2012 ANNUAL MEETING ABSTRACTS

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HYPOTHESIS
The use of total wrist arthroplasty (TWA) to treat end-stage RA and non-rheumatoid (non-RA) arthritis is controversial. There is no evidence to favour TWA over total wrist fusion. One of the reasons is the limited number of TWA series available in the literature. The purpose of this paper was to present the preliminary results of an international multi-centre study of one last generation TWA (SBI Remotion). Special focus was made on comparison between RA and non-RA wrists.

METHODS
A TWA (Denmark: M.Boeckstyns, K.Kroener, France: G.Herzberg, P.Liveneaux, L.Obert, Sweden: P.Axelsson, A.I.Sorensen) web-based registry was built. Records of pre and post-operative clinical, radiological, operative data and complications were made. The “SBI Remotion” was used in all cases. There were no conflicts of interests regarding this study. Only centres with more than 15 inclusions were considered. Data were collected at 6 weeks, 6 months and every year following the operation. Tables for implant survival and follow-up results were automatically generated and updated with concomitant statistical analysis. At the date of abstract submission, 215 cases were recorded (129 RA, 86 non-RA). Age and gender in RA and non-RA patients were respectively 63 years / 76% female and 63 years / 66% female. One hundred and twelve wrists had more than 2 years of follow-up (average 4 years, maximum 8 years): group I (RA): 75 wrists (67%), group II (non-RA): 37 wrists (33%).

RESULTS
In RA and non-RA wrists we observed respectively 5% and 6% of complications requiring revision (RA: 4 loosening, 1 ankylosis, 1 deep infection; non-RA: 2 loosening, 1 dislocation, 1 malposition, 1 ankylosis). There were respectively 2% and 7% of minor complications not requiring revision in RA and non-RA patients. The survival rate for revision of the whole series at maximum follow-up was 92% both in RA and non-RA groups. Considering the 112 wrists with more than 2 years of follow-up the improvement in terms of VAS pain and quick-DASH were respectively 48 pts and 20 pts in group I, 54 pts and 21 pts in group II (p>0,05). Post-operative arc of flexion-extension was 58° (-1°) in group I, 73° (-9°) in group II (p>0,05). Grip strength improvement was 40% in group I, 19% in group II (p=0,03). Periprosthetic osteolysis was observed in 12% in group I, 18% in group II (p>0,05).

SUMMARY
This is the first web-based international TWA registry. The significant number of inclusions allowed for statistical comparison between.

REFERENCES
1. Five to ten-year outcomes of the Universal total wrist arthroplasty in patients with RA Ward et al. JBJS 2011 p 914.

Speaker has nothing of financial value to disclose
SUMMARY
In severe CTS with impairment of thumb opposition, function may be reconstructed with an opponensplasty. If recovery of thumb opposition is predicted, we can determine whether opponensplasty should be applied or not at the time of carpal tunnel release. In this study, the duration of disease did not correlate with the recovery of thumb opposition, but there was some correlation with age. Good recovery of thumb opposition can be expected in patients under 50 years of age. However, recovery was still unpredictable in patients 50 years of age and older. Further studies, such as second lumbrical CMAP, may be required to better predict the recovery of thumb opposition in severe CTS.

REFERENCES

HYPOTHESIS
Rheumatoid arthritis often results in deformities at the metacarpophalangeal (MCP) joint. Patients with severe deformities that interfere with everyday activities can be treated by silicone metacarpophalangeal joint arthroplasty (SMPA). High level evidence for the long-term effectiveness of this procedure is unavailable. The purpose of this paper is to prospectively compare long-term outcomes for a surgical and a non-surgical cohort of rheumatoid arthritis patients.

METHODS
This is a multi-center prospective NIH funded cohort study of rheumatoid arthritis patients enrolled from 2004 to 2008. Patients could elect to undergo SMPA and medical therapy or medical therapy alone. A total of 67 surgical and 95 nonsurgical patients with severe subluxation and/or ulnar drift of the fingers at the MCP joints were recruited. The patients were followed prospectively for three years. Outcomes included the Michigan Hand Outcomes Questionnaire (MHQ), Arthritis Impact Measurement Scales (AIMS2), grip/pinch strength, Jebsen-Taylor test and ulnar deviation, extensor lag and arc of motion measurements at the MCP joints.

RESULTS
There was no significant difference in the mean age (surgical mean=60, nonsurgical mean=62), race, education, and income at baseline between the two groups. Surgical subjects had worse MHQ function and functional measurements at baseline. At 3 years, the mean overall MHQ score and the MHQ function, activities of daily living, aesthetics and satisfaction scores showed significant improvement in the surgical group compared to the non-surgical group. Ulnar deviation, extensor lag and arc of motion in the MCP and proximal interphalangeal (PIP) joints also improved significantly in the surgical group. There was no improvement in the mean AIMS2 scores and grip/pinch strength. Complications were minimal with a prosthesis fracture rate of 9.5%.

SUMMARY POINTS
- The results from extended follow-up of this cohort have shown that the benefits of SMPA continue through 3 years after surgery.
- RA patients with poor baseline functioning show long term improvement in hand function and appearance following treatment with SMPA compared to non-surgical controls.

PAPER 03
Thursday, September 6, 2012 • 2:31 – 2:37 PM
Best Papers
A Long-term Multi-center Outcomes Study of Silicone Metacarpophalangeal Joint Arthroplasty in Rheumatoid Arthritis
Level 2 Evidence

Jennifer F. Waljee, MD, MS
Patricia B. Burns, MPH
Hyungjin M. Kim, ScD
Frank D. Burke, MD
E.F. Shaw Wilgis, MD
Kevin C. Chung, MD, MS

Figure 1. Means and 95% confidence intervals from baseline to 3 years for select MHQ scores: Surgical vs. non-surgical subjects
Table 1. Mean Scores for Surgical (SMPA) vs. Non-Surgical Subjects

<table>
<thead>
<tr>
<th>MHQ Scales</th>
<th>Preoperative</th>
<th>1-Year Postoperative</th>
<th>2-Year Postoperative</th>
<th>3-Year Postoperative</th>
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</thead>
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<tr>
<td></td>
<td>SMPA</td>
<td>Non-SMPA</td>
<td>SMPA</td>
<td>Non-SMPA</td>
</tr>
<tr>
<td>Function</td>
<td>37 (22)</td>
<td>58 (19)**</td>
<td>62 (23)</td>
<td>59 (24)</td>
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<tr>
<td>ADL</td>
<td>34 (26)</td>
<td>59 (24)**</td>
<td>55 (30)</td>
<td>60 (26)</td>
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<tr>
<td>Work</td>
<td>41 (22)</td>
<td>59 (23)**</td>
<td>47 (29)</td>
<td>61 (26)</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>33 (22)</td>
<td>47 (24)**</td>
<td>68 (23)</td>
<td>52 (23)</td>
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<tr>
<td>Overall Score</td>
<td>37 (17)</td>
<td>56 (19)**</td>
<td>60 (22)</td>
<td>57 (21)</td>
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<tr>
<td>AIMS2 Scales</td>
<td></td>
<td></td>
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<tr>
<td>Physical</td>
<td>4.0 (2.4)</td>
<td>2.5 (1.9)**</td>
<td>3.4 (2.4)</td>
<td>2.4 (1.9)</td>
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<tr>
<td>Affect</td>
<td>4.2 (1.9)</td>
<td>3.1 (1.8)**</td>
<td>3.6 (1.9)</td>
<td>2.8 (1.6)</td>
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<tr>
<td>Symptom</td>
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<td>4.3 (2.4)*</td>
<td>4.9 (2.7)</td>
<td>4.0 (2.5)</td>
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<tr>
<td>Social interaction</td>
<td>4.1 (2.0)</td>
<td>3.6 (1.4)*</td>
<td>3.9 (2.0)</td>
<td>3.6 (1.4)</td>
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<tr>
<td>Physical Measurements</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Grip strength (kg)</td>
<td>5.4 (5.2)</td>
<td>8.6 (7.4)*</td>
<td>6.1 (4.5)</td>
<td>10.3 (7.8)</td>
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<tr>
<td>Key (lateral) pinch (kg)</td>
<td>3.5 (2.2)</td>
<td>4.0 (1.8)</td>
<td>3.1 (1.8)</td>
<td>4.1 (2.0)</td>
</tr>
<tr>
<td>2-point (tip) pinch (kg)</td>
<td>2.5 (1.6)</td>
<td>3.1 (1.5)*</td>
<td>2.6 (1.6)</td>
<td>3.1 (1.7)</td>
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<tr>
<td>Three-jaw (palmar) pinch (kg)</td>
<td>2.5 (1.5)</td>
<td>3.2 (1.6)*</td>
<td>2.6 (1.5)</td>
<td>3.2 (1.4)</td>
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<tr>
<td>Jebson-Taylor (s)</td>
<td>55 (27)</td>
<td>43 (12)**</td>
<td>44 (15)</td>
<td>41 (12)</td>
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<tr>
<td>Extensor lag°</td>
<td>37 (15)</td>
<td>35 (15)</td>
<td>13 (11)</td>
<td>34 (15)</td>
</tr>
<tr>
<td>MCP Arc of Motion (°)</td>
<td>20 (15)</td>
<td>37 (18)**</td>
<td>30 (16)</td>
<td>33 (19)</td>
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<tr>
<td>PIP Arc of Motion (°)</td>
<td>56 (27)</td>
<td>70 (22)**</td>
<td>67 (24)</td>
<td>71 (19)</td>
</tr>
</tbody>
</table>

Abbreviations: AIMS2, Arthritis Impact Measurement Scales 2; ADL, activities of daily living; SMPA, Silicone Metacarpophalangeal Joint Arthroplasty.

Cell values are means (SD).

1Higher scores correspond to better outcomes, except for pain where higher scores correspond to greater pain.

For all AIMS2 subscales, higher scores correspond to worse outcome.

*P < 0.05 and **P < 0.001 for between group difference at baseline.

SUMMARY POINTS

- Complementing a regenerating partially injured nerve with a SETS nerve transfer resulted in superior myelinated axonal regeneration as determined by histomorphometry.

- SETS enhanced motor recovery in the partial injury model as evidenced by a significant increase in muscle force measurements.

- Our findings may have a significant clinical application particularly in cases where prolonged regeneration across long distances is anticipated and may yield suboptimal recovery.

** PAPER 04

Thursday, September 6, 2012 • 2:39 – 2:45 PM

Best Papers

“Supercharge” Nerve Transfer to Enhance Motor Recovery

Not a clinical study

Scott J. Farber, MD
Simone Glaus, MD
Ying Yan, MD, PhD
Daniel Hunter, RA
Philip J. Johnson, PhD
Susan E. Mackinnon, MD

HYPOTHESIS

The use of a “Supercharge” end-to-side nerve transfer (SETS) will enhance functional recovery in situations of an incomplete nerve injury. SETS nerve transfer provides additional axons for early reinnervation of target muscle to prevent atrophy and fibrosis while axons from the injured nerve continue to regenerate.

METHODS

Thirty-nine Lewis rats were randomized into three groups. In all groups, the tibial nerve was transected and repaired in one of three ways. Group 1 was repaired with a 10 mm autograft (representing a partial injury) complemented by a SETS nerve transfer using the peroneal nerve. Group 2 was repaired with a 10 mm autograft only (partial injury only). Group 3 was repaired with SETS peroneal nerve transfer alone and the tibial stumps were capped to prevent regeneration across the gap, serving as control.

Nerve histomorphometry, retrograde labeling, muscle mass analysis, and muscle force testing were performed. Data was analyzed by Newman-Keuls testing and significance was determined as p<0.05.

RESULTS

Nerve histomorphometry of the distal tibial nerve showed significantly (p<0.03) increased myelinated axonal counts in Group 1 (5659±3803) as compared to Group 2 (2904±1752) and Group 3 (2400±850) at 5 and 8 weeks. Retrograde labeling at 8 weeks confirmed increased motor reinnervation in the distal tibial stump. Functional recovery was evaluated with muscle force testing at 8 weeks, which revealed a significant increase in force (p<0.05) in the “Supercharge” group (Group 1) in comparison to the partial injury group (Group 2).

Figure 1. Experimental groups

Figure 2. Myelinated Fiber Counts at 5 and 8 weeks
**PAPER 05**

Thursday, September 6, 2012 • 2:47 – 2:53 PM
Best Papers: Best Papers


Level 4 Evidence

- Jaimie T. Shores, MD
- Gerald Brandacher, MD
- Vijay Gorantla, MD
- Stefan Schneeberger, MD
- Joseph Losee, MD
- W.P. Andrew Lee, MD

**HYPOTHESIS**
Hand transplantation with good functional outcomes is possible with a novel immunotherapy protocol utilizing donor bone marrow in combination with a single maintenance agent to help minimize the risks associated with immunosuppression.

**METHODS**
Five patients underwent 8 hand/upper limb transplantations and were maintained on single agent (tacrolimus) immunosuppression protocol following donor bone marrow cell infusion.

Postoperative hand therapy was initiated immediately and patients received close monitoring of standard hematologic and immunologic parameters including renal function, tacrolimus levels, monitoring for donor specific antibodies, and time based and rejection episode based skin biopsies.

**RESULTS**
Two unilateral dominant distal forearm transplants and three bilateral transplants comprised of a right dominant transhumeral and left non-dominant distal forearm, and two bilateral mid forearm transplants were performed. Four of five patients achieved good functional outcomes enabling independent living and return to activities by 1 year post-transplant.

One of five patients did not recover satisfactory function and was non-compliant with therapy.

One patient, who had good functional recovery at one year post-transplant regressed with non-compliance of therapy and immunosuppressive medication resulting in multiple episodes of acute skin rejection requiring the use of intensified immunosuppressive therapy. All compliant patients have developed satisfactory function which continues to improve with function depending on the level of transplantation (distal better than proximal), time after transplant (function improves with time after transplant), and participation in hand therapy.

**SUMMARY**
Hand Transplantation can be performed with a novel cell based single drug immunotherapy protocol while still obtaining good functional outcomes in properly selected recipients. However, compliance with this single medication and hand therapy must be strict to obtain good results. Patient’s deviation from the mandated medication protocol results in episodes of skin rejection which lead to long-term damage to the transplanted hand which diminishes overall hand function. Lack of participation with hand therapy prevents adequate development of function following transplantation. However, patients who take their medication as instructed who are active participants in hand therapy develop very good results which allow return to an independent life.

- Grant received from Armed Forces Institute of Regenerative Medicine (Shores)
- Contracted Research: Armed Forces Institute of Regenerative Medicine (Lee)
- Ownership Interest: BioMimetic Therapeutics, Inc. (Lee)

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**PAPER 06**

Friday, September 7, 2012 • 8:45 – 8:51 AM
Clinical Paper Session 1: Thumb / CMC

Partial Arthroscopic Trapeziectomy with or without Ligament Reconstruction to Treat Thumb Osteoarthritis

Level 3 Evidence

- Pierre Desmoineaux, MD

**HYPOTHESIS**
Partial trapezial excision with ligament reconstruction has proven to be effective technique for treating primary osteoarthritis of the thumb. To determine whether ligament reconstruction affects the objective and subjective outcome, we compared the mid term outcomes of two procedures performed under arthroscopy in similar patient groups.

**METHODS**
Eighty three patients, divided into two consecutive groups, were included to undergo partial arthroscopic trapeziectomy, the former without ligament reconstruction and the latter with ligament reconstruction using the abductor pollicis longus. Thirty four patients were treated without ligament reconstruction (group 1) and forty nine patients with concomitant ligament reconstruction (group 2) were evaluated after a mean follow up of 44.4 months. The outcomes were assessed with the quick DASH and the Nelson hospital score. The objective results were analysed according to mobility and strength. Radiographs were evaluated to determine the recentering of the metacarpal at rest and under stress.

**RESULTS**
Postoperatively, the quick DASH was 20.28 in group 1 and 15.86 in group 2. The Nelson hospital score was 12.95 in group 1 and 11.04 in group 2. Group 2 had significantly better mean score for stability and willingness to undergo the surgery again under similar circumstances. The mean score for pain, strength, mobility, delay of recovery did not differ significantly between the groups. Both groups had satisfactory results with regard to cosmetic appearance and overall satisfaction. With the number available the amount of medial metacarpal recentering at rest and under stress did not differ significantly between the groups.

**SUMMARY**
Ligament reconstruction affects the outcome after partial arthroscopic trapeziectomy.
Artelon Joint Spacer Compared to Trapezium Resection and Ligament Reconstruction

Nilsson A, Lijensten E. Results from a degradable TMC joint spacer (Artelon) compared with interposition arthroplasty.

METHODS
A retrospective chart review was undertaken from 2000-2009 examining patients with CMC arthritis undergoing either placement of Artelon spacer or trapeziectomy and tendon interposition arthroplasty. As part of a prospective arm, patients were brought back to clinic for interview and functional testing. Only Artelon patients that were not subsequently revised were subjected to testing. Pain improvement was graded using a visual analog scale. Grip and pinch strength as well as range of motion at the first carpometacarpal joint were measured. Nine-hole peg, Moberg pick-up, and Jebson-Taylor Tests were performed. RAND, Michigan Hand, and QuickDASH questionnaires were administered.

RESULTS
Forty total patients received Artelon implant. Seven patients were lost to follow-up. 13 of 40 (32%) patients eventually required revisionary surgery with removal of implant and salvage arthroplasty. Twenty non-revised Artelon patients and 13 control patients were enrolled in the prospective arm. Average follow-up was 37 months for the combined groups. Two-tailed t-test and Fisher’s exact test were used to calculate significance. Patients with Artelon had significantly less pain improvement compared to control cohort (p = 0.009). Additionally, satisfaction was significantly decreased (p = 0.038). There was no significant difference in any other functional or quality of life metric.

