>0.33</td>
<td>0.19</td>
<td>0.33</td>
<td>&lt;0.01</td>
<td>0.92</td>
</tr>
<tr>
<td>Traction Views without residents CT imaging without residents</td>
<td>68.6</td>
<td>60.1</td>
<td>68</td>
<td>54.9</td>
<td>74.5</td>
<td>76.5</td>
</tr>
<tr>
<td>p Value</td>
<td>0.02</td>
<td>0.35</td>
<td>0.83</td>
<td>0.95</td>
<td>&lt; 0.01</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Table 5. Evaluation of fragment identification averages in groups with and without residents.

<table>
<thead>
<tr>
<th>Traction View</th>
<th>ORIF</th>
<th>Non-OP</th>
<th>Ex-Fix</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>114</td>
<td>7</td>
<td>20</td>
<td>141</td>
</tr>
<tr>
<td>% within Traction View</td>
<td>60.9%</td>
<td>3.7%</td>
<td>10.7%</td>
<td>75.4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Traction View</th>
<th>Non-OP</th>
<th>Ex-Fix</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>12</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>% within Traction View</td>
<td>6.4%</td>
<td>2.7%</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Traction View</th>
<th>Ex-Fix</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>% within Traction View</td>
<td>4.8%</td>
<td>.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
<th>ORIF</th>
<th>Non-OP</th>
<th>Ex-Fix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>135</td>
<td>12</td>
<td>40</td>
</tr>
<tr>
<td>% within Traction View</td>
<td>72.1%</td>
<td>6.4%</td>
<td>21.4%</td>
</tr>
</tbody>
</table>

Table 6. Diagram a treatment recommendation based on imaging modality

- Consulting fees: Synthes
- Nothing of financial value to disclose
RF E-POSTER 29: Osteosynthesis or Acute Arthroplasty for Geriatric Distal Humerus Fractures: A Systematic Review and Meta-analysis

Category: Fractures and Dislocations
Keyword: Elbow
Level 3 Evidence

♦Michael Githens, MD

Hypothesis: There is a growing body of evidence suggesting that total elbow arthroplasty (TEA) is a suitable alternative to open reduction internal fixation (ORIF) for geriatric intra-articular distal humerus fractures. The purpose of this meta-analysis was to compare TEA with ORIF in terms of functional outcomes and complications.

Methods: PubMed, Embase and the Cochrane database were utilized. The search included publications up to December 2011. Studies meeting inclusion criteria were observational studies or randomized controlled trials evaluating functional and radiographic outcomes and complications in elderly patients treated for intra-articular distal humerus fractures with either primary TEA or ORIF. Studies with mean age < 60, indications other than acute fracture for TEA or use of non-locked constructs were excluded. A quality assessment tool was used to evaluate individual study methodology. Standardized data extraction was performed and data was pooled for analysis. Descriptive statistics for functional outcomes were reported. Meta-analysis and regression analysis were performed for complication rates.

Results: Twenty-five studies with 505 patients met inclusion criteria. In 24 studies, quality was determined to be weak while one study was of moderate quality. Mean arc of motion was 101 degrees after TEA and 99.5 after ORIF. Mean Mayo Elbow Performance Scores were 90.4 after TEA and 87.4 after ORIF. There was no difference in the percentage of patients experiencing at least one complication; 32.5% after TEA versus 31.9% after ORIF. TEA resulted in 10.9% major and 25.4% minor complication rates whereas ORIF resulted in 12.9% major and 20.1% minor complication rates. The rate of deep infection was similar between groups at 3.5% (CI 1.3-5.7%) after TEA compared to 2.3% (CI 0.5-4.1%) after ORIF. There was no significant difference in rates of neuropraxia, superficial wound complications or heterotopic ossification. Radiographic loosening occurred at a rate of 4.4% (CI 2.0-6.9%) in TEA patients and non-progressive radiolucency occurred in 9.8% (CI 4.3-15.4%). Regression analysis was performed to determine if mean age, duration of follow-up, time to surgery or date of study publication had an effect on any complication rate. None of these variables had a significant effect on any complication rate in either group.

Summary: Results of this study show similar functional outcomes and range of motion after either treatment. The quality of studies was generally weak. Rates of major complications were
higher after ORIF. Ongoing research is indicated to better define the roles of ORIF vs. TEA in the management of these injuries.

♦ Nothing of financial value to disclose
RF E-POSTER 30: Reamer Irrigator Aspirator as a Novel Source of Autogenous Bone Graft for Traumatic Bone Defects of the Upper Extremity: A Case Series

Category: Fractures and Dislocations
Keyword: Forearm
Level 4 Evidence

♦ Flynn A. Rowan, MD
♦ Gregory L. DeSilva, MD
♦ Jordan Smith, MD

**Hypothesis:** The Reamer-Irrigator-Aspirator (RIA) system is a useful tool for harvesting autologous bone graft in the treatment of large segmental bone defects of the upper extremity.

**Methods:** This is a retrospective review of charts, operative notes, and imaging studies of three patients treated with autologous bone grafting to the upper extremity using RIA as the source of autograft.

**Results:** Three patients sustained high energy accidents in motor vehicle accidents. There were 2 males and 1 female with an average age of 49. By Gustillo-Anderson open fracture classification, one fracture was classified as a Type IIIA while 2 were Type IIIB requiring free tissue transfer. By the OTA fracture classification system, two fractures were classified as 22C3, and the third was classified as 22C2. All three cases were stabilized with rigid plate fixation while two additionally had an antibiotic cement spacer placed. Union was achieved in all three patients undergoing RIA autograft to the forearm. Plain radiographs demonstrated complete osseous bridging with no evidence of hardware failure, and patients were left with functional extremities.

**Summary:** Segmental bone defects of long bones poses a challenge to the treating surgeon. While short defects may be amenable to traditional bone grafting, management of large segmental defects is more challenging. The Reamer-Irrigator-Aspirator (RIA) is a new tool to harvest copious amounts of autologous cancellous bone. RIA harvested bone from the femoral medullary canal offers increased biologic activity, a large quantity of bone, and less pain and fewer complications than iliac crest bone grafting. RIA can be harvested from the contralateral femur concurrently to reduce operative time. This case series demonstrates the utility of RIA as a new technique for treating segmental bone defects of the upper extremity and is option for the upper extremity surgeon.

**References:**


3. Sagi HC, Young ML, Gerstenfeld L, Einhorn TA, Tornetta P. Qualitative and Quantitative Differences Between Bone Graft Obtained from the Medullary Canal (with a Reamer/Irrigator/Aspirator) and the Iliac Crest of the Same Patient. JBJS 2012; 94:2128-35.


7. Stafford, PR, Norris BL. Reamer-irrigator-aspirator bone graft and bi Masquelet technique for segmental bone defect nonunions: a review of 25 cases.