SUMMARY
In our practice, use of Artelon joint spacer has resulted in an explantation rate of 32%. We find this unacceptably high, and thus its use has been abandoned. In contrast to previous studies, in those patients with intact implants, pain and satisfaction are worse than trapeziectomy and tendon interposition arthroplasty.

REFERENCE
PAPER 09

Friday, September 7, 2012 • 9:09 – 9:15 AM
Clinical Paper Session 1: Thumb / CMC

Detection of Relaxin Receptor in the Synovium and Dorsoradial Ligament of the Trapeziometacarpal Joint

Not a clinical study

- Kari Clifton, PhD
Craig M. Rodner, MD
Hicham Drissi, PhD
- Jennifer Moriatis Wolf, MD

HYPOTHESIS
Basilar thumb arthritis is more common in women than men, although seen in both sexes. Attenuation or laxity of the ligaments of the trapeziometacarpal joint has been proposed to contribute to the development of osteoarthritis. The peptide hormone relaxin is produced by the corpus luteum in pregnancy to loosen ligaments in preparation for parturition, and is also secreted in non-pregnant women and in men. The mechanism of action of relaxin is mediated through remodeling of the extracellular matrix by induction of matrix metalloproteases. Relaxin receptors have been noted in the anterior oblique ligament of the basilar thumb joint previously. The purpose of this study was to identify the presence of relaxin family peptide receptor 1 (RXFP1), the cognate receptor for the circulating form of relaxin, in the dorsoradial ligament and contiguous synovium of the trapeziometacarpal joint.

METHODS
Six dorsoradial ligaments with attached synovium were sampled from patients during routine carpometacarpal joint arthroplasty of the thumb. Samples from 4 females (average age, 62 years) and two males (average age, 68 years) were examined. Uterine round ligament samples were used as positive controls. Tissues were fixed in formalin, paraffin embedded, and sectioned at 5 µm. Sections were immunostained for RXFP1 using a rabbit anti-human polyclonal antibody and visualized with diaminobenzidine (DAB).

RESULTS
All synovial tissue and dorsoradial ligament samples showed positive immunostaining for relaxin receptor. While the amount and intensity were variable, females overall showed a greater degree of staining qualitatively than the males. Synovial tissue showed staining for relaxin receptor particularly within clumps of macrophages. The positive control showed relaxin staining, as expected. Negative and background controls were also performed.

SUMMARY POINTS
- Relaxin receptors are present in the synovium and dorsoradial ligament of the trapeziometacarpal joint, indicating that these tissues are a potential target tissue for relaxin. The DRL has been shown to be an important stabilizer of the joint and these findings suggest that circulating relaxin may impact this stability.
- Although relaxin receptor was present in both females and males, it was more abundant in females. This suggests that relaxin, as a reproductive hormone in women, may have greater impact at the trapeziometacarpal joint than relaxin in men.

REFERENCES

PAPER 10

Friday, September 7, 2012 • 8:45 – 8:51 AM
Clinical Paper Session 2: Finger / Tendon

Biomechanical Analysis of Knotless Flexor Tendon Repair using Large Diameter Unidirectional Barbed Suture

Not a clinical study

- Toni E. Lin, MD
Chrisovalantis Lakhiani, BS
Michael R. Lee, MD
Michel Saint-Cyr, MD
Douglas M. Sammer, MD

HYPOTHESIS
In traditional flexor tendon repairs, suture knots can be a site of weakness, impair tendon healing, stimulate an inflammatory response, and increase the bulk of the tendon repair. Because of this, there has been an increased interest in knotless flexor tendon repair using barbed suture. Because no knots are required, it may be possible to increase...
the strength of a barbed suture tendon repair by using a large-diameter barbed suture. The purpose of the study is to biomechanically compare a traditional 4-strand tendon repair using 3-0 braided polyester with a similar knotless 4-strand tendon repair using 0 unidirectional barbed suture.

METHODS
Twenty-two matched fresh-frozen cadaveric flexor digitorum profundus tendons were lacerated and were assigned to repair by a 4-strand modified Kirchmayer-Kessler technique using 3-0 braided polyester (n=11) or knotless 4-strand repair using 0 unidirectional barbed suture (n=11). Repaired tendons were linearly distracted to failure at 20 mm/min after 1N preload. Maximum load, load at 2-mm gap formation, and mode of failure were recorded. Maximum load and load at 2-mm gap formation were compared with the Student’s t-test, and p-values less than or equal to 0.05 were considered significant.

RESULTS
The mean maximum load of the barbed, knotless suture repair was higher than that of the traditional repair (52 N vs. 42 N, p=0.01). There was no difference between the load needed to produce a 2-mm gap between the two groups (p = 0.62). The modes of failure were similar in the two groups.

SUMMARY
The 4-strand knotless tendon repairs using a large diameter barbed suture were stronger than the traditional 4-strand repairs using 3-0 braided polyester, and had similar gap formation. Other biomechanical characteristics and in-vivo performance are not known.

REFERENCES

Figure 1

PAPER 11
Friday, September 7, 2012 • 8:53 – 8:59 AM
Clinical Paper Session 2: Finger / Tendon
Is the Determination of Yield Point Reliable in Tendon Suture Testing?
Not a clinical study
♦ Olli V. Leppänen, MD
Jouni Havulinna, MD
Teemu Karjalainen, MD
Harry Göransson, MD

HYPOTHESIS
We hypothesize that the determination of the mechanical yield point in the tendon suture testing is imprecise. If that is the case, the use of the offset yield point with a defined strain limit might be of greater value to obtain information on the biomechanical behavior of the tendon-suture composites.

METHODS
Forty porcine flexor tendons with four different suture constructs (core suture and peripheral suture) were mechanically tested using a materials testing machine. The load-deformation curves were twice interpreted by three investigators, and the stiffness, the ultimate strength, and the load at yield were determined (Figure 1). The investigators were given a definition for the determination of the yield point: “the point where the irreversible deformation of the tendon-suture composite begins”. The offset yield point was determined for several strain limits using the visually determined linear part as a baseline strain. The inter- and intra-rater precisions were calculated. Both the coefficient of variation (CVrms) and the reliability coefficient (R) were calculated using the standard statistical methods.

RESULTS
The inter-rater and intra-rater precision values are summarized in Table 1. The precision of the determination of ultimate strength was superior to that of other traits, while the determination of the yield point yielded the poorest precision. The inter- and intra-rater precisions were practically of similar magnitude. The strain limit of 0.08 % yielded the optimal precision for the determination of the offset yield point, and the determination was significantly more precise when compared to the visually determined yield point.

SUMMARY POINTS
- A study without a profound methodological background cannot be used to promote science. This should apply also to the tendon suture studies.
- The precision of a widely used parameter, the load at yield point, was proven imprecise. Surprisingly, this seemed to apply to both inter- and intra-rater analyses. This implies that the problem is not solely in the lack of a proper definition for the yield point and subsequent guidelines for the interpretation; instead, this study shows that the yield point is, simply, difficult to determine using only simple visual analyze, although well-defined guidelines would exist.
- The offset yield point turned out to be determinable with good precision. In terms of the tendon suture constructs used in this study, the strain limit of 0.08 % yielded the best precision — and can, thus, be recommended for future use.
REFERENCES


Figure 1. An example of a load-deformation curve. The determination of the biomechanical traits other than the yield point is demonstrated in the figure. The yield point was defined as “the point where the irreversible deformation of the tendon-suture composite begins”.

Table 1. The inter-rater and intra-rater precisions for determination of the stiffness, the load at yield point, the ultimate strength, and the load at offset yield point.

<table>
<thead>
<tr>
<th>Inter-rater precision</th>
<th>Stiffness</th>
<th>Load at Yield</th>
<th>Ultimate Strength</th>
<th>Load at Offset Yield</th>
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<tr>
<td>CV (%)</td>
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<td>9.3</td>
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<td>2.6</td>
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<tr>
<td>R (%)</td>
<td>96.6</td>
<td>94.9</td>
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<td>99.4</td>
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<tr>
<td>Intra-rater precision</td>
<td>CV (%)</td>
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<td>8.1</td>
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</tr>
<tr>
<td></td>
<td>R (%)</td>
<td>97.3</td>
<td>95.9</td>
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</tr>
</tbody>
</table>

* offset strain limit was set to 0.08%.

Figure 2

PAPER 12

Friday, September 7, 2012 • 9:01 – 9:07 AM
Clinical Paper Session 2: Finger / Tendon

Thompson’s Procedure for Failed Mallet Finger Deformity of Tendon Origin

Level 4 Evidence

Kohei Kanaya, MD, PhD
Takuro Wada, MD, PhD
Kosuke Iba, MD, PhD
Toshihiko Yamashita, MD, PhD

HYPOTHESIS

Thompson’s procedure is unique, because it reconstructs the oblique retinacular ligament instead of repairing the terminal tendon and is indicated for failed mallet finger deformity in particular. Although Thompson’s procedure was published in 1978, there is few papers which have reported the experience of this technique. The purpose of this study is to evaluate the outcome of Thompson’s procedure for failed mallet finger deformity of tendon origin.

METHODS

Six cases of mallet finger deformity of tendon origin were treated by Thompson’s procedure. Four patients were male and two were female. The average age at the time of surgery was 42.8 years old (range; 25 to 71). The affected finger was the middle finger in three cases and one each involving the index, ring and small finger. The average period from injury to surgery was 16.2 months (range; 2 to 84). The average extensor lag on the DIP joint was 40 degrees (range; 20 to 45). All cases showed swan-neck deformity.

RESULTS

The average ROMs at the time of final examination were -3.3 degrees (range; 0 to -15) of extension and 95.0 degrees (range; 85 to 110) of flexion for the PIP joint and -6.7 degrees (range; 0 to -20) of extension and 64.2 degrees (range; 40 to 85) of flexion for the DIP joint. Swan-neck deformities were completely corrected in all cases. The performed Thompson’s procedure was shown 8 months after surgery in Figure 2. Button-hole deformity and dimple at the point of the skin fixation with button were shown in one case. There was no sensory disturbance or nail deformity. Assessment by modified Abouna and Brown criteria was shown that five of six patients were qualified as treatment successes.

SUMMARY

Thompson’s procedure is indicated for the patients who had been failed initial surgical or conservative treatments or had swan-neck deformity. Good clinical outcomes were expected even in such cases. This procedure should be reviewed as one of option for chronic mallet finger deformity of tendon origin.

REFERENCES

PAPER 13

Friday, September 7, 2012 • 9:09 – 9:15 AM
Clinical Paper Session 2: Finger / Tendon

Biomechanics of the Acute Boutonniere Deformity
Not a clinical study
◆ Luis Grau, BS
Hasan Baydoun, MD
Kevin Chen, MD
Giovanni Solitro, PhD
Mark H. Gonzalez, MD, MEng
Seth Sankary, BS

HYPOTHESIS
Damage to the central slip, triangular ligament, and oblique fibers between the lateral bands and central slip are necessary to recreate the acute boutonniere deformity. Progressive damage to these structures will cause a decrease in extension at the PIP.

METHODS
8 fresh cadaveric hands were secured onto an apparatus consisting of a motor attached to the extensor communis tendon and a digital potentiometer capable of measuring angles at the PIP joint. The PIP joint was set to 35 degrees of flexion, the motor activated and the change in angle at the PIP joint graphed over time. 4 total configurations were tested in this fashion for each finger.

In configuration 1, all structures were left intact. In configuration 2, the central slip was detached. In configuration 3, the central slip was detached and the oblique fibers of the extensor hood attaching the central slip to the lateral bands were sectioned longitudinally. In configuration 4, the triangular ligament was sectioned longitudinally, the central slip was detached and the oblique fibers of the extensor hood attaching the central slip to the lateral bands were sectioned longitudinally.

RESULTS
In all 8 digits, extension at the PIP was greatest in the intact digit (mean 17.06° SD 7.93). Detachment of the central slip from the middle phalanx produced a decrease in extension of the PIP joint in all 8 digits in average of 30% (mean 14.669° SD 7.36). In all 8 digits, when the lateral bands and the central slip were damaged, extension at the PIP joint decreased (mean 12.934° SD 6.92) by an average of 36% as compared to the intact configuration. Paradoxical motion where flexion instead of extension at the PIP joint was only achieved after all structures were damaged (mean -12.13° SD 6.92). This behavior characteristic of the boutonniere was recorded in all 8 digits.

SUMMARY POINTS
- The structures needed to be damaged to recreate the boutonniere deformity has only been hypothesized in current literature, no biomechanical model exists to date.
- The boutonniere deformity relies on subluxation of the lateral bands volar to the axis of rotation of the PIP joint.
- This study shows that, in a cadaveric model, the central slip, triangular ligament and oblique fibers need to all damaged to cause subluxation of the lateral bands which leads to an acute boutonniere deformity.
- Extension of PIP joint decreases as these structures are progressively damaged.

REFERENCES

Figure 1. Finger 3 Extension

PAPER 14

Friday, September 7, 2012 • 10:05 – 10:11 AM
Clinical Paper Session 3: Wrist Biomechanics

The Extensor Carpi Ulnaris Muscle Plays a Major Role in Destabilizing Scapholunate Deficient Wrists: A Biomechanical Study
Not a clinical study
◆ Guillem Salvà-Coll, MD, PhD
Marc Garcia-Elias, MD
Maria Mayte Leon-Lopez, MD
Alex Lluch-Bergada, MD
Manuel Llusa-Perez, MD, PhD
Alfonso Rodriguez-Baeza, MD, PhD

HYPOTHESIS
The reason why some “scapholunate advanced collapse” (SLAC) wrists remain long time asymptomatic is not known. We hypothesized decreased muscle activity of the extensor carpi ulnaris (ECU) muscle to be an important factor in this regard. Such hypothesis was based on the findings of recent investigations demonstrating that isometric contraction of the ECU causes pronation of the scaphoid relative to the radius.1 If the scapholunate ligaments are torn, such scaphoid pronation is likely to induce dorsolateral subluxation of its proximal pole over the dorsal lip of the radius. In such circumstances, the radioscaphoid joint contact would no longer be established across cartilage covered surfaces, this enhancing rapidly symptomatic joint degeneration. To prove this hypothesis, the present biomechanical investigation was designed.
METHODS
The kinetic effects of isometric loading of five wrist motor tendons (APL, ECRL, FCU and FCR) on 10 fresh normal cadaver arms and 5 arms with a SLAC pattern of carpal osteoarthritis were analyzed. A custom designed testing apparatus was used to hold the forearm and wrist vertical in neutral position. A 6 degree-of-freedom electromagnetic motion tracking device with sensors attached to the scaphoid, triquetrum, capitate and radius was used to monitor spatial changes in alignment. The rotation sustained by the scaphoid in both normal and SLAC groups was measured and compared statistically.

RESULTS
ECU is the only muscle that provokes scaphoid pronation; all other muscles induce its supination (Table 1). In normal wrists, isometric contraction of the ECU causes an average 1.48° pronation, 0.77° extension and 0.20° ulnar deviation to the scaphoid, but no radioscaphoid subluxation. In SLAC wrists, by contrast, isometric ECU contraction causes significant radioscaphoid subluxation, with the scaphoid rotating into substantial pronation (average 4.50°; p<0.008) and extension (0.69°; p=0.05). None of the other muscles exhibited such an obvious destabilizing effect.

SUMMARY
The ECU muscle has a major role in destabilizing scapholunate deficient wrists; therefore, isometric contraction of the ECU muscle should be avoided when treating SLAC wrists conservatively.

REFERENCE

<table>
<thead>
<tr>
<th></th>
<th>Scaphoid pronation/supination (degrees)</th>
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<tbody>
<tr>
<td></td>
<td>TL</td>
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<tr>
<td>SLAC N</td>
<td></td>
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<tr>
<td>Mean</td>
<td>-0.79</td>
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<tr>
<td>Std. Deviation</td>
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<td>Variance</td>
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<tr>
<td>CI 95% Lower Bound</td>
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<tr>
<td>Upper Bound</td>
<td>2.36</td>
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<td>NORMAL N</td>
<td>10</td>
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<tr>
<td>Mean</td>
<td>0.52</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>0.61</td>
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<tr>
<td>Variance</td>
<td>0.38</td>
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<tr>
<td>CI 95% Lower Bound</td>
<td>0.08</td>
</tr>
<tr>
<td>Upper Bound</td>
<td>0.96</td>
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</tbody>
</table>

* Pronation/Supination. Negative values indicates pronation, positive supination
* CI: 95% Confidence Interval for mean

PAPER 15
Friday, September 7, 2012 • 10:13 – 10:19 AM
Clinical Paper Session 3: Wrist Biomechanics
Dynamic CT Evaluation of Scapholunate Reconstructions
Not a clinical study
Aaron Babb, MD
Sanjeev Kakar, MD, MBA
Shuai Leng, PhD
Kristin Daigle Zhao, MA
Richard Berger, MD
Steven L. Moran, MD

HYPOTHESIS
Scapholunate (SL) reconstructions attempt to recreate normal kinematics using complex and variable soft tissue repairs. We hypothesize that when evaluated with 4D (3D + time) CT, the modified 3-ligament tenodesis and dorsal intercarpal capsulodesis reconstructions do not restore normal wrist kinematics.

METHODS
Ten fresh-frozen cadaveric wrists, devoid of static SL instability, a type 2 lunate or advanced carpal arthritis, were used to study the kinematics of 3-ligament tenodesis and dorsal intercarpal capsulodesis reconstructions for SL reconstruction. Five cadavers were used for each of the reconstructions. A custom, dynamic wrist simulator was used to control flexion-extension and radio-ulnar deviation of the wrist while coordinating pneumatic loads on specific tendons. The tendons were dynamically loaded with 10 N of force in the following combinations during this study: flexion (FCR, FCU, and FDP), extension (ECRL and ECU), radial deviation (FCR and ECRL) and ulnar deviation (FCU and ECU). The instability model for each cadaver was created through both a dorsal and volar approach. A dorsal ligament-sparing capsulotomy[1] was used to transect the entire SL interosseous ligament and a volar approach was used to transect the radioscapohapitate, long radioulnate and scaphotrapeziotrapezoid ligaments. The reconstructions consisted of the modified 3-ligament tenodesis[2,3] and dorsal intercarpal ligament capsulodesis[4,5]. The wrist was cycled 100 times in flexion-extension prior to each testing condition. Each wrist was tested using 4DCT scanning during three 3 conditions: intact, instability, and reconstruction. A dual-source CT scanner (Siemens Healthcare, Forchheim, Germany) was used for this work with detection capability of 0.6mm thickness. Using a non-gated technique, we were able to acquire images of wrist motion over two-seconds; then, using volume-rendering software, we reconstructed the images to create animations of the intact, instability, and reconstruction states of each specimen.

RESULTS
[4DCT videos to be shown during presentation]
The current study represents the first investigation of reconstruction techniques of the wrist using dynamic 4DCT imaging. The evaluation confirmed that neither the modified 3-ligament tenodesis, nor the dorsal intercarpal ligament capsulodesis, recreated the normal biomechanics of the internal control. However, when comparing the two, the capsulodesis performed better at controlling scaphoid motion.
SUMMARY POINTS
- Neither the modified 3-ligament tenodesis, nor the dorsal intercarpal ligament capsulodesis recreates normal biomechanics.
- Radial deviation causes the most visible instability.
- The proximal pole of the scaphoid is not controlled by either reconstruction technique.
- The dorsal intercarpal ligament capsulodesis better controls the proximal pole of the scaphoid.

REFERENCES

Figure 1. 4DCT PA Image: Instability Model

Figure 2. 4DCT PA Image: Capsulodesis Reconstruction

PAPER 16
Friday, September 7, 2012 • 10:21 – 10:27 AM
Clinical Paper Session 3: Wrist Biomechanics

The Effects of Screw Length on Stability of Simulated Osteoporotic Distal Radius Fractures Fixed with Volar Locking Plates
Not a clinical study
• Lindley B. Wall, MD
Michael Brodt, MS
Matthew J. Silva, PhD
• Martin I. Boyer, MD, FRCS(C)
Ryan P. Calfee, MD

HYPOTHESIS
Volar plating for distal radius fractures has caused extensor tendon ruptures secondary to dorsal screw prominence. This study was designed to determine the biomechanical impact of placing unicortical distal locking screws and pegs in an extra-articular fracture model. It was hypothesized that unicortical fixation of at least 75% length would outperform screws of 50% length due to a lack of dorsal subchondral support for the distal radius articular surface and that screws would be superior to peg fixation.

METHODS
Volar-locking distal radius plates were applied to 30 osteoporotic distal radius models. Radii were divided into 5 groups based on distal locking fixation: bicortical locked screws, 3 lengths of unicortical locked screws (abutting the dorsal cortex [full length], 75% length, and 50% length to dorsal cortex), and unicortical locked pegs. Distal radius osteotomy simulated a dorsally comminuted, extra-articular, fracture. Each construct’s stiffness was determined under physiologic loads (axial compression, dorsal bending, volar bending) before and after 1000 cycles of axial conditioning and prior to axial loading to failure (2mm of displacement) and subsequent catastrophic failure.

RESULTS
Cyclic conditioning did not alter constructs’ stiffness. Stiffness to volar bending and dorsal bending forces were similar between groups. Final stiffness(N/mm) under axial load was statistically equivalent for all groups: bicortical screws(230), full-length unicortical screws(227), 75% length unicortical screws(226), 50% length unicortical screws(187), unicortical pegs(226). Force(N) at 2 mm displacement was significantly less for 50% length unicortical screws(311) compared to bicortical screws(460), full-length unicortical screws(464), 75% length unicortical screws(400), and unicortical pegs(356). Force(N) to catastrophic fracture was statistically equivalent between groups, but mean values for pegs(749) and 50% length unicortical(702) screws were 16-21% less than means for bicortical(892), full-length unicortical(860), and 75% length(894) unicortical constructs.

SUMMARY
Locked unicortical distal screws of at least 75% length produce construct stiffness similar to bicortical fixation. Unicortical distal fixation for extra-articular distal radius fractures should be entertained to avoid extensor tendon injury since it does not appear to compromise initial fixation.
In both groups, the scaphoid and lunate were dissected out, pinned with 2 orthogonal K-wires in each of the bones, and potted in polymethylmethacrylate. A 5N pre-load was applied on the load frame, followed by 200 cycles from 5-20N. Load to failure was applied at 5mm/s. In initial testing, one control specimen failed during cycling and that pair was excluded from analysis. The data were analyzed using the nonparametric Wilcoxon Test. A significance level of 0.05 was accepted.

RESULTS
The reconstructed ligament elongated significantly more during cycling than the control group. The stiffness of the reconstructed ligament was significantly less than the control group. Load to failure was not significantly different (Table 1). Mode of failure in the reconstruction group was by breaking off the radial wall of the lunate (3), pulling out of the lunate (1) or pulling out of the scaphoid (3). The control group all failed by midsubstance tears.

SUMMARY
This new technique for anatomic reconstruction of the vital dorsal band of the SL-ligament may provide secure enough bone tunnel fixation and obviate the need for prolonged pin fixation and immobilization that has traditionally been required in non-anatomic reconstruction techniques commonly used for chronic static and dynamic scapholunate instability. Our data supports consistent and reproducible load to failure in reconstructed group which might translate to future clinical application.

REFERENCES

Table 1: Elongation, stiffness and load to failure results

<table>
<thead>
<tr>
<th></th>
<th>Control Mean ± St Deviation</th>
<th>Reconstruction Mean ± St Deviation</th>
<th>p value</th>
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<tbody>
<tr>
<td>Elongation</td>
<td>0.081 ± 0.042 mm</td>
<td>0.589 ± 0.258 mm</td>
<td>0.028*</td>
</tr>
<tr>
<td>Stiffness</td>
<td>82.07 ± 44.1 N/mm</td>
<td>37.94 ± 10.4 N/mm</td>
<td>0.028*</td>
</tr>
<tr>
<td>Load to failure</td>
<td>115.4 ± 63.15 N</td>
<td>70.8 ± 8.7 N</td>
<td>0.14</td>
</tr>
</tbody>
</table>

* statistically significant.

Figure 1: Left Scapholunate Ligament Reconstruction with Extensor Indicis Proprius
**HYPOTHESIS**
During the 3 years following successful correction of Dupuytren’s contracture with collagenase clostridium histolyticum (CCH), in joints with recurrence (defined below) fixed-flexion contracture (FFC) progresses slowly; in joints without recurrence, FFC remains at or near initial post-treatment levels.

**METHODS**
We evaluated long-term efficacy and safety of CCH in subjects previously enrolled in Phase III trials at the third year of an ongoing 5-year, non-treatment follow-up study. Subjects were reevaluated annually for evidence of recurrent joint contracture and safety beginning 2 years after their first CCH injection. Recurrence was defined as ≥20° increase in contracture in the presence of a palpable cord in a joint previously successfully corrected (reduction of contracture to 0°-5°), or patient underwent further medical/surgical intervention. We report the incidence and extent of contracture over 3 years in subjects who did and did not experience recurrence after successful treatment.

**RESULTS**
A total of 643 subjects were enrolled (84% male, mean age 66 years). Of 1080 CCH-treated joints (648 metacarpophalangeal (MP) and 432 proximal-interphalangeal (PIP)), 623 joints (451 MP , 172 PIP) were successfully corrected. Data were available for 417 MCP joints (Figure 1) and 155 PIP joints (Figure 2). FFC values were not included for joints that received medical/surgical intervention. In recurrent MCP joints (n=96), the mean pre-treatment FFC was 37°, which was reduced to 2° with treatment; mean FFCs at post-treatment years 1, 2, and 3 were 6°, 23°, and 33°, respectively. In non-recurrent MCP joints (n=321), mean pre-treatment FFC was 38°, which reduced to 1° with treatment; mean FFCs at post-treatment years 1, 2, and 3 were 2°, 2°, and 3°, respectively. In recurrent PIP joints (n=89), mean pre-treatment FFC was 40°, which reduced to 3° with treatment; mean FFCs at post-treatment years 1, 2, and 3 were 12°, 29°, and 37°, respectively. In non-recurrent PIP joints (n=66), mean pre-treatment FFC was 35°, which reduced to 2° with treatment; mean FFCs at post-treatment years 1, 2, and 3 were 3°, 6°, and 8°, respectively. No new long-term adverse events (AEs) or serious AEs were identified and attributed to CCH.

**SUMMARY POINTS**
- In patients successfully treated with CCH, non-recurrent joints maintained mean FFC levels similar to (MCP) or slightly higher (PIP) than FFC levels at the time of treatment success.
- Recurrent joints progressed slowly, still had not reached pre-treatment mean FFC levels after 3 years, and only reached the generally agreed 20°-30° threshold for re-treatment after about 2 years.
**PAPER 19**

Friday, September 7, 2012 • 10:13 – 10:19 AM
Clinical Paper Session 4: Soft Tissue / Dupuytren’s

**Histology of Cords from Dupuytren’s Patients: A Comparison After Collagenase Injection/Fasciectomy, Primary Fasciectomy and Repeat Fasciectomy**

Not a clinical study

- Marie A. Badalamente, PhD
- Lawrence C. Hurst, MD
- Abner Ward, MD
- Travis Parker, MD
- Jingxuan Liu, MD
- Jakub Tatka

**HYPOTHESIS**

The hypothesis of this study was that the gross and histologic characteristics of cords from patients with Dupuytren’s disease treated by collagenase injection followed by fasciectomy for recurrence would not differ from that in Dupuytren’s patients who were treated by primary fasciectomy or repeat fasciectomy for recurrence.

**METHODS**

A total of 28 Dupuytren’s cord samples were obtained at surgery between 1998 and 2010. These consisted of 12 cords from patients treated with collagenase and then fasciectomy for recurrence, 8 cords from primary fasciectomy and 8 cords from repeat fasciectomy for surgical recurrence. All cords were prepared for histologic evaluation and stained with hematoxylin and eosin. Slides were examined in a blinded manner. A histology evaluation scale was established based on presence/absence of: cellularity, collagen alignment, myxoid (glycosaminoglycans), perivascular inflammation, vascular proliferation, adipose vacuoles and hemosiderin deposition. A timeline of collagenase injections, prior to surgery, was obtained. All operative notes were reviewed.

**RESULTS**

There were no differences in areas of cellular density or collagen alignment in any sample studied (Fig 1). Review revealed that six of the 12 collagenase treated cords had myxoid and three of eight repeat fasciectomy cords also had myxoid. The primary fasciectomy cord samples showed no myxoid. The remainder of the histologic evaluations in all samples revealed parameters known to be associated with the fibromatosis of Dupuytren’s disease including: vascular proliferation, perivascular inflammation, adipose (fat) vacuoles and hemosiderin deposition. The mean time from collagenase injection(s), until fasciectomy, was 30.08 ± 22.3 months (range 6-75 months). The macroscopic tissue quality of all cord samples was similar. In particular, collagenase treated cords were of the same hard collagenous consistency as the tissue “softer” and not distinguishable from other anatomic structures, thus making surgery, if required, more difficult. This was not found to be the case during any fasciectomy performed after collagenase injection(s).

**SUMMARY**

This study has shown that Dupuytren’s cords treated by either collagenase injection(s) and subsequent fasciectomy for recurrence, or primary fasciectomy or repeat fasciectomy for recurrence are histologically similar and resemble the classic fibromatosis characteristic of the disorder.

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**PAPER 20**

Friday, September 7, 2012 • 10:21 – 10:27 AM
Clinical Paper Session 4: Soft Tissue / Dupuytren’s

**Does Collagenase Injection Disrupt or Digest the Dupuytren’s Cord? A Magnetic Resonance Imaging Study.**

Level 4 Evidence

- Edward Moon, MD
- Keith Crivello, MD
- Hollis Potter, MD
- Scott Wolfe, MD

**HYPOTHESIS**

It is unknown whether collagenase weakens the Dupuytren’s cord sufficiently to cause failure during manipulation or if there is actual digestion and reduction in cord volume. We hypothesize that post-injection magnetic resonance imaging (MRI) will demonstrate a reduction in cord volume without injury to surrounding soft tissue structures.

**METHODS**

Five patients with isolated contractures of the ring or middle metacarpal-phalangeal joint (MPJ) were enrolled. Patients received a baseline MRI of the hand, which was repeated 30 days following collagenase injection and manipulation. Range of motion (ROM) data was collected at baseline and at the final MRI follow-up. The Dupuytren’s cord was evaluated with respect to the following: volume, signal intensity, inflammatory changes, and continuity. Additionally, signal intensity and inflammatory changes of the flexor tendons as well as an evaluation of the digital neurovascular structures were recorded. Descriptive statistics and a paired t-test were used to quantify the changes seen on MRI.

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*Speaker has nothing of financial value to disclose*
RESULTS
Five males (avg. age 68) with a mean MPJ contracture of 33 degrees (range 25 - 40) were treated with collagenase injection (four ring fingers and one middle finger). All five patients had full correction with zero residual contracture after manipulation, and correction was completely maintained at an average of 39 days. MRI demonstrated complete discontinuity of the cord in each case, and a significant reduction of cord volume by an average of 72% (670 mm³ - 188 mm³, p = 0.0013). There was a significant increase in cord signal intensity by an average of 320% (632 - 2021, p = 0.022). There was no evidence of flexor tendon ruptures or neurovascular injury. There was an increase in signal intensity of the flexor tendons, which was not statistically significant (superficialis 235 - 342, p = 0.07; profundus 191-223, p = 0.46).

SUMMARY POINTS
- Treatment of isolated Dupuytren’s MPJ contractures with collagenase caused cord disruption without injury to surrounding soft tissue structures by clinical and imaging criteria.
- There is a significant increase in signal intensity within the cord demonstrating disorganization of collagen, which is not seen in the tendons.
- Collagenase causes a statistically significant decrease in cord volume as measured by MRI, indicating a reduction in diseased tissue rather than simple cord division. Local chemical dissolution of the cord may have prognostic implications in terms of correction and recurrence following collagenase injection.

Figure 1
Axial MRI image demonstrating appearance of Dupuytren's cord before (left) and after (right) injection with collagenase and manipulation

Figure 2
Coronal MRI image demonstrating appearance of Dupuytren's cord before (left) and after (right) collagenase injection and manipulation

PAPER 21
Friday, September 7, 2012 • 10:29 – 10:35 AM
Clinical Paper Session 4: Soft Tissue / Dupuytren’s
Blockade of Matrix Metalloproteinase-3 after Traumatic Nerve Injury Offers a Novel Treatment for Improving Functional Recovery
Not a clinical study
- Tom Chao, MD
Peter Hanh, MD
Derek Frump, BS
Vincent J. Caiozzo, PhD
Tahseen Mozaffar, MD
- Ranjan Gupta, MD

HYPOTHESIS
Functional recovery after surgical repair of traumatic nerve injury is often rather poor. As long-term denervation leads to destabilization of the target end-organ, i.e. the motor endplate, this loss of functional end points for reinnervation may be responsible for poor outcomes following nerve repair. Recent research supports that this destabilization process is secondary to removal of trophic elements such as agrin that maintain the neuromuscular junction (NMJ). Furthermore, it has been found that matrix metalloproteinase-3 (MMP-3) is responsible for removing agrin from the NMJ. The goal of this study seeks to examine whether the NMJ may be preserved after denervation if MMP-3 is inactivated.

MATERIALS AND METHODS
A murine model for a segmental sciatic nerve injury was created and the plantaris muscles were extracted from wildtype and MMP-3 knockout mice at 1 week, 2 week, 1 month, and 2 month time periods after injury. Immuno-histochecmical analysis was performed to define the integrity of the NMJ cellular components as well the key molecular mediators, agrin and MuSK. Western blot techniques were used to quantify Agrin, MuSK, and Ach receptor subunit alpha and gamma levels. Functional evaluation of 1 month denervated muscles from wildtype and MMP-3 knockout animals were tested in an ex vivo setting in order to determine the degree to which they remain responsive to acetylcholine activation. Two-tailed t-test was performed with p value < 0.05 constituting significance.

RESULTS
In contrast to wildtype mice, MMP-3 knockout muscle showed that AchRs remained intact up to the 2 month time point. Agrin immunofluorescence was also observed late after denervation in the knockout but not the wildtype. MuSK remained significantly phosphorylated up to 1 month after denervation in knockout mice. Functional assessment of the muscles demonstrated that the amount of activation with acetylcholine in MMP-3 knockouts was substantially greater than that in the wildtype muscles (1.84±0.346 N vs 0.674±0.221 N), indicating that the motor end plate in knockout mice retained greater activation potential despite denervation at one month after denervation.