♦ Nothing of financial value to disclose
Hypothesis: Proximal phalangeal fractures account for the majority of hand fractures and can result in a great deal of morbidity in motion deficit. Periarticular pinning has been shown to be a good treatment option in fractures at the base of the proximal phalanx. The goal of this study was to review results of periarticular pinning of the proximal phalanx in fractures at the base as well as the shaft.

Methods: A retrospective review of the senior author's records over 6 years yielded 50 surgical treatments of proximal phalangeal fractures in 43 patients. All underwent periarticular pinning of their unstable fractures. Records were reviewed to ascertain time to healing, fracture demographics, functional results and complication rates.

Results: A total of 19 males and 24 females underwent percutaneous periarticular pinning between 2006 and 2012 under the care of the senior author. A total of 50 fingers were treated. This included 16 shaft and 34 basal fractures. Five fractures were open (10%). The small finger was involved in 62%, the ring in 30%, index and middle in 4% each. Most fractures were either transverse or oblique and just over half had comminution and/or impaction. Three patients developed PIP stiffness requiring tenolysis, one patient had a pin site infection that was treated with antibiotics, and another had a pin site infection with some loss of reduction. Average follow up was 105 days. Average time to union defined as clinically nontender fracture site and radiographic bony bridging from date of surgery was 34.7 days. Twenty six fingers (52%) achieved excellent results, lacking 10 degrees or less of motion. Seven patients (14%) had good results, lacking less than 20 degrees of motion in either direction. Another seven had fair results, lacking 40 to 60 degrees of motion. And one had poor results lacking greater than 60 degrees of motion. Two of the patients who underwent tenolysis as a secondary procedure achieved excellent motion as an end result, lacking only 10 degrees of full extension. Results for shaft fractures were not significantly different from those for base fractures.

Summary:
- Percutaneous periarticular pinning is a good surgical option for unstable metaphyseal and diaphyseal fractures of the proximal phalanx.
- Most fractures are expected to unite within four weeks.
• Loss of PIP motion can be expected in 15 to 30 percent of patients, sometimes necessitating a secondary procedure.

References:

● Consulting fees: Techniques in hand and upper extremity surgery, Journal of Orthopaedic Trauma
♦ Nothing of financial value to disclose
RF E-POSTER 32: Scaphoid Morphology and Trans-Scaphoid Perilunate Fracture-Dislocations

Category: Fractures and Dislocations  
Keyword: Wrist  
Not a clinical study

♦ Mark C. Shreve, MD  
♦ Jensen Henry, BA  
♦ Anthony Sapienza, MD  
● Nader Paksima, DO, MPH

Hypothesis: We identified a distinct type of scaphoid morphology, previously undescribed, in which the scaphoid has a prominent dorsal lip that covers the proximal pole of the capitate. The purpose of this study was to examine this dorsal lip in a population of normal wrists, and compare this to a series of patients with trans-scaphoid perilunate injuries. Our hypothesis was that patients with this injury tend to have more dorsal coverage of the capitate by the scaphoid.

Methods: A list of all wrist computed tomography scans from 2005-2012 were obtained from our institution’s radiology department. Scans were excluded based on the following criteria: fractures of the scaphoid, distal radius, or any other carpal bones; severe erosive arthritis; poor image quality (>2mm cuts or not true axial cuts); excessive radial/ulnar deviation or flexion/extension; and patient age 30% overlap). The average dorsal scaphoid overlap was 23.75±15.03% for the asymptomatic population and 36.92±10.36% for the cases. This was a significant difference (p=0.018).

Summary:
- The scaphoid can be classified into two groups based on dorsal overlap on the capitate: type I 30%.
- The data suggest that there is a trend towards higher incidence of type II scaphoids in patients with trans-scaphoid perilunate injuries.
Figure 1. Example of Dorsal Overlap. (A) Axial CT image demonstrating dorsal overlap (arrow), reference angle to volar capitate surface (dashed lines), and distances used for dorsal overlap calculation (solid lines). (B) Radiograph of patient showing overlap, indicated by the arrows. (C) Axial CT image demonstrating no overlap. (D) Radiograph of patient with no overlap. S = scaphoid; C = capitate.

- Contracted research: Stryker grant for distal radius research
- Ownership interest: Small Bone Innovations
- Consulting fees: Stryker, IMDS
- Nothing of financial value to disclose
Hypothesis: We sought to identify a group of patients at our institution who sustained carpometacarpal joint dislocations and retrospectively determine their outcomes following a variety of treatments in order to determine outcomes of these injuries following treatment, to identify a classification system of these complex injuries, and thereby derive a treatment algorithm for carpometacarpal dislocations.

Methods: A retrospective review was performed of the electronic medical record of all patients treated between 2004-2011 by the orthopaedic surgery service at our institution. Outcomes were measured in terms of range of motion, grip strength, and any associated complications following treatment.

Results: Fifty patients were identified who underwent their initial treatment on average 3.6 days after injury with an average of 143 days follow-up. Over-all 81% of patients regained full range of motion and 76% of the grip strength of the contralateral hand. Sixty percent of patients were amenable to non-operative treatment as they were stable following initial closed reduction. Ninety-three percent of patients who underwent non-operative treatment had full range of motion in comparison to 74% of patients who underwent operative treatment. Patients who sustained a fracture and dislocation of the same metacarpal were more likely to require operative treatment due to residual instability.

Summary: Carpometacarpal dislocations have a favorable prognosis when treated in an expeditious fashion. Patients who underwent non-operative treatment had better outcomes in terms of range of motion and grip strength. The nature of the carpometacarpal dislocation to include whether it involved a single or multiple carpometacarpal joints and the presence of an associated carpal fracture did not have a significant impact on the type of treatment required or on patient outcomes. Carpometacarpal dislocations with fracture and dislocation of the same metacarpal more frequently required operative fixation. Our proposed classification system provides guidance for treatment and for the prognosis of these complex injuries.
Hypothesis: Midcarpal Instability (MCI) is a form of carpal instability non-dissociative. Patients demonstrating MCI exhibit a painful catch-up clunk during ulnar deviation and pronation of the wrist. The purpose of this study was to present our results and experience with arthroscopic shrinkage capsulorrhaphy for MCI.

Methods: This was a retrospective review. The medical records of all patients that underwent electrothermal capsular shrinkage and midcarpal pinning for MCI between 2005 and 2012 were reviewed. A total of 29 surgical procedures were performed. The average age at time of surgery was 29 years, with 21 right-sided injuries and 8 left sided. Nine patients had a history of previous trauma of the affected hand. Wrist range of motion, grip strength, the midcarpal shift test and complications were assessed after an average post-operative duration of 7.3 months (range 1 to 54 months). Patients were contacted by telephone after a mean of 4.1 years after surgery and asked if the midcarpal clunk had persisted or relapsed, whether they considered the surgery a success or not. Patients were also asked to complete the Patient Rated Wrist Evaluation questionnaire (PRWE).