SUMMARY POINTS
- Acetylcholine receptors are resistant to destabilization by denervation in MMP-3 knockouts.
- Agrin is maintained at the motor end plate in MMP-3 knockouts despite denervation.
- Functional activation of denervated muscle in MMP-3 knockouts remains robust relative to their wildtype counterparts.

Figure 1
Axial MRI image demonstrating appearance of Dupuytren's cord before (left) and after (right) injection with collagenase and manipulation

Figure 2
Coronal MRI image demonstrating appearance of Dupuytren's cord before (left) and after (right) collagenase injection and manipulation

• Grant received from Auxilium Investigator Initiated Trial (Moon)
• Honoraria: TriMed, Inc., SBI (Wolfe)
• Consulting Fees: Extremity Medical, TriMed, Inc (Wolfe)
• Intellectual Property Rights/Patent Holder: KinematX Total Wrist Arthroplasty, Extremity Medical, NJ (Wolfe)
This research provides novel, exciting data that supports investigation of the use of small molecule therapy with MMP-3 inhibitors in-vivo to improve functional recovery after traumatic nerve injury.

REFERENCES

Figure 1

Grant received from OTA, OREF (Chao)
Contracted Research: NIH/NINDS, OTA, OREF (Gupta)
Honoraria: Arthrex (Gupta)

PAPER 22

Friday, September 7, 2012 • 11:25 AM – 11:31 AM
Clinical Paper Session 5: Miscellaneous

Minimal Clinically Important Differences on the DASH, Quick-DASH and PRWE

Level 2 Evidence

Amelia Adams, MD
Jeffrey Ketchersid, BS
Wen Hui Tan, BS
Ryan P. Calfee, MD
Daniel Howard, BA

HYPOTHESIS

This study was designed to define the minimal clinically important difference (MCID) in DASH, Quick-DASH and PRWE for common atraumatic conditions of the hand, wrist and forearm.

METHODS

One hundred and two patients undergoing non-operative treatment for isolated tendinitis, arthritis, or nerve compression syndromes from the elbow to the hand were enrolled in a prospective cohort study. Patients completed the DASH, Quick DASH and PRWE at enrollment, two weeks (N=89), and four weeks (n=74) after initiating nonoperative treatment. Minimal clinically important change on each patient-rated functional measure was determined using a validated anchor based approach consisting of fifteen-item scales for change in pain and change in function as well as a four-item overall response to treatment. Those patients reporting improvement were categorized as “no change”, “minimal improvement”, and “marked improvement” groups based on responses to anchor questions. Final patient categorization for data analysis required consistent grouping on at least 2 of the 3 anchor questions. The minimal clinically important difference was calculated as the mean change score for each outcome measure in the “minimal improvement” group. Subgroup analysis used ANOVA testing to compare MCID values according to diagnostic category.

RESULTS

During follow up, 65 data-points were collected following “no change”, 31 represented “minimal improvement”, and 55 were categorized as “marked improvement”. These anchor-based categories clearly demarcated incremental improvement on each outcome measure (Figure 1). The minimal clinically important difference for the DASH was 11 (SD 13). The MCID for the Quick DASH was 16 (SD 14). The MCID was 14 (SD 15) for the PRWE. Changes in the DASH and QuickDASH were highly correlated (r=.97) with significant correlation between these measures and the PRWE as well (r=.77). There were no significant (p=.31) differences between MCID’s on any of the patient-rated measures when analyzing data according to diagnostic category (tendonitis, nerve compression, arthritis).

SUMMARY POINTS

- Longitudinal changes on the DASH of 11 points, the Quick DASH of 16 points, and the PRWE of 14 points represent minimally clinically important changes.
- Minimal clinically important changes on validated surveys of patient-rated upper extremity function are similar for multiple atraumatic conditions.
- These MCID values should serve as a basis for sample size calculations for future investigation using these common patient-rated function measures.

REFERENCES
A National Survey of Program Director Opinions of Core Competencies and Structure of Hand Surgery Fellowship Training

Not a clinical study

• Erika Davis Sears, MD
Bradley Larson, BS
Kevin C. Chung, MD, MS

HYPOTHESIS
Recent changes toward competency-based training and evaluation have great relevance in hand surgery, where trainees come from different primary specialties and where the scope of practice of hand surgery is not uniform. The purpose of this national survey supported by the ASSH was to assess program directors’ opinions of components of hand surgery that graduates should be proficient in by the end of training and opinions of structures of training programs.

METHODS
All program directors (n=74) of ACGME accredited hand surgery fellowships were invited to participate. A web-based survey was designed to rate 9 general areas of practice, 97 knowledge topics, and 172 procedures that graduates should be proficient in by the end of training. Respondents were asked to rate each component into one of three categories (essential, exposure needed, or unnecessary). The knowledge topics and procedures were divided into 18 categories, and included detailed procedures and disorders involving the hand, wrist, forearm, and peripheral nerves.

RESULTS
62 program directors (84% response rate) completed the survey. A majority (74%) preferred the fellowship model over an integrated model. Program directors were divided in support for (38%) and against (39%) the creation of two-year fellowship programs. However, 65% of program directors believed that a one-year fellowship is sufficient to train a competent hand surgeon (Table 1). Greater than 90% of respondents believed wrist, distal radius/ulna, and peripheral nerve conditions were essential areas of practice for graduates to master. Forearm conditions were rated as essential by 61% of respondents, whereas microsurgery was rated as essential by less than half of respondents (48%) (Table 2). Of the detailed components, 76 of 97 knowledge topics and 98 of 172 procedures were rated as essential by at least 50% of respondents. Burns was the only category in which no knowledge topics or procedures were rated as essential by at least 50% of respondents.

SUMMARY POINTS
- With reforms toward competency-based training and the varying scope of practice in hand surgery, there is a need to define competencies in which graduates should be proficient.
- A majority of program directors feel graduates should be proficient in wrist, distal radius/ulna, forearm, and peripheral nerve conditions by the end of training. However, less than half of program directors feel graduates should be proficient in microsurgery and free-tissue transfer.
- Implementation of novel training methods within the one-year fellowship model is needed to improve exposure to core competencies.

Table 1. Program Director Opinions of Curriculum Structure for Hand Surgery Training

<table>
<thead>
<tr>
<th>Statements Rated</th>
<th>Strongly Agree/Agree</th>
<th>Neither Agree Nor Disagree</th>
<th>Strongly Disagree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I support the creation of additional pathways for hand surgery training, such as a 5 or 6 year integrated residency.</td>
<td>24%</td>
<td>13%</td>
<td>63%</td>
</tr>
<tr>
<td>I prefer a fellowship model over an integrated residency training model.</td>
<td>74%</td>
<td>16%</td>
<td>10%</td>
</tr>
<tr>
<td>A one-year hand surgery fellowship is sufficient to train a competent hand surgeon.</td>
<td>65%</td>
<td>16%</td>
<td>19%</td>
</tr>
<tr>
<td>I support creation of a two-year fellowship model.</td>
<td>38%</td>
<td>23%</td>
<td>39%</td>
</tr>
</tbody>
</table>

Table 2. Program Director Opinions of General Areas of Practice Essential for Graduates to be Proficient in By the End of Hand Surgery Training

<table>
<thead>
<tr>
<th>General Areas of Practice</th>
<th>&gt;90%</th>
<th>&gt;80%</th>
<th>&gt;70%</th>
<th>&gt;60%</th>
<th>&gt;50%</th>
<th>&gt;40%</th>
<th>&gt;30%</th>
<th>≤30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrist conditions</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distal radius and ulna conditions</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid forearm and proximal forearm conditions</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow conditions</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper arm and shoulder conditions</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clavicle and scapula conditions*</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peripheral nerve conditions</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brachial plexus conditions</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microsurgery and free tissue transfer</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Rated as unnecessary in hand surgery training by >61% of respondents

• ASSH Hand Education Research Grant (Sears)
METHODS
Seventy closed malpractice claims filed for alleged negligent treatment of distal radius fractures by orthopaedic surgeons insured by the largest medical professional liability insurer in New York State from 1981-2005 were reviewed for demographic, clinical, and legal information. We separately reviewed defendants’ personal closed malpractice claim histories from 1975-2011. We estimated the overall incidence of malpractice claims among distal radius fractures treated in New York State (NYS) using the NYS Statewide Planning and Research Cooperative System (SPARCS) database and the 2008 American Academy of Orthopaedic Surgeons (AAOS) census data.

RESULTS
The overall incidence of malpractice claims for distal radius fracture management was low (0.04%). Malunion was the most common complaint across claims (97%) regardless of treatment type. The number of claims filed for operatively treated fractures increased over time, paralleling the documented increasing rates of operative management. Only 18% of nonoperatively treated fractures were followed according to the AAOS recommendation of weekly radiographs for the first three weeks. A majority of claims (73%) documented poor interpersonal relationships. Most defendants were sued often (median lawsuits per career = 9), all were male, and only 6% were fellowship-trained in hand surgery. Male plaintiffs in this study were significantly older than males treated for distal radius fractures in New York State (p < 0.0001). Defendants lacking board certification were significantly more likely to make indemnity payments (p = 0.04). Thirty-eight of 70 cases resulted in an indemnity payment. Of the thirty-five cases that settled before trial, the mean and median amounts were $167,449 and $144,293 respectively.

SUMMARY POINTS
- Severe malunion is the major feature of malpractice litigation involving distal radius fracture management.
- Poor doctor-patient relationships can amplify a poor clinical outcome, possibly resulting in a lawsuit.
- When treating distal radius fractures non-operatively, the surgeon must be vigilant about surveillance radiographs through the first 3 weeks to detect any significant redisplacement.
- Being a female surgeon and having certification from American Board of Orthopaedic Surgery is protective against making an indemnity payment.

REFERENCES

Figure 1
- Consulting Fees: Trmedics, consultant; Advisory Board Village Health Works (Glickel)
- Honoraria: Medarts (Glickel)
- Royalty Support: Extremity Medical (Barron)
HYPOTHESIS
TGF-β expression is essential for tendon development and regulates tenocyte gene expression in vitro via a Smad3-dependent pathway \cite{1,2}. Therefore, we hypothesized that Smad3 modulates tendon gene expression during and after development and interacts directly with key tendon transcription factors.

METHODS
Gene Expression qPCR Analyses:
Hindlimb and tail tendons were isolated from 6-week old mice. RNA was extracted using the Purelink RNA Mini Kit (Invitrogen) and cDNA was reverse transcribed using the iScript cDNA synthesis kit (BioRad). Expression was assessed by SYBR green fluorescence during qRT-PCR with established primers. Data was analyzed using a two-tailed t-test assuming unequal variances.

Immunohistochemistry:
Mouse embryos were harvested at embryonic day (E) 16.5 and forelimbs sectioned axially. Achilles tendons of 6-week old mice were harvested and sectioned longitudinally. Protein expression was analyzed using antibodies for Smad3 (Abcam), Collagen1 (Abcam) and TenascinC (gift of H. Erickson, Duke University).

Co-Immunoprecipitation:
10T1/2 cells were transfected using lipofectamine with expression vectors for Smad3, Scleraxis, and/or Mohawk. Cells were grown for 18 hours and lysed. Complexes were immunoprecipitated from cell lysates by Flag-M2 affinity gel (Sigma) or by HA-probe Y-11 (Santa Cruz) before analysis by western blot.

RESULTS
Smad3 Modulates Gene Expression in Embryonic and Adult Mice:
Immunohistochemistry of embryonic forelimbs and adult tendon reveals decreased levels of Collagen1 and TenascinC in Smad3-/- animals relative to wild-type (Figure 1).

Quantitative PCR analyses of mature Smad3-/- tendons reveal reduced mRNA expression of several markers of tenocyte differentiation. In Smad3-/- tendons, expression of the key tendon transcription factors Scleraxis and Mohawk was reduced to 64% (p=0.18) and 46% (p=0.04) of wild-type respectively. Collagen1 expression was reduced to 8.6% of wild-type (p=0.001), TenascinC expression to 65% (p=0.18) and Tenomodulin to 20% (p=0.05).

Smad3 Interacts with Scleraxis and Mohawk:
Western blot analysis of lysates from cells transfected with Smad3 and Scleraxis reveals the presence of Smad3 after immunoprecipitation with an antibody to the Scleraxis construct, suggesting that Smad3 and Scleraxis interact directly in the same protein complex. Similarly, the presence of Mohawk in immune complexes after precipitation of lysates with an antibody to Smad3 reveals that Mohawk and Smad3 also interact directly (Figure 2).
SUMMARY POINTS
- Smad3 is a crucial regulator of tendon gene expression during embryonic development and in adult mice.
- Regulation of tendon gene expression by Smad3 may occur via its direct interaction with the key tendon transcription factors Scleraxis and Mohawk.
- Modulation of the Smad3 pathway may improve the results of flexor tendon repair.

REFERENCES

PAPER 27
Friday, September 7, 2012 • 11:33 – 11:39 AM
Clinical Paper Session 6: Basic Science
Motor Nerve Recovery after Autologous Nerve Graft is not Enhanced by Vascular Endothelial Growth Factor Administration

HYPOTHESIS
It has been known that vascular endothelial growth factor (VEGF) stimulates Schwann cell invasion and new vessel formation which might be beneficial for nerve regeneration. We hypothesized that administration of VEGF enhances motor nerve recovery after autologous nerve graft in the rat model.

METHODS
Sixty-nine rats were randomly divided into three experimental groups and a unilateral 10 mm sciatic nerve defect was made. Group I was repaired with reversed autograft, group II received an osmotic pump with VEGF, and group III added a silicone tube around the nerve graft to decrease the surrounding blood supply. Nine animals in each group were sacrificed on day 3 to evaluate improvement in capillary formation using imaging software. Fourteen animals in each group were sacrificed on 16 weeks after initial procedure to evaluate the functional motor nerve regeneration using compound muscle action potential, maximum isometric tetanic force and wet muscle weight of the tibialis anterior and passive ankle plantar flexion angle.

RESULTS
The average capillary density on day 3 was 10.7±3.8 % in group I, 21.4±5.3 % in group II, and 0.9±0.9 % in group III. These differences were significant (p < .001, p < .001, respectively). However, the average maximum isometric tetanic force at 16 weeks was 54.4±10.6 % in group I, 57.5±13.6 % in group II, and 47.6±14.2 % in group III. No difference was found with or without VEGF administration (p = 1.000). Although the muscle force was generally worse in group III, this difference was not statistically significant (p = .232, p = .643, respectively).

SUMMARY POINTS
- Early capillary formation on autologous nerve graft is enhanced by VEGF administration.
- The neovascularization effect of VEGF administration does not translate into better motor nerve recovery in the long term.

REFERENCES
Grant received from Mayo Clinic – Kelly Award/Aircast Foundation Award (Lee)
Contracted Research: Mayo foundation, Integra Life Sciences, Musculoskeletal Transplant Foundation, Sonoma Orthopedics Research Grant, AAHS Research Grant (Shin)
Consulting Fees: Accumed (Shin)

METHODS
Fifty Sprague-Dawley Achilles tendon-calcaneus composite TBI grafts were harvested. Untreated (native) grafts (Group 1) were compared with grafts subjected to physicochemical decellularization (Groups 2 and 3). Group 2 grafts underwent low-power targeted ultrasonication (5 minutes, 31,830, 112W) while Group 3 grafts underwent high power targeted ultrasonication (10 minutes, 64,800, 114W). Groups 2 and 3 then underwent chemical decellularization with 5% peracetic acid, 1% EDTA and 2% SDS.

Histological assessment included H&E, Masson’s Trichrome, SYTOGreen nucleic acid stain and high power field cell counts (hpf). Using a pair-matched design, load to failure and ultimate tensile stress (UTS) of treated grafts were compared with controls. All data was statistically evaluated using paired T-test. Decellularized grafts were then seeded with adipodervived stem cells (ASCs) transplanted with a GFP+ and luciferin construct and replanted. Bioluminescence of seeded grafts were evaluated in vitro after 3 and 10days, and after implantation in vivo.

RESULTS
Physicochemical decellularization resulted in significant reduction of visible cells and nucleic acid material, while structure of the TBI was preserved. Average cell counts were 164±61, 14±6, 13±7 per hpf for Groups 1 (native), 2 (low power) and 3 (high power) respectively (p<0.01). Biomechanical comparison of untreated and treated grafts (group 3) revealed no difference in failure load (76±18 and 70±6 N respectively, p=0.24) and UTS (10.1±4.8 and 10.6±3.0 N/mm² respectively, p=0.65). In vitro seeded grafts displayed greater bioluminescence at 10 days compared to 3 days after seeding in vitro (ROI=1.03 x 10⁸ vs 9.35 x 10⁷, respectively). Histology demonstrated successful GFP+ cell revitalization of all component tissues in the composite construct (bone, fibrocartilage and tendon).

SUMMARY POINTS
- Physicochemical decellularization of composite TBI grafts using a combination of targeted ultrasonication and chemical treatment results in functionally decellularized bio compatible scaffolds.
- Decellularization preserves structural properties and biomechanical properties.
- Decellularized composite grafts can be successfully reseeded with pluripotent stem cells, and cell fate can be monitored in vivo with bioluminescent labels.
- Decellularized composite tissue grafts reseeded with stem cells may constitute a future treatment option for reconstruction of tendon-bone injuries of the extremities.

REFERENCE
The Impact of Antiplatelet Medication on Hand and Wrist Surgery

HYPOTHESIS

Hand surgery can be safely performed in patients on antiplatelet medications. While non-catastrophic bleeding at the surgical-site is greater in patients on antiplatelet medication, the magnitude of bleeding is low, the impact on patient-rated function is minimal, and the re-operation rate is low.

METHODS

This prospective cohort trial compared outcomes of hand and wrist surgery in patients without interruption of daily antiplatelet medications (aspirin[61], clopidogrel[4], dipyridamole[1], combination therapy[10]; n=76 procedures) to control patients (n=76 procedures). Baseline data included patient demographics, physical examination (2-point discrimination, fingertips distance to distal palmar crease [DPC]), and standardized patient-rated assessment of upper extremity function (QuickDASH) and general health (SF-12). Postoperative data (2weeks, 4weeks) incorporated additional measurements: Visual Analog Scale (VAS) scores of pain and swelling, extent of ecchymosis (mm), and examination for hematoma. Complication rates for the antiplatelet group were determined. Patient groups were compared statistically on all outcome measures with subgroup analysis based on antiplatelet dosage (high vs low [81mg aspirin]). Control and antiplatelet populations were matched according to health status (SF-12) and percentage of bony procedures (16%).

RESULTS

One patient on antiplatelet medication required reoperation for surgical site bleeding following wrist arthrodesis (1.3%, 95% CI 0.1-6.3%). The extent of postoperative ecchymosis was similar in the antiplatelet and control patients at 2 weeks (18mm vs 11mm, p=0.2) and 4 weeks (4% vs 3%, p=0.9). Patient rated-function (QuickDASH) (Figure 1) and VAS scores (Figure 2) were equivalent at baseline and follow up between groups. 4 patients in each patient group had increased 2-point discrimination (=2mm change) at 2 week follow-up and the groups had similar rates of increased post-operative DPC (=1cm change). No significant differences were identified between high dose antiplatelet patients (n=21) and low dose patients (n=31) on QuickDASH or VAS scores following soft tissue procedures despite clinically relevant increases in ecchymosis at 2 weeks (21mm vs 7mm) and hematoma formation at 2 weeks (27% vs 12%).

SUMMARY POINTS

- Continuation of perioperative antiplatelet medication is associated with rare bleeding complications.
- Non-catastrophic surgical-site bleeding associated with perioperative antiplatelet medication use does not negatively impact patient-rated or objective measures of function.
- The advantage of minimizing thromboembolic risk by maintaining perioperative anti-platelet treatment in hand surgery patients substantially outweighs any benefits associated with discontinuing these medications.

REFERENCES


Figure 1. Patient-rated function on QuickDASH

Figure 2. TBI composite construct with 0.9mm micro screw (a), Composite construct implanted in rat as allograft (b), Micro CT image of graft and screw in place (c), Bioluminescence of reseeded graft 10 days in vitro (d)
There was a significant difference in the extent of union on CT at ten weeks (85% vs. 70%; p=0.048) favoring treatment with a cast excluding the thumb. The union rate was 98% overall when adhering to intention-to-treat (1 nonunion in the thumb-cast group) and 100% with nonoperative treatment; as one patient with a wrist fracture treated with the thumb immobilized elected operative treatment one week after enrollment, subsequently used crutches and developed nonunion. There were no significant differences between the groups for wrist motion, grip strength, MMWS, DASH score, VAS for pain, or union.

**SUMMARY POINTS**
- Treatment with a below-elbow cast without immobilization of the thumb results in a higher extent of union on CT at ten weeks.
- There was no difference in arm-specific disability between nondisplaced scaphoid waist fractures treated in a below-elbow cast including or excluding the thumb.
- Nondisplaced fractures of the scaphoid waist can be adequately treated in below-elbow cast without immobilization of the thumb.

**REFERENCES**

**PAPER 31**
Friday, September 7, 2012 • 1:08 – 1:14 PM
Clinical Paper Session 7: Scaphoid

**Predicting Union and Time to Union in a Cohort of Acute Scaphoid Fractures**
Level 4 Evidence

Ruby Grewal, MSc, MD
Nina Suh, MD
Joy MacDermid, PhD

**HYPOTHESIS**
The purpose of this study was to identify prognostic factors for non-union and time to union for conservatively treated acute scaphoid fractures using computerized tomography.

**METHODS**
This retrospective cohort study identified cases with scaphoid CT scans from a tertiary hospital radiology database for the years 2004 - 2010. Subjects that presented >6 weeks from injury or were treated surgically were excluded. CT scans for each fracture were reviewed and the following potential predictors were collected: location, orientation of...
fracture line, displacement (mm), presence of a humpback deformity, comminution, cysts, and/or sclerosis along the fracture line. The percentage union was determined using the formula described by Singh et al. (1). The associations between union rates and categorical variables were assessed with a chi-square test, and continuous variables with an ANOVA test. For time to union, ANOVA was used for categorical predictors and Pearson correlation coefficient to test the significance of association to continuous variables. For categorical factors that were found to have a statistically significant association with union, an odds ratio was used to determine the strength of the association. The relative importance of potential predictors of time to union was assessed with multiple linear regression.

RESULTS
The majority of fractures in this cohort occurred in males (83.1%, 182/219), involved the scaphoid waist (79.0%, 173/219) and were undisplaced (81.3%, 178/219). There were 28 proximal pole fractures (12.8%) and 18 distal pole fractures (8.2%). The odds of developing a non-union was increased in proximal pole fractures, displaced fractures and fractures with a humpback deformity; however sclerosis, cysts or delay in receiving treatment (up to 6 weeks) did not influence union (Table 1). Time to union was significantly longer for proximal pole fractures, displaced fractures, comminuted fractures, and fractures with sclerosis (Table 2). Displacement was correlated with longer union times (Pearson r =-0.24, p<0.001).

Multiple linear regression estimated the effect of these predictor variables on union times as follows: time to union (days) = 47.6 + 28.6(comminution) + 45.0(displaced) + 101.8(sclerosis) + 46.1(proximal pole) indicating that these 4 factors are important independently and have an additive effect on increasing time needed to achieve union.

SUMMARY POINTS
Using computerized tomography, scaphoid fractures that are more likely to require prolonged immobilization and/or have high odds of becoming non-unions can be identified. These factors should be taken into account when counseling patients in regards to treatment options, likelihood of success and expected union times.

REFERENCE

Table 1. Union Rate based on Fracture Characteristics

<table>
<thead>
<tr>
<th>Union Rate</th>
<th>Yes</th>
<th>No</th>
<th>p value</th>
<th>Odds Ratio (95% CI interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humpback*</td>
<td>77.8% (14/18)</td>
<td>96.0% (193/201)</td>
<td>0.001</td>
<td>6.89 (1.85 - 25.73)</td>
</tr>
<tr>
<td>Displacement*</td>
<td>87.8% (36/41)</td>
<td>96.1% (171/178)</td>
<td>0.036</td>
<td>3.40 (1.02 - 11.29)</td>
</tr>
<tr>
<td>Comminution</td>
<td>89.3% (25/28)</td>
<td>95.3% (182/191)</td>
<td>0.19</td>
<td>2.43 (0.62 - 9.57)</td>
</tr>
<tr>
<td>Sclerosis</td>
<td>100% (6/6)</td>
<td>94.8% (200/211)</td>
<td>0.57</td>
<td>n/a</td>
</tr>
<tr>
<td>Cysts</td>
<td>95.5% (40/42)</td>
<td>94.4% (167/177)</td>
<td>0.82</td>
<td>0.84 (0.18 - 3.96)</td>
</tr>
<tr>
<td>Proximal Pole*</td>
<td>85.7% (24/28)</td>
<td>Distal Pole: 100% (18/18) Waist: 95.4% (165/173)</td>
<td>0.065</td>
<td>3.81 (1.07 - 13.6)</td>
</tr>
</tbody>
</table>

Table 2. Fracture Characteristics and Time required to Achieve Union

<table>
<thead>
<tr>
<th>Time to union (days)</th>
<th>Yes</th>
<th>No</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humpback</td>
<td>83.5</td>
<td>68.1</td>
<td>0.43</td>
</tr>
<tr>
<td>Displaced*</td>
<td>107.0</td>
<td>61.9</td>
<td>0.004</td>
</tr>
<tr>
<td>Comminution*</td>
<td>103.2</td>
<td>65.5</td>
<td>0.007</td>
</tr>
<tr>
<td>Sclerosis*</td>
<td>165.7</td>
<td>67.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cysts</td>
<td>87.2</td>
<td>66.1</td>
<td>0.07</td>
</tr>
<tr>
<td>Proximal Pole*</td>
<td>113.3</td>
<td>Distal Pole: 52.5 Waist: 65.1</td>
<td>0.008</td>
</tr>
</tbody>
</table>

• Contracted Research: Canadian Institutes of Health Research, National Institute of Health, Physiotherapy Foundation Canada, Primary Health Care System Program, The Department of Surgery Research Fund, Worker Safety Insurance Bureau (MacDermid)
the intact specimens and specimens with 2.5mm, 3.5mm and 4.5mm holes. The mean intact contact areas in the neutral (72.5 mm² ± 16.4 mm²) and extended (74.0 mm² ± 20.6 mm²) position were greater than in flexed position (47.2 mm² ± 9.9 mm²; p=0.18, 0.12, respectively).

**SUMMARY POINTS**
- Measurement of contact pressures and areas of the radioscaphoid articulation are consistent with previously published studies.
- Preliminary data suggests that the proximal scaphoid may be able to accommodate osteochondral defects of up to 4.5mm without statistically significant increases in mean or peak contact pressures.
- Ongoing studies include assessment of the effect of similar osteochondral defects in distal scaphoid on contact pressures in the scaphotrapezial joint.

**REFERENCES**

**METHODS**

**METHODS**
Twelve patients with established scaphoid waist nonunions are presented. Average patient age was 22 years (range 15-45). All were male and eight involved the dominant wrist. Time from injury to treatment averaged 1.6 years. All patients underwent preoperative computerized tomographic scanning with measurements of the degree of collapse and bone loss. Open reduction was performed through an anterior approach with correction of the deformity and placement of a distal to proximal screw. The resultant defect was then simply filled with pure cancellous autograft obtained from the ipsilateral distal radius. All patients underwent postoperative computerized tomographic imaging to document union and degree of correction. Patients were evaluated clinically by an independent examiner for the purposes of this study.

**RESULTS**
All patients united their scaphoid. At a minimum one year follow-up, total wrist range of motion averaged 132 degrees, with significant improvement in wrist extension when compared to pre-operative values (P<0.02). Grip strength also improved significantly (P<0.05) and measured averaged 103% of the opposite side at follow-up. The Mayo Wrist Score averaged 88 ± 6 (range 80-100). The average intra-scaphoid angle improved from 49 degrees to 32 degrees (normal <35 degrees). Pain at follow-up as measured on a visual analog scale averaged 0.3 (range 0-2).

**SUMMARY POINTS**
- With stable internal screw fixation, scaphoid waist nonunion with collapse and bone loss can be successfully treated using only pure cancellous bone graft.
- To our knowledge, this is the first report in the literature documenting this.
- Advantages include marked simplification of surgical carpentry, the use of local autograft, and rapid incorporation of cancellous bone without compromise of scaphoid reduction and carpal alignment.

**PAPER 33**

Friday, September 7, 2012 • 1:24 – 1:30 PM  
Clinical Paper Session 7: Scaphoid

**Scaphoid Non-union with Humpback Deformity Treated without Structural Bone Graft**
Level 3 Evidence

- **Mark S. Cohen, MD**  
  Kianoosh Fallahi, MD  
  Sanjai K. Shukla, MD

**HYPOTHESIS**
Conventional treatment of scaphoid nonunion with collapse deformity and bone loss involves the use of a structural corticocancellous bone graft. With internal screw fixation, it is proposed that length and alignment can be restored and maintained using only pure cancellous interposition graft.

**METHODS**

**METHODS**

- **Consulting Fees:** Mylad (Cohen)  
  Royalty Support: Integra (Cohen)  
  Contracted Research: Integra (Cohen)
Salvage of Failed Instrumentation of the Distal Radius with Spanning Dorsal Distraction Plating

HYPOTHESIS
Correction of nonunion and malunion after instrumentation of distal radius fracture represents a reconstructive challenge. Resultant compromise of the bone stock makes fracture fragments poor substrate for fixation. Very often, the only resolution of this problem is wrist fusion. In this study we endeavor to determine if application of a spanning dorsal distraction plate, to neutralize force across the wrist, alone or in combination with a volar locking plate, can be utilized to restore alignment and improve outcomes for this difficult problem.

STUDY DESIGN
11 patients were referred to our institution over a 6 year period (2005-2011) with either nonunion (7 patients) or malunion (4 patients) of the distal radius and compromise of fracture fragments after previous instrumentation. These patients underwent reduction and spanning distraction plate application an average of 10 months after initial fracture fixation. Records were reviewed under an IRB approved protocol and standard metrics of upper extremity function were recorded and analyzed.

RESULTS
All patients went on to achieve bony union with acceptable anatomic alignment. Mean time to removal of dorsal distraction plate was 155 days (Range 88-243). Initial wrist arc of motion averaged 20° (Range 0-70). Final wrist arc of motion averaged 72.5° (Range 0-130). All patients experience improvement in QuickDASH scores. Scores improved from a mean of 66.9 (Range 34.1-100) at initial evaluation to a mean of 20.7 (Range 0.9-52.3) at final visit. Mayo wrist score of greater than 60 was achieved in 7/11 (63.6 %) patients. One patient required wrist fusion due to persistent pain. Two patients required additional intervention after for loss of height of the radial column.

SUMMARY POINTS
- Management of distal radius complications after prior instrumentation can be challenging. Previously reported outcomes are suboptimal, particularly for fractures with an intraarticular component.
- A dorsal spanning distraction plate to manage this difficult problem (Figure 1).
- Fusion was avoided in 10/11 patients with generally significant improvement in alignment and function (Figure 2), even in the setting of infected nonunion.
- Two patients with intraarticular fractures required repeat operative intervention for management of loss of radial column height.
- In patients with a compromised, previously instrumented distal radius nonunion or malunion, we suggest consideration of correctional osteotomy in and dorsal distraction plate alone for extraarticular fractures and in combination with non-spanning plates for intraarticular injuries.

Alignment in Nonoperatively Treated Distal Radius Fractures: Are our Current Predictors Predictive?

HYPOTHESIS
Multiple methods have been described to predict loss of reduction in distal radius fractures treated nonoperatively. We sought to independently validate the McQueen equation and LaFontaine’s criteria in a large series of distal radius fractures. Additionally, we wished to evaluate post reduction volar cortical alignment (volar hook) on the final reduction of these patients. We hypothesized that restoring the volar cortical integrity would aid in maintenance of the volar tilt.
METHODS
We prospectively screened 609 consecutive distal radius fractures using the McQueen equation and LaFontaine’s criteria for instability. We excluded patients with < 10° of dorsal tilt upon presentation leaving 316 fractures of which 182 were treated nonoperatively and form the basis of this study. Patients were managed with short arm casts and seen every other week by an attending surgeon. We measured the following parameters on the initial reduction and final radiographs: dorsal tilt, radial height, radial inclination, ulnar variance, and the presence of carpal malalignment. We defined “volar hook” (VH) as having collinear alignment of the cortical edges of the fracture at the volar surface. We performed univariate analysis to determine how predictive the McQueen percentage and the number of Lafontaine’s criteria present were for each radiographic parameter. Additional univariate analyses were done on the radiographic components of each score, VH, sex, and age. Based on the univariate analysis, a multivariate analysis was performed including age, VH, dorsal comminution (DC), intraarticular fracture (IAF), and gender against all radiographic outcome parameters and any change during healing.

RESULTS
The tables below detail the results of both the univariate and multivariate analysis. In the univariate analysis, the McQueen percentage and the total number of LaFontaine’s criteria present predicted the final ulnar variance and the change in radial height and inclination (Table 1). Additionally, carpal malalignment at healing was predicted by VH and age.

SUMMARY POINTS
- We were able to validate the McQueen equation and LaFontaine’s criteria for ulnar variance, radial height, and radial inclination. However, neither method was predictive of final dorsal tilt nor carpal malalignment.
- Age was the most important factor in predicting the final healing for all radiographic parameters.
- Hooking the volar cortex was the strongest predictor of final volar tilt, the change in volar tilt, and carpal malalignment at union.
- These data suggest that restoration of volar cortical alignment and age are the most important predictors of success in nonoperative treatment of distal radius fractures.

Table 1. Factors that were statistically significant in the univariate analysis for each radiographic outcome

<table>
<thead>
<tr>
<th>Final Position</th>
<th>Dorsal Tilt</th>
<th>Ulnar Variance</th>
<th>Radial Height</th>
<th>Radial Inclination</th>
</tr>
</thead>
<tbody>
<tr>
<td>VH, DC, G</td>
<td>Age, US, LF, MQ</td>
<td>Age, IAF, LF, MQ, G</td>
<td>Age, LF, MQ</td>
<td></td>
</tr>
<tr>
<td>Change during Rx</td>
<td>VH</td>
<td>DC, G</td>
<td>Age, IAF, LF, MQ</td>
<td>Age, LF, MQ</td>
</tr>
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</table>

Table 2. Factors that were statistically significant in the multivariate analysis for each radiographic outcome

<table>
<thead>
<tr>
<th>Final Position</th>
<th>Dorsal Tilt</th>
<th>Ulnar Variance</th>
<th>Radial Height</th>
<th>Radial Inclination</th>
</tr>
</thead>
<tbody>
<tr>
<td>VH, DC, Age, G</td>
<td>Age</td>
<td>Age, IAF, G</td>
<td>Age, DC</td>
<td></td>
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<tr>
<td>Change during Rx</td>
<td>VH</td>
<td>DC</td>
<td>Age, IAF</td>
<td>Age</td>
</tr>
</tbody>
</table>

VH = Volar hook, DC = Dorsal comminution, IAF = Intraarticular fracture, LF = LaFontaine’s, MQ = McQueen’s, G = Gender, US = Ulnar styloid fracture

HYPOTHESIS
Prominent and distal plate positions are thought to increase the risk of flexor tendon rupture after volar plate fixation of distal radius fractures. Currently, there are no recommendations as to what is too prominent or too distal. We hypothesized that in patients with confirmed flexor tendon ruptures following volar plating of distal radius fractures, the plate position would be further distal and more prominent than in a group without ruptures.