Results: The total study population included 27 patients: 14 males and 13 female. Postoperatively on physical exam, 96% displayed a negative midcarpal shift test, n=24. The average pre and postoperative wrist flexion was 60° and 47° respectively, n = 23, p = 0.001. The average pre and postoperative wrist extension was 69° and 50° respectively, n = 23, p < 0.001. The average grip strength was 47 lbs preoperatively and 45 lbs postoperatively, n = 10, p = 0.731. Four patients required partial or total wrist fusion, 4 patients had superficial wound infections while 2 patients developed deep infections. Nine patients could be reached by telephone; the mean PRWE was 13/100, the wrist clunk had relapsed or persisted in 5 patients (56%) and 7 patients (78%) considered the surgery a success, while 2 did not.

Summary:
• While the short-term postoperative assessment demonstrated the absence of midcarpal shift in the majority of cases, they also demonstrated a significant loss of wrist flexion and extension.
• Infection occurred in 21% of patients. The risk of infection could potentially be reduced by burying the k-wires.
• Medium term patient rated outcomes indicate that the majority of patients had good functional outcomes and were satisfied with treatment, although the midcarpal clunk relapsed in a high proportion of cases.

 References:

● Consulting fees: Biomet, Auxilium, SBi, Arthrex
♦ Nothing of financial value to disclose
Hypothesis: Rapid magnetic resonance imaging (Active-MRI) protocol can be utilized to evaluate the wrist during real-time active motion, and the resulting images enable measurement of metrics typically evaluated in the setting of wrist instability.

Methods: A 3T MR protocol utilizing a balanced steady-state free precession (bSSFP) pulse sequence (TrueFISP, Siemens Healthcare, Inc.) was developed for imaging the wrist at a single plane during active movement, with 0.94mm x 0.94mm in-plane spatial resolution, 6mm slice thickness, and temporal resolution of 475ms per image (2D Active-MRI). To measure motion parameters that occurred out of the single plane, novel real-time 3T MRI protocols were developed, utilizing another bSSFP sequence (FIESTA, GE Healthcare, Inc.) in 3D acquisition mode. Volumetric data was obtained during active motion, in different scans providing the following isotropic spatial and temporal resolutions: 1.2mm and 5.03s; 1.6mm and 2.95s, 2.0mm and 2.12s (3D Active-MRI). Fifteen wrists of asymptomatic volunteers were scanned with 2D Active-MRI, and four wrists of asymptomatic volunteers were scanned with 3D Active-MRI protocols. Specifics of evaluated motions and measurements are shown in Figure 1. All measurements were performed by consensus of two experienced observers (fellowship-trained musculoskeletal radiologist and an orthopedic hand surgeon) in neutral and at the maximal endpoints of the range of motion.

Results: The real-time 2D Active-MRI imaging protocol allowed measurements of parameters in the single plane of the examined wrist motion (see Table 1). 3D volume rendering was able to show out-of-plane movement and allowed more precise measurements. Ulnar variance was only measured in one wrist. In pronation, neutral, and supination UV was -1mm, -2mm, and -4mm, respectively. The SL and CL angles were measured in radial/ulnar deviation in 4 wrists. The mean SL angles in ulnar deviation, neutral, and radial deviation were 60deg, 72deg, and 68deg,
respectively. The mean CL angles in ulnar deviation, neutral, and radial deviation were 0deg, 13deg(volar), and 2deg(dorsal), respectively.

Summary:
- High resolution real-time 2D single plane and 3D volumetric MR images of the wrist can be successfully acquired during active wrist motion with negligible artifacts.
- Active-MRI can be successfully used to obtain objective information relevant to wrist mechanics and instability with no radiation exposure.
- Active-MRI of the wrist is much faster than routine “static” 2D and 3D MR imaging, and may assist in a physiologic and functional imaging evaluation.

References:
Figure 1 – Images obtained and parameters measured during active wrist motion

ECU – extensor carpi ulnaris; DRUJ – distal radioulnar joint; SL – scapholunate; CL – capitolunate; RL – radiolunate

Table I: Quantitative metrics derived from 2D motion-MRI images of the wrist during the different maneuvers.

<table>
<thead>
<tr>
<th>Pronation/Supination maneuver*</th>
<th>Pronation</th>
<th>Neutral</th>
<th>Supination</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRUJ subluxation ratio in dorsal direction [mean (range)] **</td>
<td>0.14 (0.059 to 0.27)</td>
<td>0.10 (0.056 to 0.2)</td>
<td>0.040 (-0.063 to 0.17)</td>
</tr>
<tr>
<td>ECU tendon location relative to its groove</td>
<td>Dislocated</td>
<td>1/14 (7%)</td>
<td>2/14 (14%)</td>
</tr>
<tr>
<td></td>
<td>Perched</td>
<td>2/14 (14%)</td>
<td>7/14 (50%)</td>
</tr>
</tbody>
</table>

Radial/ulnar deviation
<table>
<thead>
<tr>
<th>Metric</th>
<th>Ulnar deviation</th>
<th>Neutral</th>
<th>Radial deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL gap (mm) [mean (range)]</td>
<td>1.43 (1 to 2)</td>
<td>1.43 (1 to 2)</td>
<td>1.43 (1 to 2)</td>
</tr>
<tr>
<td>Ulnar variance (mm) [mean (range)]</td>
<td>-0.93 (0 to -2)</td>
<td>-0.93 (0 to -2)</td>
<td>-0.92 (0 to -2)</td>
</tr>
</tbody>
</table>

Clenched fist maneuver

<table>
<thead>
<tr>
<th>Metric</th>
<th>Relaxed fist</th>
<th>Clenched fist</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL gap (mm) [mean (range)]</td>
<td>1.36 (1 to 2)</td>
<td>1.64 (1 to 3)</td>
</tr>
</tbody>
</table>

Neutral and Dorsiflexion***

<table>
<thead>
<tr>
<th>Metric</th>
<th>Neutral</th>
<th>Maximum dorsiflexion</th>
</tr>
</thead>
<tbody>
<tr>
<td>RL angle (°) in dorsal direction [mean (range)]</td>
<td>3.7 (0 to 17)</td>
<td>29.5 (12 to 49)</td>
</tr>
<tr>
<td>CL angle (°) in dorsal direction [mean (range)]</td>
<td>4.9 (-8 to 17)</td>
<td>26.7 (7 to 46)</td>
</tr>
<tr>
<td>SL angle (°)[mean (range)]</td>
<td>59 (34 to 84)</td>
<td>48.5 (29 to 69)</td>
</tr>
</tbody>
</table>

* One volunteer unable to complete the pronation/supination motion protocol

** DRUJ Subluxation ratio, as described by Park et al, JBJS(Am) 2008

*** The wrist harness limited the ability for achieving the full range of volarflexion in a subset of volunteers therefore measurements for volarflexion are not reported.

● Contracted research: NIH
♦ Nothing of financial value to disclose
RF E-POSTER 36: Concomitant Endoscopic Carpal and Cubital Tunnel Release: Safety and Efficacy

Category: Nerve/Neuromuscular
Keyword: Hand
Level 4 Evidence

Danielle M. Cross, MD
Kristofer S. Matullo, MD

Hypothesis: To describe the results of seventeen cases in which dual endoscopic carpal and cubital tunnel releases were performed for patients presenting with concurrent carpal and cubital tunnel syndromes.

Methods: A retrospective review of all patients in a single surgeon practice that presented with concomitant ipsilateral carpal and cubital tunnel syndromes was performed. Within an 8 month period, seventeen patients had undergone nineteen concomitant ipsilateral endoscopic carpal and cubital tunnel release after failing conservative treatment. Pre and post operative measurements included subjective numbness/tingling, subjective pain, manual muscle testing of the abductor pollicis brevis (APB), Intrinsic, and Flexor Digitorum Profundus (FDP), static 2-point discrimination, quick-DASH scores, grip strength, chuck pinch strength, and key pinch strength. Complete data is available for 15 patients and 17 total procedures.

Results: 13 male and 4 female patients (average age of 50.5), underwent dual endoscopic cubital and carpal tunnel release. Two patients were lost to follow-up and eliminated from data analysis. Pre and post-op comparisons were completed for median DASH scores, grip strength, chuck pinch strength, and key pinch strengths at their pre-operative visit and at 12 weeks. DASH scores improved significantly from a median of 67.5 to 16 (p= 0.002), grip strengths improved from 42 pounds to 55.0 pounds (p= 0.30), chuck pinch strength improved significantly from 11 to 15.5 pounds (p=0.02) and key pinch strengths increased significantly from 13 to 18 pounds (p= 0.003). Average static 2-point discrimination decreased from 5.9mm to 4.8mm. 82% of patients had complete resolution of pain, and the remaining 18% experienced pain only with strenuous activity. 100% of patients had complete resolution of median nerve symptoms; 88% of patients had substantial improvement of numbness and tingling symptoms, and 12% had residual ulnar nerve symptoms. 92% of patients had improvement to 5/5 APB strength, while 100% of patients had improvement to 5/5 Intrinsic and FDP strength. Two minor complications occurred, including one superficial hematoma and one superficial cellulitis.

Summary: Preliminary data demonstrates that dual endoscopic carpal and cubital tunnel release is a safe and effective treatment option for patients who present with concurrent cubital and carpal tunnel syndromes recalcitrant to non-surgical management. Post-operative results and complications are comparable to endoscopic carpal and cubital tunnel releases performed alone.
Table 1: Subjective Data Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Op</th>
<th>Post-op</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbness/Tingling</td>
<td>100% had both ulnar and median nerve symptoms</td>
<td>- 100% resolution of median nerve sx</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 88% had substantial improvement overall in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>median and ulnar sx</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 12% had residual ulnar sided numbness</td>
</tr>
<tr>
<td>Pain</td>
<td>100% had pain in both ulnar and median nerve distributions</td>
<td>- 82% had complete resolution of pain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 18% residual pain w/activity</td>
</tr>
<tr>
<td>Two-Point Discrimination</td>
<td>5.9mm</td>
<td>4.8mm</td>
</tr>
<tr>
<td>APB, FDP, Intrinsic strength</td>
<td>average 4/5 strength throughout.</td>
<td>- 92% patients had improvement to 5/5 APB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>strength</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 100% pts had improvement to 5/5 FDP/Intrinsic strength</td>
</tr>
</tbody>
</table>

Table 2: Objective Data Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre-Operative Median (IQR) [raw range]</th>
<th>Post-Operative Median (IQR) [raw range]</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>DASH</td>
<td>67 (57 – 79.50) [29 – 93]</td>
<td>16 (7 – 27) [0 – 77]</td>
<td>.002</td>
</tr>
<tr>
<td>Grip</td>
<td>43 (22 – 77.50) [4 – 113]</td>
<td>52.50 (35.50 – 91.75) [3 – 115]</td>
<td>.50 (ns)</td>
</tr>
<tr>
<td>Key pinch</td>
<td>12.50 (7 – 17.75) [2 – 23]</td>
<td>18 (13 – 23) [0 – 24]</td>
<td>.03</td>
</tr>
<tr>
<td>Chuck pinch</td>
<td>11 (5.25 – 13.75) [1 – 20]</td>
<td>15 (10 – 17) [0 – 20]</td>
<td>.004</td>
</tr>
</tbody>
</table>

* Consulting Fees: Synthes (Matullo)
♦ Nothing of financial value to disclose
Hypothesis: Carpal tunnel release is a common procedure, however a subset of patients have persistent symptoms post surgery and suffer from chronic regional pain syndrome. Interposition of well-vascularized soft tissue may be necessary to treat these patients, and the abductor digiti minimi flap may be useful in this setting.

Methods: After median nerve neurolysis, the abductor digiti minimi is elevated on its proximal pedicle. The muscle is split longitudinally and rotated to provide coverage of the median nerve. This procedure was performed on 7 wrists in 6 patients.

Results: The median age was 68 years old (range 49-80). The average follow up is 2.75 years. All patients were satisfied with the procedure and would repeat it as necessary.

Summary: The abductor digiti minimi flap is a reliable flap with minimal donor site morbidity. It provides predictable coverage and is a good option when treating recurrent carpal tunnel syndrome associated with chronic regional pain syndrome.

References:

● Contracted research: AO Foundation grant
● Ownership interests: OHK company
● Consulting fees: OHK company
● Intellectual property rights/patent holder: Trimed Co
♦ Nothing of financial value to disclose
RF E-POSTER 38: Schwann Cell-derived Desert Hedgehog has a Neuroprotective Effect Against Mechanical Stimuli

Category: Nerve/Neuromuscular
Keyword: Wrist
Not a clinical study

♦ James Jung, BS
♦ Derek Frump, BS
♦ Tahseen Mozaffar, MD
● Ranjan Gupta, MD

Hypothesis: Defining the molecular mechanisms responsible for the changes induced by chronic nerve compression (CNC) injuries is crucial to develop novel adjunct treatment. Desert hedgehog (dhh) is a Schwann cell produced protein critical for the formation of nerve perineurium. As Schwann cells have been implicated as vital in the pathogenesis of CNC injuries, we hypothesized that desert hedgehog is crucial in the neuroprotective effect offered by Schwann cells and may possibly serve as a potential therapeutic target.

Methods: An in-vivo model of CNC injury was created in dhh-/- mice (Jackson Labs) by atraumatically placing a 3mm inert tube around the sciatic nerve. Electrophysiology was performed bi-weekly and protein analysis was performed to detail changes in the basal lamina and fibro-proliferative response. Immunofluorescence was performed for ECM proteins. Toluidine blue staining was performed for axon histology and g-ratio measurements and analyzed stereologically using VisioPharm. Moreover, nerves were further analyzed via electron microscopy (EM) for myelin debris.