METHODS
Three blinded reviewers evaluated the lateral radiographs of 8 patients treated for flexor tendon ruptures following volar plating of distal radius fractures and 23 control patients without ruptures. The radiographs were graded for plate prominence relative to the volar critical line using the grading system recently described by Soong. The distances between the plate and the volar critical line (PCL) and volar rim of the distal radius (PVR) were measured (Figure 1).

Chi-square analysis and independent samples t-tests were performed to determine the association between Soong grade, PCL or PVR, and flexor tendon rupture. We used a receiver operating characteristic curve to determine key threshold PCL and PVR distances associated with strong positive and negative predictive values for rupture, and we calculated the sensitivity and specificity for rupture at each threshold value.

RESULTS
A higher Soong grade was associated with flexor tendon rupture (p=0.001). Six of the 8 ruptures were Grade 2, and 2 ruptures were Grade 1. None of the controls were Grade 2, 13 were Grade 1, and 10 were Grade 0. Patients with ruptures had an increased mean PCL distance (p<0.001) and a decreased mean PVR distance (p<0.001) than controls. Plate prominence greater than 2.0 mm was associated with flexor tendon rupture with a sensitivity of 0.875, a specificity of 0.870, and positive and negative predictive values of 0.700 and 0.952, respectively. Plate position distal to 3.0 mm from the volar rim had a sensitivity of 0.875, a specificity of 0.957, and positive and negative predictive values of 0.875 and 0.957, respectively, for tendon ruptures.

SUMMARY POINTS
- Plate prominence > 2.0 mm from the volar critical line and plate position within 3.0 mm of the volar rim significantly increase the risk of flexor tendon rupture following volar plating of distal radius fractures.
- To decrease rupture risk, we recommend considering prophylactic hardware removal after union in all patients with PCL > 2.0 mm and PVR < 3.0 mm.

REFERENCE
PAPER 37

Friday, September 7, 2012 • 2:44–2:50 PM
Clinical Paper Session 8: Distal Radius

The Effect of Acute Scapholunate Dissociation on the Functional Outcome in Intraarticular Fractures of the Distal Radius
Level 4 Evidence

Gertraud Gradl, MD
Paul V. Neuhaus, MD
Thomas Fuchsberger, MD
Thomas Pillukat, MD
David C. Ring, MD, PhD
Karl J. Prommersberger, MD

HYPOTHESIS
The primary null hypothesis of this study is that there is no significant difference with respect to functional outcome, pain and disability between patients with an intra-articular fracture of the distal radius and either an acute, repaired scapholunate dissociation (SLD) or no ligament injury.

METHODS
We retrospectively analyzed 24 patients with an intraarticular DRF and SLD that was diagnosed and repaired (Group I) and compared them to 24 patients with DRF without associated ligament injury (Group II) (34 women, 14 men; average age 55 years, range 19 to 75). The two cohorts were analyzed for differences in motion, grip strength, pain (visual analog scale), DASH scores, and radiographic alignment between cohorts. A chi-squared analysis was used to determine radiographic differences of arthritis.

RESULTS
There were no significant differences in mean range of motion, grip strength, Quick DASH score, Mayo wrist score, pain level or radiographic arthrosis between cohorts. There was no correlation between radiographic signs of osteoarthritis and the QuickDASH score, and pain level.

SUMMARY
The outcomes of intraarticular fractures of the distal radius with or without associated operatively treated SLD are comparable.

PAPER 38

Saturday, September 8, 2012 • 8:45 – 8:50 AM
Clinical Paper Session 9: DRUJ

Linked Distal Radioulnar Joint Arthroplasty: Short-term Outcome of the APTIS Prosthesis
Level 4 Evidence

Tyler Fox, MD
Eric Wagner, MD
Richard A. Berger, MD, PhD
Sanjeev Kakar, MD, MBA

HYPOTHESIS
Painful radioulnar convergence following resection of the distal ulna can produce substantial disability and prove a challenging surgical problem. Linked distal radioulnar joint arthroplasty will provide pain relief and restore functional stability to the distal radioulnar articulation in this difficult patient population.

METHODS
A search of our institutional joint registry between January 1st, 2008 and December 31st, 2010 revealed a consecutive series of eleven APTIS prostheses. One patient was lost to follow up. The remaining ten patients comprised the study group with a mean follow up of 3.3 years (2.2-4.0 yrs). Two male and eight female patients with a mean age of 47.1 years had been treated with a mean of 4.1 wrist surgeries prior to linked distal radioulnar joint arthroplasty. Pre and postoperative wrist range of motion, forearm rotation, and grip strength were recorded. Outcome measures included DASH, PRWE, and patient satisfaction questionnaires.

RESULTS
At final follow up, nine of the ten prostheses survived free from revision or removal. The remaining implant required revision at seven months for ulnar component loosening. A staged reconstructive procedure was successful and the revised implant remains well fixed at 2.2 years following reimplantation. Five of ten patients were treated with secondary procedures for either extensor tendon irritation or prominent radial sided strength, pain (visual analog scale), DASH scores, and radiographic alignment between cohorts. A chi-squared analysis was used to determine radiographic differences of arthritis.
screw tips. Despite these complications nine of ten patients, including the patient requiring implant revision, responded that they were either satisfied or very satisfied with the outcome of their arthroplasty, and that they would choose to undergo the procedure again. The pre to postoperative arc of forearm rotation on average remained unchanged.

**SUMMARY POINTS**
- At a short term follow up linked distal radioulnar joint arthroplasty successfully restored functional stability to the distal radioulnar articulation providing high rates of patient satisfaction.
- Implant survival free from revision or removal at three years averaged 90% in this series.
- Fifty percent of patients, however, required reoperation over the follow up period for either, prominent hardware or, extensor tendon irritation.
- Linked distal radioulnar joint arthroplasty is a viable option for treating painful radioulnar convergence.

**METHODS**
Nine patients received the Scheker total joint endoprosthesis between March 2006 and November 2010. Prior to this all patients had undergone at least one surgical procedure affecting their DRUJ (mean 3.4, range 1-7).

Indications for the Scheker arthroplasty were disabling pain at the distal ulna due to; failed Darrachs procedure (2 patients), failed Sauvé-kamandji procedure (2 patients), failed Bowers procedure, Essex-Lopresti injury (with primary ulna- and radial head excision); instability and inflammatory arthritis, instability and posttraumatic osteoarthritis; and DRUJ synostosis. The post follow up visits ranged between 12 to 62 months (median 35). Standardized pre- and postoperative assessments included radiographic examination, evaluation of pain by a 10 cm Visual-Analogue Scale (VAS), measurement of Range of Motion (ROM) and grip strength. Patient perceived function and health status was evaluated using the Disabilities of the Arm, Shoulder and hand questionnaire (DASH). A non-parametric statistical method, Wilcoxon signed rank test, was used to assess the significant difference between preoperative and postoperative outcomes. P values less than .05 were considered significant.

**RESULTS**
All patients but one improved regarding pain. The median value on the VAS decreased from 6 cm preoperatively to 0.5 cm most recently. The median DASH score improved from 43 to 29 at the latest follow up (p=.024). There were no significant changes in ROM. Median grip strength increased from 17 to 21 kg (p=.018) There were 4 minor adverse events which responded favorably to treatment. One patient experienced transient carpal tunnel syndrome, one patient was surgically treated for De Quervains disease and two patients were conservatively treated for lateral epicondylalgia.

No signs of loosening have been detected under radiography.

**SUMMARY POINTS**
- The Scheker total joint implant arthroplasty led to a dramatic reduction in pain.
- Significant improvements were also noticed in grip strength as well as in patient perceived hand function and health.
- Wrist- and forearm range of motion has not been impaired.
- No major complications or signs of early loosening have been discovered.
- In our short-term observations, we have found the Scheker total joint endoprosthesis to be a safe, effective option for treating patients with previously failed DRUJ surgery.

**REFERENCES**
Saturday, September 8, 2012 • 8:59 – 9:04 AM
Clinical Paper Session 9: DRUJ

Dynamic CT Imaging For Diagnosis of Scapholunate Joint Instability

Not a clinical study

Sanjeev Kakar, MD, MRCS
Shuai Leng, PhD
Cynthia McCollough, PhD
Steven L. Moran, MD
Richard A. Berger, MD
Kristin Daigle Zhao, MA

HYPOTHESIS

A novel dynamic imaging method comprised of 4-dimensional (4D; 3D + time) CT can accurately diagnose scapholunate (SL) joint instability.

METHODS

Patients with a suspected diagnosis of SL instability, determined by clinical examination and standard x-ray imaging, underwent 4DCT scans during wrist movement. All patients presented complaining of pain and functional disability due to symptomatic instability of the wrist. A 4DCT technique was developed to acquire dynamic image data while patients move their wrists in radial-ulnar deviation, flexion-extension and dart thrower’s motion. A commercial dual source reconstruction algorithm was used to generate images with 75 ms temporal resolution and 4D movies. Two blinded fellowship trained hand surgeons reviewed movies of both wrists for each motion and scored the difference between the normal and injured wrist using a 5 point ordinal scale (1=no difference to 5=obvious difference).

RESULTS

Four patients with a clinical suspicion of unilateral scapholunate wrist ligament injury were scanned in a dual source 128-slice CT scanner (Definition Flash, Siemens Healthcare, Forchheim, Germany). Motion of the scaphoid and lunate and the joint space between them were clearly visualized throughout the wrist motion cycle. For all patients, at least one motion was scored 4 or higher by both reviewers, indicating a substantial difference between the normal and injured wrists. The average scores from both reviewers over all 4 subjects were 4.0, 4.0 and 2.8 for radial-ulnar deviation, flexion-extension and dart thrower’s motion.

SUMMARY POINTS

- The 4DCT technique generated high spatial and high temporal resolution images of the moving wrist joint.
- Radial-ulnar deviation and flexion-extension motions qualitatively demonstrated a difference between the injured and uninjured wrist as compared to the dart thrower’s motion.
- 4DCT imaging may provide clinicians a useful tool for detecting scapholunate injury. Early detection and treatment may lead to more timely and efficacious treatment.

Saturday, September 8, 2012 • 9:06 – 9:11 AM
Clinical Paper Session 9: DRUJ

Failure of Proximal Row Carpectomy (PRC) and Four-corner Fusion (4CF) in Patients Younger than 50

Level 3 Evidence

Matthew S. Zimmermann, MD
Arnold-Peter C. Weiss, MD
Heather Gotha, MD

HYPOTHESIS

Many studies have identified advantages and disadvantages specific to both PRC and 4CF. PRC is a simple procedure but carries risk of subsequent osteoarthritis (OA). 4CF has a higher risk of complications but maintains the native radiolunate joint. It has been suggested that PRCs performed in young patients are especially prone to failure. We hypothesize that younger patients will have a higher likelihood of failure due to pain and/or secondary OA following PRC when compared to 4CF.

METHODS

All patients who had a proximal row carpectomy or four-corner fusion by the lead author at less than 50 years of age were included in this study. Patients were excluded if they had a history of inflammatory arthritis. Patients were compared in regards to the development of complications including secondary OA development and the need for subsequent surgery.

RESULTS

The average age at time of surgery was 38 in both groups. There was no difference between the groups in regards to workers compensation or gender. The average time of follow up was 34 months. Between 1995 and 2010 there were 34 patients under age 50 who underwent 4CF and 22 patients who underwent PRC. During the period of followup, six of the PRCs and 2 of the 4CF patients went on to total wrist fusion (p<0.05). Reasons for conversion included degenerative changes and unremitting pain. When comparing failure secondary to the development of degenerative changes at the radiocarpal joint, there were 3 failures in the PRC group and none in the 4CF group (p<0.05). Two additional patients in the PRC group underwent subsequent surgery, one for carpal tunnel release and one for neurolysis of superficial branch of the radial nerve.
In the 4CF group, four patients required removal of the fusion plate, one patient later underwent pisiform excision and one patient had a carpal tunnel release (p=0.34). There were no nonunions in the 4CF group.

SUMMARY POINTS
- In patients younger than 50 years of age, PRC fails significantly more frequently than 4CF.
- When considering failures secondary to the development of severe degenerative changes, PRC also fails significantly more often.
- The number of additional surgeries required for patients undergoing 4CF was not statistically significant.
- The use of PRC as a salvage surgery in young patients should be considered carefully.

REFERENCES

SUMMARY
Successful Arthroscopic Repair of Geissler Grade III Scapholunate Ligament Injury
Level 4 Evidence

HYPOTHESIS
Open procedures for Geissler grade III scapholunate injuries are well-described in the literature and include dorsal capsulodesis, limited intercarpal fusions, tenodesis, soft tissue reconstruction of the dorsal scapholunate ligament, and bone-ligament repairs (1,2,3,4,5). These open procedures are associated with an increased risk of complication secondary to the sequelae of a dorsal wrist incision, and the long-term outcomes are mixed. While it is accepted protocol to treat Geissler grade I-II injuries with arthroscopic debridement and percutaneous pinning, it has yet to be confirmed if patients with additional instability can also be successfully treated with this approach (6,7). Our hypothesis is that this technique can be applied to Geissler grade III injuries with satisfactory outcomes and reduced complications.

METHODS
Four patients presenting with posttraumatic wrist pain were diagnosed with carpal instability. They demonstrated a positive scaphoid shift test, scapholunate gapping on grip-view radiographs, and MRI showing a scapholunate tear. Arthroscopy confirmed the degree of injury as a Geissler stage III scapholunate ligament injury (8). Arthroscopic debridement of the scapholunate ligament with a coblation-based device (ArthroCare, ArthrCare Corp, Austin Texas), and closed reduction and percutaneous pinning across the scapholunate and scaphocapitate joint was performed. Immobilization . Visual analogue pain score, grip strength, range of motion, radiographic assessment, and the Mayo wrist score was used for evaluation of outcomes (9).

RESULTS
3 male and 1 female patient was treated. The mean age was 48 years, and average follow-up 1 year. K-wires were removed 8-10 weeks after surgery. Range of motion and grip strength exercises are started at 3 months. Visual analogue pain score average was 6.8 preoperative and 1.1 postoperative. Mean range of wrist motion was 57.5° of flexion to 62.5° of extension. Average grip strength on Jamar dynamometer was 71% of the normal contralateral extremity. Radiographic evaluation showed no increase in scapholunate joint gap, and no progression to DISI deformity. The Mayo wrist score demonstrated 2 excellent and 2 good results. There were no complications.

SUMMARY
Arthroscopic debridement of the scapholunate ligament and closed reduction with K-wire fixation of the scapholunate joint for Geissler grade III injury demonstrates reduced pain, increased range of motion, a stable joint space, and satisfactory outcomes over 1 year. Further assessment of this operative technique with direct comparison to standard approaches is warranted.

REFERENCES
PAPER 43

Saturday, September 8, 2012 • 8:45 – 8:50 AM
Clinical Paper Session 10: Elbow

Outcomes and Risk Factors for Poor Functional Outcomes in Open Elbow Fractures
Level 2 Evidence

♦ Jonathan Dickens, MD
Kevin F. Wilson, MD
Scott Tintle, MD
Reed Heckert, MD
Benjamin K. Potter, MD

HYPOTHESIS
High energy open periarticular elbow fractures are severe injuries, frequently complicated by high rates of osteomyelitis, concomitant osseous and neurovascular injuries, guarded functional outcomes, and potential amputations. The purpose of this study is to characterize combat-related open elbow fractures and determine factors that may predict poor outcomes.

METHODS
After Institutional Review Board approval, we identified all patients with an open elbow fracture sustained between May 2004 to May 2011 during Operations Iraqi Freedom and Enduring Freedom. Patient demographics, injury characteristics, associated injuries, treatment, and complications were recorded. Functional outcomes were analyzed with ROM, activity status, and Mayo Elbow Performance Score.

RESULTS
Sixty-one open elbow fractures were sustained in 56 patients (5 bilateral) with a mean age of 25 years (19 to 42 years) and a mean Injury Severity Score of 32.2 (range 4-75). After a mean follow-up of 28 months (range 2 to 71 months), patients received a mean 10.1 (range 3-25) elbow surgeries and 72% (44/61) required a revision surgery following definitive treatment. At the time of final follow-up, 66% (40/61) of extremities manifested a concomitant nerve deficit, 75% (46/61) of elbows developed Heterotopic Ossification (HO), 26% (16/61) developed a culture positive deep wound infection, 25% (15/61) received a rotational or free tissue transfer, and 11% (7/61) required an amputation. The mean Mayo Elbow Performance Score was 67.3 (range 30-100, 45% good to excellent) and 33% (20/61) of service members remained on active duty. Only associated vascular injury and Gustillo and Anderson fracture type were predictive of deep infection (p<0.019). Gustillo and Anderson fracture type, nerve injury, HO, deep infection, need for soft tissue transfer, traumatic brain injury, and intraarticular distal humerus fracture type were predictive of deep infection (p<0.019). Gustillo and Anderson fracture type, nerve injury, HO, deep infection, need for soft tissue transfer, traumatic brain injury, and intraarticular distal humerus fracture were significantly predictive of poor Mayo Elbow Performance Scores (p<0.025). The type of definitive fixation (internal or external fixation) and presence of intraarticular proximal radius or olecranon fractures did not predict worse Mayo Elbow Performance Scores (p>0.105).

SUMMARY
Few studies assess open periarticular elbow fractures and risk factors that contribute to poor outcomes. In the largest series of open elbow injuries to date, we found that poor outcomes are strongly predicted by more severe soft tissue injury, associated nerve injury, HO, infection, and traumatic brain injury. Intraarticular open distal humerus fractures have worse outcomes compared to open proximal radius and olecranon fractures.

PAPER 44

Saturday, September 8, 2012 • 8:52 – 8:57 AM
Clinical Paper Session 10: Elbow

Results of Proximal Ulna Fractures Treated with a Multiplanar, Locked Intramedullary Nail: First Multicenter Experience
Level 4 Evidence

♦ Scott G. Edwards, MD
• Mark S. Cohen, MD

HYPOTHESIS
The theoretical advantages of intramedullary nailing for olecranon fractures are less risk of soft-tissue irritation and resulting hardware removal. This is the first clinical report to evaluate a new multiplanar, locked intramedullary implant indicated for both transverse and comminuted olecranon fractures.

METHODS
28 consecutive patients with displaced proximal ulna fractures underwent open reduction and internal fixation using a multiplanar, locked intramedullary implant and were followed for a minimum of 24 months (range: 24-30 months). Of the 28 fractures, 18 were transverse or oblique (AO/OTA 21-B1.1), 10 were comminuted (AO/OTA 21-B1.2; B1.3), 4 of which also involved the coronoid, and 7 were nonunions. Average patient age was 45 years (range: 25 to 65 years). Patient clinical outcome measures where monitored at approximately six weeks, twelve weeks, and one year following the surgery. Included in this evaluation was range of motion, visual analog pain score, and strength. Patients were immobilized for 3-5 days postoperatively, after which motion was allowed. Strengthening was initiated at 6 weeks. Radiographs were taken at each follow up visit until union.

RESULTS
At 4 weeks, patients demonstrated average extension of 20° (range: 0° to 40°) and flexion of 115° (range: 100° to 130°) with full supination and pronation compared to the contralateral side. Patient pain scores averaged 5 out of 10, with a range of 2 to 8. One patient developed an ulna neuropathy 6 weeks after surgery that eventually required ulnar nerve transposition. At 8 weeks, all patients were within 10° of full extension-flexion and were able to extend 82% of weight compared to the contralateral side. All fractures progressed to radiographic union by 8 weeks. At 24 months, patient pain scores averaged 2 out of 10, with a range of 0 to 4, motion remained the same, and all patients had resumed normal work, athletic, and leisure activities. Average extension...
strength was 94% of weight compared to the contralateral side. There were no incidences of nonunion, infection, triceps extension problems, or hardware failure or irritation. No patients were lost to follow up.

SUMMARY POINTS
- This new multiplanar, locked intramedullary implant appears to be a safe and effective method to treat transverse and comminuted proximal ulna fractures and nonunions.
- It allows for early motion for both stable and unstable fracture patterns without loss of fixation.
- Good outcomes in terms of motion, strength, and union may be expected within 8 weeks after surgery and continue for at least two years.

PAPER 45
Saturday, September 8, 2012 • 8:59 – 9:04 AM
Clinical Paper Session 10: Elbow
Spontaneous Distal Biceps Tendon Ruptures: Are They Related to Statin Administration?
Level 3 Evidence
Christiana Savvidou, MD
Rodrigo Moreno, MD

HYPOTHESIS
Cases of statin attributed tendinous complications have been reported in the literature. The purpose of this study is to identify a possible correlation between statin administration and incidence of spontaneous distal biceps tendon ruptures.

METHODS
We retrospectively reviewed 104 patients with distal biceps tendon rupture that were treated surgically from 2004 to 2010. Patients were divided into two groups based on the mechanism of injury. Group 1 involved spontaneous tendon rupture and Group 2 involved rupture after severe extension force to a flexed elbow with eccentric contracture of the tendon. We recorded and analyzed data for patient demographics, statin administration, range of motion (ROM) and strength of the operated and of the non-operated extremity.

RESULTS
From the 104 patients, 102 were male and 2 were female with average age 47 years (range, 22 – 78). After statistical analysis, there was a trend towards increased spontaneous ruptures in patients taking statins with nearly two times more likely to have spontaneous distal biceps tendon rupture with use of statins. Patients in Group 1 compared to Group 2 were older, had weaker postoperative strength in both operated and non-operated hand and had similar postoperative ROM. Patients taking statins compared to those that were not taking statins were older, had same postoperative strength in both operated and non-operated hand and had similar postoperative ROM.

SUMMARY POINTS
- Based on the results of our study, there is a trend of increase of spontaneous distal biceps tendon ruptures in patients taking statins with two times increased risk to have spontaneous distal biceps tendon rupture with use of statins.
- Larger prospective studies and categorization of age with further analysis would be useful in further defining a possible stronger relationship between spontaneous distal biceps tendon ruptures, statins and age.
syndrome. Consistent with results of short-term follow-up, plate irritation requiring removal remains the most common cause for reoperation over time. Other complications remain rare even at long-term follow-up.

REFERENCES

PAPER 47
Saturday, September 8, 2012 • 9:13 – 9:18 AM
Clinical Paper Session 10: Elbow
Capitellar Osteochondrosis Dissecans in the Female Gymnast is not Always Career Ending: Results after Arthroscopic Treatment
Level 4 Evidence
◆ Mykola J. Bartkiw, DO 
◆ Hill Hastings, II, MD 
Larry Nassar, DO

HYPOTHESIS
Capitellar osteochondrosis dissecans (OCD) in the young female gymnast does not mandate discontinuation of sport.

METHODS
27 female gymnasts (age 9-16 years) with 34 operative elbows and 41 arthroscopic surgeries were retrospectively evaluated 0.5–7 years (average 3.5 years) following arthroscopic treatment for OCD.

Group 1: (27 patients) Age at time of injury, gymnastic level, number of years in sport, operative findings and lesion size were recorded. All compartments were visualized. OCD lesions, graded by the Voloshin classification, were treated through both a direct lateral and accessory lateral portal with a 2.7 mm arthroscope. [Figure 1]

Group 2: 14 patients (19 operative elbows) returned for follow-up and scoring by the Mayo Elbow Performance Score (MEPS) and Modified Andrews Elbow Scoring System (MAESS). Variable differences were detected by student t-test (= p<0.05).

RESULTS
Group 1: Average age starting gymnastics was 4.4 years old (range 2-7), years in sport 7.75 years (range 5-12), and age at symptom onset 11.8 years. 40% had bilateral involvement, with the dominant elbow affected first in 40%. Average lesion size was 10.6mm (4mm-20mm). MR arthrography was unreliable in detecting instability. All but 2 lesions at surgery showed a plane of cartilage instability, required debridement/microfracture and consisted of cartilage without bone. The other 2 were stable, drilled antegrade, injected with platelet factors, yet later became unstable.

Group 2: 79 % (11/14) of gymnasts returned to the same or higher level of gymnastics, although occasional or mild pain persisted in 7/11 who returned. 93% (13/14) achieved excellent/good MEPS and MAESS scores. All regained full extension and diminished pain. No differences were seen in lesion size between athletes able or not able to return to sport, nor differences with respect to the age starting gymnastics or age of symptom onset (p>.05). Return-to-sport athletes showed a greater number of years in the sport (8.27 years) than those unable to return (6 years) (p=.01). [Figure 2]

SUMMARY
In this largest review of OCD in the female gymnast, 79% of gymnasts arthroscopically treated returned to same or higher level of competition. Greater number of years in sport correlated with a higher likelihood of return. Average lesion size was 10.6mm (4mm-20mm) and always consisted of cartilage without bone. Evaluation and treatment mandates both direct lateral and accessory lateral arthroscopic portals and small arthroscope. 40% bilateral involvement mandates evaluation of both elbows. Long-term implications of this injury in gymnasts are yet to be determined.

Figure 1: Summary of the capitellar lesion grade for all 27 charts reviewed. The arthroscopic grading system was based upon the system described by Voloshin, et al. [Voloshin I, Schena A. Elbow Injuries in Athletes, 2nd ed. Philadelphia: Lippincott Williams and Wilkins, 2006.]

◆ Speaker has nothing of financial value to disclose

Figure 2: Analysis of the 14 gymnasts (9/14) available for follow-up, with comparison of gymnasts who returned to competition(=11) to those that were unable to return (=3). * = size of lesion not available.
** = only one of the elbows was treated surgically and allowed verification of lesion size. *** = Patient 2 returned for 5 years, before elbow symptoms resolved in her quitting gymnastics.
A Systematic Review of Distal Upper Extremity Bypass Surgery: A Comparison of Arterial and Venous Conduits

HYPOTHESIS

A formal analysis of the outcomes of venous and arterial grafts for distal upper extremity bypass has not been performed. The purpose of this study was to conduct a systematic review evaluating and comparing the efficacy of venous and arterial grafts in the distal upper extremity.

METHODS

A PubMed search using "Veins/surgery"[MAJR] OR "Arteries/surgery"[MAJR] AND "Radial artery/surgery"[MAJR] OR "Ulnar Artery/surgery"[MAJR] as MeSH terms was performed yielding 794 studies. Manual review of the titles produced 42 possible studies. These studies were evaluated by two different reviewers and selected based upon the following inclusion criteria: (1) reported distal upper extremity bypass surgery; (2) provided complete information on the type of graft used; and (3) examined the patency of reconstruction. Selected studies underwent bibliographical review to include additional reports missed by the primary search. Studies meeting inclusion criteria underwent data extraction, focusing on demographics, site of revascularization, type of vascular conduit used, subjective and objective outcomes, and postoperative anticoagulation regimens.

RESULTS

16 studies met inclusion criteria, spanning 1990 to 2011. A total of 151 bypass grafts were performed in 150 patients for distal upper extremity revascularization. 120 bypass grafts were used for revascularization of the distal ulnar artery circulation, 27 for the distal radial artery circulation, and 4 for both distal ulnar and radial artery occlusions. At average follow-up of 34.5 months the overall patency rate was 86.8 percent. Of the 151 bypass grafts, 19 were arterial conduits. Arterial graft donor sites included the deep inferior epigastric artery, subscapular artery, thoracodorsal artery and the descending branch of the lateral femoral circumflex artery. The patency rate for arterial conduits was 100 percent at mean follow-up of 18.4 months. The remaining 132 bypass procedures utilized vein grafts from various sites, including the saphenous, cephalic, and basilic veins. At an average follow up of 36.8 months, the overall patency rate for vein grafts was 84.9 percent. There was a statistically significant difference (p=0.006) between the patency rates of the arterial conduits compared to the venous conduits. All studies reported improved ischemic symptoms including reduction of cold sensitivity, pain, and digital ulceration.

SUMMARY

This systematic review shows a high patency rate and clinical efficacy of distal upper extremity bypass surgery with a mean follow-up approaching three years. There appears to be a benefit of utilizing arterial versus venous conduits, although this may need further examination given the small number of arterial reconstructions reported in the literature.

Table 1. Systematic Review of Distal Upper Extremity Bypass Surgery

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of grafts</th>
<th>Design</th>
<th>LOE</th>
<th>Type of Graft</th>
<th>Patency</th>
<th>Evaluation Method</th>
<th>Follow up months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harris et al. 1990</td>
<td>9</td>
<td>Retrospective</td>
<td>IV</td>
<td>Saphenous Vein</td>
<td>100</td>
<td>Doplher and angiography</td>
<td>24</td>
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<tr>
<td>Smith et al. 2004</td>
<td>8</td>
<td>Case Series</td>
<td>IV</td>
<td>Saphenous vein</td>
<td>100</td>
<td>Doplher</td>
<td>15.5</td>
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<tr>
<td>Zemmer et al. 2007</td>
<td>3</td>
<td>Case Series</td>
<td>IV</td>
<td>Saphenous vein</td>
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<td>Doplher</td>
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<td>Rockwell et al. 2007</td>
<td>9</td>
<td>Retrospective</td>
<td>IV</td>
<td>Saphenous vein</td>
<td>100</td>
<td>Doplher and angiography</td>
<td>8.75</td>
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<td>Ottesen et al. 2009</td>
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<td>Retrospective</td>
<td>IV</td>
<td>Saphenous vein</td>
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<td>Doplher</td>
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<tr>
<td>Tenenbaum et al. 2011</td>
<td>3</td>
<td>Case Series</td>
<td>IV</td>
<td>LFVA</td>
<td>100</td>
<td>Color Doppler</td>
<td>18</td>
</tr>
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Table 2. Summary Data for Systematic Review of Arterial and Venous Conduits in Distal Upper Extremity Bypass

<table>
<thead>
<tr>
<th>Extremity Bypass</th>
<th>Study</th>
<th>No. of grafts</th>
<th>Design</th>
<th>LOE</th>
<th>Type of Graft</th>
<th>Patency</th>
<th>Evaluation Method</th>
<th>Follow up months</th>
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</thead>
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<tr>
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<td>6</td>
<td>Retrospective</td>
<td>IV</td>
<td>Saphenous Vein</td>
<td>100</td>
<td>Doplher and angiography</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Vein</td>
<td>5</td>
<td>Retrospective</td>
<td>IV</td>
<td>Saphenous vein</td>
<td>100</td>
<td>Doplher</td>
<td>15.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Case Series</td>
<td>IV</td>
<td>Saphenous vein</td>
<td>100</td>
<td>Doplher</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Retrospective</td>
<td>IV</td>
<td>Saphenous vein</td>
<td>100</td>
<td>Doplher and angiography</td>
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<td>Doplher</td>
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<td>100</td>
<td>Doplher</td>
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Success of Digital Replantation: Experience of Two U.S. Level-I Trauma Centers

HYPOTHESIS

Despite worldwide advances in microsurgical techniques, digital replantation is being performed less frequently in the United States compared to 15 years ago. There is increasing concern that the high success rates reported in the literature, primarily from Asian countries, may not be attainable for many centers due to the decreased frequency of replantation. We hypothesized that the success rates of digital replantation at two U.S. major academic Level-I referral hospitals would be lower than the 80-90% survival rates reported in the literature.

Table 3. Summary Data for Systematic Review of Arterial and Venous Conduits in Distal Upper Extremity Bypass

<table>
<thead>
<tr>
<th>Extremity Bypass</th>
<th>Study</th>
<th>No. of grafts</th>
<th>Design</th>
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<tr>
<td>Artery</td>
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<td>Vein</td>
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<td>Retrospective</td>
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<td>IV</td>
<td>Saphenous vein</td>
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<td>Doplher and angiography</td>
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<td>IV</td>
<td>Saphenous vein</td>
<td>100</td>
<td>Doplher</td>
<td>12</td>
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</tbody>
</table>
METHODS
We performed a retrospective chart review of all cases of digital replantation at the two institutions performed from 1996 to 2011. All replantations were performed by fellowship-trained hand surgeons. Data including patient demographics, digit(s) replanted, mechanism and level of injury, and success of replantation (defined as complete viability at last follow-up) were recorded.

RESULTS
A total of 134 digital replantations were performed in 101 patients. The majority of patients were male (n = 97) and 39 patients (40%) were documented smokers. The thumb (n = 44) was most commonly replanted, followed by the long finger (n = 35). The mechanism of injury was best classified as sharp in 91 digits, crush in 23 digits, and avulsion in 20 digits. Tamai level of amputation was level I in no digits, level II in 6 digits, level III in 57 digits, level IV in 57 digits and level V in 14 digits. Replantation was successful in 76 digits (57%).

SUMMARY POINTS
- Success of digital replantation (55%) at two academic Level-I trauma hospitals was lower than the currently reported success rates of 80-90% in the literature. We suggest that this success rate more accurately reflects modern success of digit replantation in the United States.
- We suspect that this modest success may be explained by a more limited experience with digit replantation and lack of dedicated replantation operative teams and microsurgical post-operative care units characteristic of regional microsurgical specialty centers existing in other countries.
- These data potentially indicate a need to re-evaluate the indications and ideal clinical settings for optimizing outcomes of digit replantation.

REFERENCES

- Contracted Research: Boyer (Shrine grant) (Goldfarb)
- Royalty Support: Wolters Kluwer (Goldfarb)
PAPER 51

Saturday, September 8, 2012 • 10:29 – 10:35 AM
Clinical Paper Session 11: Soft Tissue / Microsurgery

Evaluation of Appropriateness of Patient Transfers for Hand and Microsurgery to a Level I Trauma Center
Not a clinical study

Ilvy H. Friebe, MD
Jonathan Isaacs, MD
Satya Mallu, MD
Anton Kurdin, BS
Varatharaj Mounasamy, MD
Harinder Dhindsa, MD

HYPOTHESIS
The Emergency Medical Treatment and Active Labor Act (EMTALA) was instituted to protect patients and ensure access to appropriate levels of medical care. Tertiary centers are obligated to accept transfer of any patient referring facility feels under-qualified or lacking the resources to treat. At our tertiary medical center many Orthopaedic related transfers are for hand or microsurgical trauma. Inappropriate transfers are inconvenient to the patient and the patient’s family, add unnecessary financial burden to an already stressed medical system, and waste valuable tertiary resources. We hypothesize that referring facilities often have ulterior motives other than the patient’s welfare when requesting many of these transfers.