Results: Nerve conduction velocities (NCV) showed a marked rapid decline in dhh-/- relative to wildtype mice. NCV declined from 52.15±0.5 m/s at baseline to 15.06±0.578 m/s at 2 weeks. There was a slight improvement at 4 and 6 weeks to 25.63±1.514 m/s and 26.13±1.21 m/s, respectively. Wildtype animals show the slowest NCV at 6 weeks but never reached the profound slowing seen in dhh-/- animals. Immunohistochemical analysis for collagen IV, laminin-a-2, and fibronectin showed abnormally profuse scarring in dhh-/- at 2 weeks. Interestingly, this response was less profound in the dhh-/- mice at six weeks. G-ratios were measured after 2 weeks CNC injury in normal and compressed nerves (0.64±0.004 vs. 0.67±0.005). The percentage of large caliber axons was significantly reduced after CNC in dhh-/- (0.404±0.009 vs. 0.153±0.035) but there was a substantial increase in the percentage smaller caliber fibers (0.543±0.007 vs 0.727±0.011).

Summary: CNC injuries can be characterized by a progressive decline in NCV. In dhh-/- mice, NCV shows a more rapid and severe decline relative to wildtype after CNC injury as well as a
significant loss of large caliber myelinated axons. These data point to a vital role for the dhh protein in the physiological function of myelinated axons. Our studies suggest a possible neuroprotective role of desert hedgehog in peripheral nerve as the lack of this protein accelerates the peripheral nerve demyelination and dysfunction secondary to the sustained mechanical stimuli of CNC injury.

- Contracted research: NIH/NINDS, OTA, OREF
- Nothing of financial value to disclose
Modality-specific Predegeneration of Nerve Grafts Enhance Nerve Regeneration Specificity

Category: Nerve/Neuromuscular
Keyword: Hand
Not a clinical study

♦ Negin R. Rassekh, MD
♦ Chunyu Li, MD, PhD
♦ Andres O'Daly, MD
♦ Alka Vyas, PhD
♦ Thomas M. Brushart, MD

**Hypothesis:** Predegeneration of nerve graft to upregulate growth factor production by Schwann cells enhances nerve regeneration. Furthermore, growth factors produced by ventral root and cutaneous nerve, pure populations of motor and sensory Schwann cells, promote modality-specific regeneration of their native axon population. We now ask whether similar selectivity can be generated at the individual axon level by selectively predegenerating the axons of one modality within a graft of mixed nerve.

**Methods:** Experiments were performed on 250gm female Lewis rats under sterile conditions using intramuscular ketamine (87mg/Kg) and xylazine (13 mg/Kg). Procedures were approved by the Johns Hopkins Animal Care and Use Committee. Grafts in the shape of an inverted "Y" consisted of the femoral nerve trunk and its cutaneous (saphenous) and muscle (quadriceps) branches. Two groups of 10 grafts each were used to replace the femoral nerves of recipient animals. In both groups, motor axons were predegenerated for 3 weeks to optimize production of motor-specific growth factors (M-3) by transecting the L2, L3, and L4 ventral roots. Sensory axons were not predegenerated in one group (M-3; S-0), and were predegenerated for 12 weeks in the other by excising the L2, L3, and L4 DRGs (M-3; S-12). Regeneration was evaluated 8 weeks after graft transfer with retrograde double labeling; results were analyzed with a two-tail t-test.

**Results:** No specificity was generated in the M-3;S-0 group. A mean of 135 motoneurons projected correctly down the femoral muscle branch and a mean of 105 projected incorrectly down the sensory branch (p=0.38). Dramatic specificity was encountered, however, when the sensory axons had been axotomized for 12 weeks (M-3;S-12). A mean of 162 motoneurons projected down the muscle branch, and a mean of only 73 projected down the sensory branch (p<0.001).
Summary: The consequences of predegenerating motor Schwann cells within mixed nerve depend upon the overall regeneration environment. In the absence of acute Wallerian degeneration and with chronically denervated sensory Schwann cells, preferential reinnervation of appropriate motor pathways is dramatic. The inhibitory breakdown products of acute Wallerian degeneration, in contrast, prevent motor axons from responding to an identical motor environment. A potential for regeneration specificity is thus unrealized when nerve repair is performed during the acute phases of Wallerian degeneration, the current clinical standard. Modality-specific predegeneration of nerve graft is thus a novel technique for exploring the mechanisms of regeneration specificity that also suggests new strategies for enhancing the outcome of clinical nerve repair.

♦ Nothing of financial value to disclose
RF E-POSTER 40: Alternatives to Sural Nerve Grafts: A Case Series of 141 Patients

Category: Nerve/Neuromuscular
Keyword: Hand
Level 4 Evidence

♦ Louis Poppler, MD
♦ Susan E. Mackinnon, MD

Hypothesis: In most cases, donor nerves can be harvested from the same extremity, often through the same incision and provide adequate caliber and length to bridge a nerve gap in a tension free manner.

Methods: A retrospective chart review of 141 consecutive patients who underwent any kind of nerve graft or allograft between 2001 and 2012 in a single surgeon practice for a total of 157 nerve grafts is presented. Nerve donor, nerve recipient, graft length, cable number, graft caliber match, and operative site data were collected and then analyzed using Microsoft Excel. No patient’s were excluded.

Results: 145 nerve grafts and 12 allografts were performed between 2001 and 2012. 110 of these were in the upper extremity. Donor nerves included: Sural, Medial Antebrachial Cutaneous, Lateral Antebrachial Cutaneous, Median Sensory Nerve to 3rd Web space, Dorsal Cutaneous Ulnar Nerve, Obturator, Anterior Interosseous Nerve, Peroneal, Radial Sensory and Cervical nerves. The Sural nerve was used as a donor in only 42 cases (26.8%) with a trend away from Sural as the senior author changed her practice. Acellular allograft was used in only 12 (7.6%) cases and was most often used in conjunction with a nerve autograft to repair the donor nerve in reverse end to side manner. Same donor site was achieved in 84 cases (60.4% of 139 grafts performed in an extremity) and same extremity was achieved in 89 cases (64%).

Summary:
- Alternatives to Sural Nerve exist for nerve grafting and we would recommend using sural as a last resort donor for upper extremity nerve reconstruction.
- Options in the upper extremity include Medial Antebrachial Cutaneous, Lateral Antebrachial Cutaneous, Median Sensory Nerve to 3rd Web space, Dorsal Cutaneous Ulnar Nerve, Obturator, Anterior Interosseous Nerve, Peroneal, Radial Sensory and Cervical nerves.
- In over 60% of cases a nerve graft can be harvested through the same incision used to repair a nerve defect.
- In 64% of cases we were able to stay confined to one extremity.
- These results underestimate the ability to avoid a second donor incision as the authors practices changed during the time frame of this series.
• Prospective studies are needed to compare functional outcomes of various nerve grafts.

References:

♦ Nothing of financial value to disclose
RF E-POSTER 41: Postoperative Pain Scores with Brachial Plexus Block After Distal Radius Fracture Fixation

Category: Pain & Disability (chronic)
Keyword: Forearm
Level 4 Evidence

♦ Megan A. Meislin, MD
♦ Randip R. Bindra, MD, FRCS
♦ Ben Johnson
♦ Michael S. Bednar, MD

Hypothesis: Pain experienced after internal fixation of distal radius fractures can be minimized with brachial plexus block.

Methods: The pain experienced by patients postoperatively after distal radius fracture fixation was recorded prospectively. All patients were operated under general anesthesia with a brachial plexus block administered for postoperative pain control. Patients were prescribed narcotics to use as needed for pain and discharged home on the day of surgery. Each patient filled out a pain chart indicating VAS scores and number of pain pills used during the first 14 days post-operatively. The following data were recorded by chart review: age, sex, mechanism of injury, complexity of fracture, surgery time and tourniquet time. The median pain intensity score, represented by VAS, for each type of fixation was reported and compared with each other using the Kruskal-Wallis test. Pearson chi-square and Fishers Exact test were used to compare categorical variables (as appropriate) and ANOVA was used to compare continuous variables. Spearman’s rho correlations were performed to assess for association between pain scores and procedure characteristics.

Results: Complete data was available for 17 patients: 16 females and 1 male. The average age of patient was 62.5 (range, 28 to 81). There were 4 extra-articular fractures and 13 fractures involved the radiocarpal joint space. The average length of time the infraclavicular block lasted was 22.68 hours with a maximum average VAS score of 4.35 on post operative day one and incrementally decreased each day. By day seven the average score was close to 1, the lowest VAS score possible. No patient require re-admission for pain control. No difference in pain scores was observed when comparing fracture patterns. Average pain pills taken per day was 2.5 pills including both narcotic and nonnarcotic medications.

Summary:
- Pain was effectively controlled by the brachial plexus block with most patients not requiring any analgesics for 23 hours postoperatively.
- On average, pain was resolved by 1 week postoperatively.
Pain control was consistently obtained between extra-articular and intra-articular fracture patterns.

It is possible to perform distal radius fracture fixation as outpatient surgery and patients can be expected to have good pain relief.

References:

Consulting fees: DePuy
Nothing of financial value to disclose
RF E-POSTER 43: The Safety of Outpatient Hand and Upper Extremity Surgery- A Statistical Review of Complications In 28,737 Cases

Category: Practice Management
Keyword: Other
Level 4 Evidence

♦ Sameer Jain, MD
● Joseph E. Imbriglia, MD
♦ John Fowler, MD

**Hypothesis:** The purpose of our study was to determine the safety and rate of complications in outpatient hand and upper extremity surgery. We hypothesized that hand and upper extremity surgery was safe to perform in the outpatient setting.

**Methods:** A retrospective review of cases at a single ambulatory surgery center over an 11 year period was performed. 28,737 procedures were performed and included in our analysis. Procedures canceled in the pre-operative holding area (101 total) were not counted. Adverse events were defined as events causing harm to a patient or leading to additional treatment. Using state reportable adverse events criteria as a guideline, we broke these into 7 main categories; infection, post-operative transfer to a hospital, wrong site surgery, retention of a foreign object, post-operative deep vein thrombosis, medication error, and ‘other’ surgery related complication. These adverse events were than analyzed to see if they lead to additional laboratory testing, hospital admission, return to the operating room, emergency department visits, physical or mental disability.

**Results:** There were 65 reportable events for an overall complication rate of .23%. There were no mortalities. There were 21 infections (.07%). 17 (.06%) patients were transferred from the surgery center to the hospital post-operatively. The causes of these transfers consisted of cases of irregular heart rhythms, uncontrolled hypertension, low oxygen saturations, issues with pain control, post-operative drowsiness, and generalized seizures. 21 patients (.07%) were admitted to the hospital during the postoperative period, with poor pain control being the single largest cause. There were no cases of wrong site surgery or retained foreign bodies. There was 1 case (.003%) of post-operative pulmonary embolism. There was 1 medication error (.003%) that lead to a rash and no further morbidity. There were 4 patients (.01%) who were taken back to the operative suite due to excessive bleeding or hematoma formation.

**Summary:** Even as more procedures are able to be completed on an out-patient basis, there remains a paucity of literature on the subject. A literature search showed no specific articles on the safety of outpatient hand and upper extremity surgery. Our study shows that with proper patient selection, a very low (.23%) complication rate can be achieved. Outpatient surgery
centers can offer improved patient outcomes and fewer adverse events when compared to hospital based surgery. Our review showing few complications, and no deaths, supports our view that hand and upper extremity surgery can be completed safely in the outpatient setting.

References:

- Royalties/honoraria: Auxilium (Xiaflex Presentations)
- Consulting fees: Auxilium - Xiaflex, Acumed
- Nothing of financial value to disclose
Hypothesis: The repair strength, repair site bulkiness, and friction are important considerations after zone II flexor tendon repair. Improved repair strength with new suture material allows for an early motion therapy. However, reducing repair site bulkiness and friction remains a challenge. The purpose of this study was to characterize the gliding resistance, repair gapping, and breaking strength of a common suture construct to a modified construct with fibrin glue augmentation.

Methods: Twelve human cadaveric flexor digitorum profundus tendons were transected and repaired with four-core sutures. Specimens were divided in two groups and either a running epitendinous suture (n=6) or fibrin glue (n=6) augmentation. Gliding resistance, 2mm gapping, and breaking strength of the repaired tendon were compared between both groups.

Results: The linear stiffness, force to produce a 2mm gap and ultimate failure were similar in both repair methods. However, the four-core suture with running epitendinous suture construct displayed significantly less gliding resistance than the four-core suture repair with fibrin glue augmentation.

Summary: Fibrin glue augmentation to zone II flexor tendon repairs provides comparable repair strength to a running epitendinous suture; however, the significantly increased gliding resistance associated with fibrin glue diminishes its use for flexor tendon repair augmentation.
- Contracted research: Wright Medical
- Nothing of financial value to disclose
Hypothesis: Triceps ruptures are an uncommon injury resulting from eccentric load. Function and strength can be restored adequately with repair through bone tunnels. Techniques may need to be altered based on the pattern of detachment.

Methods: A retrospective chart review over a 6 year period yielded 16 operatively treated triceps repairs. Two patients were removed from the analysis due to confounding variables, one with a total elbow arthroplasty and the other with a complex distal humerus fracture. The remaining 14 patients’ surgical reports and follow up notes were reviewed for mechanism of injury, pattern of rupture, complications and functional results.

Results: Fourteen patients had an average follow up of 8.9 months (range 1.6 to 44 months). There was a 3.7 to 1 male to female predominance. The left elbow was involved in 10 of 14 cases; all patients were right hand dominant. Four patients had a delay in diagnosis which averaged 3.25 weeks. All but 3 patients achieved full flexion (in those lacking full flexion, on average the patients lacked 10 degrees). All but 2 patients achieved full extension (the average flexion contracture was 4 degrees). All patients returned to full function according to each of their preoperative levels. Two patients achieved 4/5 strength, all the others achieved 5/5. Complication rate was 29 percent (four patients). All the complications were related to suture prominence and in 3 cases required a surgical procedure for suture removal.

Summary:
- Triceps ruptures are complex injuries that have the following patterns in our series:
  - Bony avulsion
  - Small bony fragment which can be incorporated in the repair
  - Large bony fragment requiring fixation
- Soft tissue rupture
  - Complete rupture with or without delamination
  - Incomplete rupture
    - Deep/medial intact
Central fibers disrupted
  o Superficial/lateral disruption
    • Deep/medial disruption

- Repair through bone tunnels yields successful outcomes in the majority of patients even with delay in diagnosis.
- Most complications were related to suture prominence and efforts should be made to attempt to decrease suture bulk or bury the suture to decrease these incidents.

References:

- Contracted research: Skeletal Dynamics (Ring); AO Foundation grant (Jupiter)
- Royalties/honoraria: Wright Medical; Skeletal Dynamics; Medartis (Ring)
- Ownership interests: OHK company (Jupiter)
- Consulting fees: Wright Medical; Biomet; Skeletal Dynamics; Acumed (Ring); OHK company (Jupiter)
- Intellectual property rights/patent holder: Trimed Co (Jupiter)
- Stock Options: Illuminos (Ring)
- Nothing of financial value to disclose
RF E-POSTER 46: A Systematic Review of Outcomes of Treating Enchondroma of the Hand

Category: Tumor
Keyword: Hand
Level 3 Evidence

♦Abdo Bachoura, MD
●John D. Lubahn, MD, FACS

Hypothesis: Enchondroma of the hand is the most common primary tumor of the hand. Despite its relatively high prevalence, much variability exists with regard to the surgical management of this benign tumor. We systematically reviewed the existing literature for the management of hand enchondroma by curettage alone, curettage followed by packing of the residual defect with cancellous bone graft, and curettage followed by packing with materials that provide structural support, such as bone cement.

Methods: We reviewed articles retrieved from MEDLINE using the search query “enchondroma*[TI] AND (hand OR Wrist OR carpus OR phalanges OR fingers OR metacarpals OR thumb) NOT Review” and applied limitations to include English language articles and humans. Reports with less than 5 patients were excluded. Secondary selection required the studies to report data with at least 1 month of clinical follow up. Outcomes of interest included qualitative or quantitative post-operative range of motion. Clinical outcomes were categorized into 2 categories: 1) no functional restrictions or 2) functional limitations. Post-operative fracture and tumor recurrence were also compared in the 3 groups. In addition, the complication rate of patients who presented with pathological fractures and were treated within 10 days of injury were compared to patients who presented with a pathological fracture and were allowed more than 10 days to heal prior to treatment. Chi square tests were used for statistical analysis.

Results: We identified 91 papers and selected 17 after applying the inclusion and exclusion criteria. A total of 298 patients were identified: 119 underwent curettage alone, 121 underwent curettage followed by bone grafting, and 58 underwent curettage followed by replacement with synthetic bone fillers. There were no significant differences in the functional outcomes, incidence of post-operative fracture or recurrence in any group. There were no significant differences in the complication rate between patients who presented with a pathological fracture and were treated immediately as compared to those who were allowed to heal first.

Summary:
- Considerable variation exists in the reporting of clinical, patient rated and radiographic outcomes of hand enchondroma treatment.
- Curettage alone appears to be as effective as curettage followed by various types of filling when considering post operative function, the risk of post-operative fracture and recurrence.
- Curettage alone appears to be the simplest and most cost effective method to treat hand enchondromas as it avoids patient morbidity associated with autograft, or the added cost associated with off-the-shelf filling materials.

References:
- Royalties/honoraria: grant support
- Nothing of financial value to disclose
RF E-POSTER 47: Simulation Exercise for Microsurgical Training

Category: Vascular/Microvascular
Keyword: Other
Not a clinical study

Lauren B. Grossman, MD
David Komatsu, PhD
Marie A. Badalamente, PhD
Andrew M. Braunstein, MD
Lawrence Hurst, MD

Hypothesis: Microsurgical skills require extensive training. We hypothesized that implementing a turkey wing model for resident training, would increase comfort level and microsurgical skills.

Methods: Residents were given a survey on their comfort level with microsurgery, a pretest on techniques and then a lecture on the subject. Residents then observed surgical dissection of a turkey wing (Figure 1) with microvascular and nerve repair (Figure 2). Residents then performed the same dissection and repairs. A post-test was given. The results of the pre-test, post-test, eight specific microsurgical assessments for each repair, and a combined surgical score for each repair (sum of all eight specific outcomes) were compared between two groups. Group 1 consisted of PGY 2 and 3 residents and Group 2 consisted of PGY 4 and 5 residents. Additionally, the pre-test and post-test scores were pooled for all residents to assess the effect of training independent of training level. Differences between groups were assessed by performing Independent-Samples Mann-Whitney U Tests (alpha <0.05).

Results: The survey results pre and post presentation, demonstration and completion of the anastomoses showed the majority of residents became more comfortable with microsurgical technique and identifying structures after the exercise. The lecture and training significantly increased knowledge of microsurgical techniques with an increase of 46% seen between the pretest and posttest scores of all residents (p=0.001). Improvements were seen for 85% of residents, 15% showed decreases. A significant increase of 42% (p<0.001) was seen for the survey of comfort with all of the residents reporting an increase in comfort with these techniques. The seniors scored 54% higher on both the presurvey (p=0.009) and 44% higher on the postsurvey (p=0.024) than the juniors. In addition to the survey and tests, each resident’s wing with his/her anastomoses were evaluated. When comparing the performance of the seniors to the juniors, two measures were found to significantly differ. Seniors outperformed juniors on arterial suture placement by 31% (p=0.009) and were 12.5% better for combined nerve surgical score (p=0.046).

Summary:
- A turkey wing model for anastomoses of the artery, vein and nerve represents a realistic simulation of a digital artery, vein and nerve.
- This is a practical training method for residents in an Orthopaedic Surgery program or other programs that require microsurgical skills.
- ACGME requirements have now mandated surgical skills training to be effective July 2013.
- This laboratory training method is easy, convenient, inexpensive and simple to set up and complete.

**Figure 1:** Turkey Wing Dissection – Schematic of neurovascular structures in the chicken wing.

**Figure 2:** Mediano-Ulnaris nerve repair; Schematic of nerve repair with alignment and suturing of epineurium.

- Contracted research: Non-cash support of equipment donated by SBI, Synthes, Stryker and Depuy; Material funding for sawbone materials provided to the Institution ($1250 from SBI, $2800 from Synthes (Grossman); Auxilium Pharmaceuticals (Badalamente, Hurst)
- Royalties/honoraria: Biospecifics Technologies Corp. (Badalamente); SUNY Stony Brook (Hurst)
- Consulting fees: Auxilium Pharmaceuticals (Badalamente, Hurst); Pfizer (Hurst)
- Nothing of financial value to disclose
RF E-POSTER 51: A Meta-Analysis and Systematic Review of Distraction Osteogenesis in Hand Surgery: What are the Benefits, Complication Rates, and Duration of Treatment?

Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Hand
Level 3 Evidence

Steve J. Kempton, MD

Hypothesis: Distraction osteogenesis is proposed to be an effective, simple, and reliable option for the management of traumatic and congenital hand deformities, however, a general consensus in regard to length gain, treatment time, and complication rates has not been previously defined. Through a systematic review and meta-analysis of the published literature, this work discusses the utility of distraction osteogenesis, hypothesizing that distraction in children and of the metacarpal will have fewer complications when compared to adults and phalangeal distraction respectively.

Methods: A PubMed search for articles reporting results of distraction osteogenesis in the hand was performed. Data collected included age, sex, bone distracted, latency period, distraction rate, consolidation period, treatment time, length gained, and complications. A meta-analysis was done to assess the effect of age, gender, bony segment, distraction length, and total treatment time on complication development.

Results: Thirty articles (424 distractions) met inclusion criteria. The average length gained from distraction was 2.2 cm; the average total treatment time was 116 days; and the average complication rate was 43.2% (Table 1). Pediatric patients had significantly fewer complications when compared to adults (p=0.000013). There was no significant difference in the proportion of complications between metacarpal and phalangeal distraction (p=0.83). All studies that underwent meta-analysis were homogeneous (I2 < 0.05 and symmetric funnel plot). None of the variables analyzed by meta-analysis were shown to significantly impact the odds ratio for complication development (p > 0.05) (Table 2).

Summary: Distraction osteogenesis is a viable option in the management of traumatic and congenital hand deformities. The results of this review reveal an average complication rate higher than previously reported by large single surgeon series. Of significance, adults appear to have more complications when compared to children, but metacarpal and phalanx distractions showed no difference in complication development. Compared to other methods of reconstruction, distraction osteogenesis has important advantages; no donor site morbidity,
maintenance of sensation, replacement of like with like, and being technically simple and affordable. Comparing functional outcomes, however, is difficult as high-quality studies measuring hand function after distraction are lacking. Despite this, both toe-to-hand transfer and distraction osteogenesis should be a part of the surgeon’s armamentarium to restore metacarpal and phalangeal length.

References:

Table 1. Summary of Technique and Outcomes According to Age and Bony Segment (MC vs Phalanx)

<table>
<thead>
<tr>
<th>Population Subset</th>
<th>Number of Distractions</th>
<th>Age (y)</th>
<th>Latency (d)</th>
<th>Distraction Rate (mm/d)</th>
<th>Length (cm)</th>
<th>Total Distraction Time (d)</th>
<th>Complications (%)</th>
<th>Major Complications (%)</th>
<th>Minor Complications (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>424</td>
<td>20</td>
<td>7</td>
<td>0.75</td>
<td>2.2</td>
<td>116</td>
<td>43.2</td>
<td>25.1</td>
<td>18.4</td>
</tr>
<tr>
<td>Pediatric</td>
<td>207</td>
<td>8.4</td>
<td>6.6</td>
<td>0.86</td>
<td>1.8</td>
<td>106.3</td>
<td>34.4</td>
<td>20.4</td>
<td>14.0</td>
</tr>
<tr>
<td>Adult</td>
<td>150</td>
<td>33</td>
<td>7.6</td>
<td>0.73</td>
<td>2.3</td>
<td>148</td>
<td>63.6</td>
<td>37.8</td>
<td>25.9</td>
</tr>
<tr>
<td>Metacarpal</td>
<td>219</td>
<td>18.8</td>
<td>7</td>
<td>0.8</td>
<td>2.5</td>
<td>135</td>
<td>44.3</td>
<td>25.6</td>
<td>18.7</td>
</tr>
<tr>
<td>Phalanx</td>
<td>115</td>
<td>17</td>
<td>6.4</td>
<td>0.82</td>
<td>1.7</td>
<td>84</td>
<td>43.8</td>
<td>21.9</td>
<td>21.9</td>
</tr>
<tr>
<td>Thumb Metacarpal</td>
<td>97</td>
<td>27</td>
<td>8</td>
<td>1</td>
<td>2.9</td>
<td>157</td>
<td>53.6</td>
<td>35.1</td>
<td>18.6</td>
</tr>
</tbody>
</table>

Table 2. Statistical Analyses for Risk Factors of Complications

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (C.I.)*</th>
<th>F (p-value)</th>
<th>Proportion (p-value)</th>
<th>Studies in Meta-Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Pediatric vs Adult)</td>
<td>1.04 (0.46-2.35)</td>
<td>0% (0.78)</td>
<td>34.9% v.s. 62.3% (1.38x10^-4)</td>
<td>Arata, 2001; Baccari, 2006; Erdem, 2009; Foucher, 2001; Hosny, 2012; Houshian, 2001; Matev, 1980; Seitz, 1991; Seitz, 1995</td>
</tr>
<tr>
<td>Gender (Male vs Female)</td>
<td>0.45 (0.19-1.06)</td>
<td>23.6% (0.24)</td>
<td>28.8% v.s. 50.0% (0.03)</td>
<td>Arata, 2001; Arslan, 2001; Baccari, 2006; Das, 2009; Erdem, 2009; Houshian, 2001; Miyawaki, 2002; Seitz, 1995</td>
</tr>
<tr>
<td>Segment (Metacarpal vs Phalanx)</td>
<td>0.58 (0.26-1.33)</td>
<td>0% (0.45)</td>
<td>41.5% v.s. 43.4% (0.83)</td>
<td>Arata, 2001; Baccari, 2006; Foucher, 2001; Hosny, 2012; Houshian, 2001; Matsuno, 2004; Seitz, 1995</td>
</tr>
<tr>
<td>Rate (&lt;0.5mm/day or &gt; 0.5mm/day)</td>
<td>N/A</td>
<td>N/A</td>
<td>46.8% v.s. 40.5% (0.25)</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>-2.22 (-8.34-3.89)</td>
<td>0% (0.90)</td>
<td>24.7% v.s. 36.2% (0.51)</td>
<td>Arata, 2001; Baccari, 2006; Bosch, 2004; Das, 2009; Erdem, 2009; Foucher, 2001; Heitmann, 2004; Hosny, 2012; Kato, 2002; Seitz, 1995</td>
</tr>
<tr>
<td>Length</td>
<td>0.19 (-1.31-1.70)</td>
<td>38.4% (0.08)</td>
<td>22.1% v.s. 23% (0.50)</td>
<td>Arata, 2001; Bosch, 2004; Baccari, 2006; Das, 2009; Erdem, 2009; Foucher, 2001; Heitmann, 2004; Hosny, 2012; Houshian, 2001; Kato, 2002; Miyawaki, 2002; Seitz, 1995</td>
</tr>
</tbody>
</table>

♦ Nothing of financial value to disclose