METHODS
A retrospective chart review was performed of all patients transferred to a Level I referral center (Virginia Commonwealth University Medical Center) from January 2010 until October 2011 for hand and microsurgical trauma. Data was collected on the indication for transfer, mode of transfer, time and day of the week, patient demographics, and insurance status. Additionally, the transferring facilities were contacted and asked whether there was orthopaedic, hand, or plastic surgery coverage at the transferring facility. Brief synopses of the indication for transfer and hospital course were created for all patients and a survey was sent to five Orthopaedic Hand Surgeons and two Emergency Medicine physicians who were asked to rate the appropriateness of the transfer. Statistical analysis was performed to determine whether appropriateness of transfers was influenced by nonmedical variables.

RESULTS
Over a 22 month period, a total of 95 hand or microsurgical patients were urgently or emergently transferred to VCU medical center. Of these, 66% (n=62) of the transfers were considered inappropriate by the surveyed physicians. A statistically greater number of inappropriate transfers was found for under-insured patients or patients presenting during non-business hours.

SUMMARY POINTS
- A large percentage of patients are being transferred to tertiary care centers for reasons other than medical necessity.
- This abuse of EMTALA hurts patients and unfairly burdens referral centers.

REFERENCES
1. Are Patients Being Transferred to Level-I Trauma Centers for Reasons Other Than Medical Necessity? Koval, K; Tingey, C; Spratt, K. JBJS. 2006; 88:2124-2132.

PAPER 52

Saturday, September 8, 2012 • 10:05 – 10:11 AM
Clinical Paper Session 12: Finger

Percutaneous Pinning of Proximal Phalangeal Base Fractures: Unacceptable Outcomes
Level 3 Evidence

Safi Faruqui, DO
Peter J. Stern, MD

HYPOTHESIS
Percutaneous pinning has been well described for fixation of extra-articular fractures of the base of the proximal phalanx. We hypothesize that closed reduction of proximal phalangeal base fractures stabilized by either trans-articular (through the metacarpal head) or extra-articular percutaneous pins both have high complication rates with variable outcomes.

METHODS
A retrospective chart review identified 338 patients with proximal phalangeal base fractures. Fifty isolated proximal phalanx base fractures were treated with closed reduction and percutaneous pinning by one of two techniques: trans-articular (25 fractures) or extra-articular cross-pinned (25 fractures) across the base of the proximal phalanx. The mean patient age was 45 years. The average follow up time was 8 months. All fractures were considered unstable and not amenable to closed treatment. Outcome measures included total active motion and complications. Complications included pin loosening, superficial pin track infection, flexion loss or extensor lag (>15 degrees) at any joint, residual flexion contractures (>15 degrees) at any joint, malunion, nonunion, and any secondary procedures.
RESULTS
The mean total active motion for the trans-articular group and cross-pinning group was 201° and 198°, respectively. Proximal interphalangeal joint motion was notably affected, with nearly half of the patients in each group sustaining a flexion loss of greater than 20° (average: 27° each group). Eight contractures of the PIP joint were found in the trans-articular group (average: 34°) and seven contractures of the PIP joint were found in the cross-pinning group (average: 28°). Loss of motion was also seen at the metacarpalphalangeal joint in both the trans-articular groups (range: 0-79°) and cross-pinning group (range: 4-82°). There were more secondary procedures in the trans-articular group (6) versus the cross pinning group (2). The overall complication rates for the trans-articular and cross-pinning groups were 56 and 48 percent, respectively. There was no statistical significance found between groups in any of the outcome parameters used.

SUMMARY POINTS
- Contrary to earlier literature, percutaneous fixation of isolated fractures of the base of the proximal phalanx has an unacceptably high complication rate. Particularly disturbing is the fact that these results occurred despite early operative intervention, minimal soft tissue damage, and early postoperative hand therapy.
- Both techniques resulted in permanent reduction in range of motion at the MCP and PIP joints. Despite early operative intervention minimizing soft tissue injury and initiating early range of motion protocols, our results for total active motion were substantially lower than what has been reported regardless of fixation technique.

REFERENCES

Table 1: Range of Motion and Complications in the trans-articular and cross-pinning groups

<table>
<thead>
<tr>
<th>RANGE OF MOTION:</th>
<th>Trans-Articular</th>
<th>Cross-Pinning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arc of Motion MCPJ (mean)</td>
<td>0°-7°</td>
<td>3°-8°</td>
</tr>
<tr>
<td>Arc of Motion PIPJ (mean)</td>
<td>11°-83°</td>
<td>7°-79°</td>
</tr>
<tr>
<td>Arc of Motion DIPJ (mean)</td>
<td>4°-54°</td>
<td>2°-51°</td>
</tr>
</tbody>
</table>

Table 2: Loss of PIP Joint motion

<table>
<thead>
<tr>
<th>Flexion Loss at PIPJ *</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Number of Patients</td>
</tr>
</tbody>
</table>

Table 3: Complications

<table>
<thead>
<tr>
<th>COMPLICATIONS:</th>
<th>Number of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion Loss at MCPJ *</td>
<td>11</td>
</tr>
<tr>
<td>Flexion Loss at PIPJ *</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 2. Loss of PIP Joint motion

- Consulting Fees: Board of Trustee: JBJS (Stern)
- Relationship with other orgs/entities: Board of Trustee: JBJS (Stern)

PAPER 53
Saturday, September 8, 2012 • 10:13 – 10:19 AM
Clinical Paper Session 12: Finger

Osteochondral Graft from the 2nd or 3rd CM Joint for the Treatment of Unilateral Osteochondral Lesion in the Finger Joint

Level 2 Evidence

Akira Kodama, MD

Osteochondral defects may limit the range of motion, cause pain and produce angular deformities. Particularly in children, the treatment may become extremely difficult after the growth end, because the secondary changes of the joint and the periarticular soft tissue with growth worsen these complications. Therefore, the early stage reconstruction of the joint surfaces is necessary to restore a joint function.

Our method for reconstructing osteochondral defects of the joint surface of the fingers is described. An osteochondral graft is harvested from the distal or proximal side of the second or third carpometacarpal joint in the ipsilateral hand. The graft is transplanted to the defect in the proximal or distal interphalangeal joint. The graft is then fixed with small K-wires. Active finger motion exercise is encouraged three weeks after surgery.

Seventeen cases with a follow-up period of more than 6 months were reviewed. The follow-up group was consist of 10 children and 7 adults. Grafts had been transplanted to the proximal interphalangeal joint in 9
patients and to the distal interphalangeal joint in 8. The follow-up period averaged 64 months.

The mean angular deformity decreased from 30 to 3.8 degrees and the mean active range of motion increased from 26 to 39 degrees postoperatively. Neither pain nor tenderness was observed except for a patient who had dislocation of PIP joint postoperatively. No donor site morbidity was appreciated. X-rays revealed good joint congruity. The joint space was maintained in all patients except two. Osteoarthritis occurred in two patients postoperatively, in one adult patient who underwent grafting of the entire joint surface and the other patient developed dislocation of the proximal interphalangeal joint postoperatively and required arthrodesis. Remodeling of the joint surface was observed with most of the child cases.

This procedure provided a good result concerning correction of the angular deformity and pain relief. But the postoperative range of motion increased insufficiently. The cases with more than 60% of the articular defect and with the defect of condyle tended to acquire inadequate postoperative range of motion.

Osteochondral graft from the second or third carpometacarpal joint to osteochondral defect of the small joint in the hand is less complicated and corrects the angular deformity with minimal donor site morbidity. This procedure may be more effective for cases with less than 50% of the articular defect, with defect on the hemiarticular surface of base of phalanx and in children.

REFERENCES

RESULTS
Four hundred and ninety of 2234 (21.9%) patients returned to the same practice with a second trigger finger. Four hundred and sixty four patients had a single visit for diagnosis of trigger finger and never returned. The remainder returned after an average of 2.1 years (range, 7 days to 10 years) after diagnosis of the first trigger finger. Predictors of return with a second trigger finger include carpal tunnel syndrome (OR 2.0, 95% CI 1.6 to 2.6), insulin-dependent diabetes mellitus patients (OR 1.9, 95% CI 1.1 to 3.4) and duration of follow-up in years (OR 1.6, 95% CI 1.5 to 1.7).

SUMMARY
Patients diagnosed with idiopathic trigger finger can be advised that about 1 in 5 patients return to the same practice with another trigger finger, with approximately double the risk in patients that have carpal tunnel syndrome or insulin-dependent diabetes.

PAPER 54
Saturday, September 8, 2012 • 10:21 – 10:27 AM
Clinical Paper Session 12: Finger
Risk Factors for the Return with a Second Trigger Finger
Level 2 Evidence
Steven Ferree, BS
Valentin Neuhaus, MD
Stéphanie J.E. Becker, MD
Jesse B. Jupiter, MD
Chaitanya S. Mudgal, MD, MS, MCh
David C. Ring, MD, PhD

HYPOTHESIS
No demographic factors or concomitant illnesses are associated with return with a second trigger finger.

METHODS
Two thousand two hundred and thirty four patients with Quinell grade 2 or greater triggering of 1 or more fingers were retrospectively analyzed. Predictors of return to the same practice with a second idiopathic trigger finger were assessed in bivariate analysis and stepwise binary logistic regression.
the phalanx (metacarpus) were step-cut for the graft base. Two pieces of the osteochondral graft were harvested from the 5th and 6th ribs through an ipsilateral transverse sub-mammary incision. The harvested grafts were then shaped to form a matching pair of articular surfaces of the MCP or PIP joint with adequate contour. The grafts were step-cut and stabilized using mini screws. The finger was immobilized with a splint for a week, followed by range of motion exercises. Two cases needed an additional collateral ligament reconstruction and another case needed tenolysis. Clinical assessment was based on the range of motion and the Japanese Society for Surgery of the Hand version of the Disability of the Arm, Shoulder and Hand questionnaire (DASH-JSSH). Two-sided paired t-test was utilized to compare pre- and postoperative range of motion and DASH-JSSH score.

RESULTS
The average clinical follow-up was 31.3 months (range, 12-73 months). Average arc of motion was 0° before surgery versus 74.2° after surgery. Postoperative increase was 72.5°(range, 70-75°) in the MCP joints and 74.5°(range, 60-95°) in the PIP joints (p<0.001). Average active range of extension/flexion of the reconstructed joints indicated 0°/72.5° (MCP joints) and -1.5°/76.0° (PIP joints). Mean preoperative DASH-JSSH score was 37 (range, 24-49), improving significantly to 11 (range, 4-19) postoperatively (p<0.001). Radiographs demonstrated complete union of the bony part of the grafts in all cases and there was no evidence of bony bridging nor narrowing of the joint space. Donor site in the rib did not demonstrate any problems except for scaring.

SUMMARY
Total joint arthroplasty using costal osteochondral graft demonstrated anatomical and biological reconstruction with successful and satisfactory results in the treatment of finger joint ankylosis.

REFERENCES

Figure 1. A 28-year-old woman visited a hospital due to ankylosis of the PIP joint of her right ring finger. A: Radiograph demonstrated bony ankylosis of the PIP joint. B: Surgical exploration revealed bony ankylosis of the PIP joint. The joint was cut with a chisel closely at the original level of the joint. C: Two pieces of the osteochondral graft were harvested from the 5th and 6th ribs and trimmed to form “a matching pair of articular surfaces of the PIP joint”. D: After repeated checking of joint congruity the grafts were firmly fixed to the graft floor using mini screws.

Figure 2. A, B: Two years and 10 months after the total PIP joint arthroplasty, active extension/flexion of the PIP joint of her right ring finger indicated 10°/75°.

PAPER 56
Saturday, September 8, 2012 • 2:15 – 2:21 PM
Clinical Paper Session 13: Pediatrics / Trauma
Circumferential vs Bivalved Cast Immobilization for Displaced Forearm Fractures: A Randomized Clinical Trial to Assess Safety and Efficacy
Level 1 Evidence
 Donald S. Bae, MD
Clarissa Valim, MD ScD
Patricia Connell, MPH
Katherine Brustowicz, BA
Peter M. Waters, MD

INTRODUCTION
Though most displaced forearm fractures in children may be treated with closed reduction (CR) and immobilization, little is known about the safety and efficacy of circumferential versus bivalved cast immobilization. The purpose of this study was to determine the effects of circumferential versus bivalved cast immobilization on maintenance of reduction and associated complications following CR of pediatric forearm fractures.

HYPOTHESIS
Bivalved casting is as efficacious and safe as circumferential immobilization for displaced pediatric forearm fractures.

METHODS
Two hundred and five children with displaced radius and ulna fractures were randomized to either circumferential (n=104) or bivalved (n=101) long-arm casts following CR. Mean age was 10 ± 3 years. Mean fracture angulation of the radius and ulna was 12.7 ± 14.4 and 22.1 ± 11.3 degrees, respectively. There were no significant differences between groups in terms of age, gender, or initial fracture displacement and angulation. Clinical and radiographic evaluations were performed at 1,
2, 4, and 6 weeks post-reduction. Loss of reduction (defined as change in angulation of greater than 10 degrees), need for remanipulation or surgery, and associated complications of compartment syndrome, cast saw injury, and neurovascular compromise were recorded.

RESULTS
Overall, mean angulation of the radius and ulna fractures improved from 12.7 ± 14.4 and 22.1 ± 11.3 degrees at time of injury to 2.1 ± 3.2 and 4.4 ± 4.1 degrees following CR, respectively. Mean cast index following reduction was 0.79 ± 0.07 in the bivalved group and 0.81 ± 0.06 in the circumferential group. 9 patients in the circumferential casting group converted to bivalved casts due to pain and/or swelling. Mean angulation of the radius and ulna was 3.0 ± 4.7 and 8.2 ± 5.9 at 4 weeks, with no significant difference between groups. 39 patients (19%) had radiographic loss of reduction and 42 patients (21%) required remanipulation or surgical reduction and fixation. There were no significant differences between groups with respect to loss of reduction rate or need for surgical treatment. Associated complications were rare, with 1 bivalved patient sustaining a cast saw injury and 3 bivalved patients with transient neurologic abnormalities. No patients developed compartment syndrome.

SUMMARY POINTS
- Cast immobilization alone is effective for the majority of patients following CR of displaced forearm fractures.
- There are no significant differences in maintenance of reduction, need for surgery, or complications between circumferential or bivalved long-arm casts.

TABLE 1. Definitive fixation method and unsuccessful reduction techniques attempted prior to definitive procedure.

<table>
<thead>
<tr>
<th>Definitive Fixation Method</th>
<th>Failed Fixation Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Closed Reduction (N=63)</td>
</tr>
<tr>
<td>None</td>
<td>63</td>
</tr>
<tr>
<td>Closed Manipulation Only</td>
<td>25</td>
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<tr>
<td>Other Open Procedure</td>
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</table>

PAPER 57
Saturday, September 8, 2012 • 2:23 – 2:29 PM
Clinical Paper Session 13: Pediatrics / Trauma

Surgical Management of Pediatric Radial Neck Fractures
Level 4 Evidence

Ryan M. Zimmerman, MD
Leslie A. Kalish, ScD
Peter M. Waters, MD
M. Timothy. Hresko, MD
Donald S. Bae, MD

BACKGROUND
The management of pediatric radial neck fractures is challenging, due to controversies regarding what constitutes acceptable alignment, the spectrum of surgical techniques, and often suboptimal outcomes. The purpose of this study was to assess the characteristics, management, and outcomes of pediatric radial neck fractures undergoing surgical treatment.

HYPOTHESES
1. Surgeons would begin with closed manipulation and proceed to more invasive techniques before resorting to open reduction.

2. Worse outcomes are seen with greater initial fracture displacement, presence of associated injuries, and open reduction techniques.

MATERIALS AND METHODS
A retrospective analysis was performed of 151 children who underwent surgery for radial neck fractures from 2001-2011. Mean age was 8.4 ± 2.9 years; 39% were male. Mean follow-up was 13.3 ± 20.0 months. In addition to clinical motion and radiographic alignment, complications of heterotopic ossification (HO), avascular necrosis (AVN), premature physeal arrest, neurovascular injury, and additional surgery were recorded. Acceptable outcome was defined as active elbow flexion = 120°, flexion contracture < 20°, forearm rotation > 90° with = 45° of both supination and pronation, and the absence of any complications. Subgroups were compared with the Kruskal-Wallis, Mann-Whitney and Fisher’s Exact tests.

RESULTS
Isolated radial neck fractures occurred in 54%, while 46% had associated injuries, including ulna fractures and Monteggia variants. Mean preoperative angulation was 43 ± 20° and displacement was 38 ± 36°. Nine different reduction techniques were used, and a total of 22 different procedural combinations were employed. Forty-two percent were treated definitively with closed manipulation, 28% via a closed surgical technique and 30% with an open reduction. There was a strong association between more invasive fixation methods and greater initial fracture angulation and displacement (p<0.001). Open procedures were more likely in children <10 years old (p=0.01). The overall complication rate was 27%, with 20% HO, 3% AVN and 3% premature physeal closure. Sixty-nine percent had an acceptable outcome. No differences were seen in the presence of associated injuries. Better outcomes were associated with age <10 years, decreased fracture severity, and use of less invasive techniques (p<0.001).

SUMMARY POINTS
- There was considerable variability in surgical treatment. Less invasive procedures were not always attempted before open reduction.
- Acceptable outcome was achieved in 69%. Better outcomes were associated with age <10 years, less severe fractures, and less invasive surgical technique.
- Pediatric radial neck fractures should treated initially with closed manipulation, followed by closed reduction techniques, before resorting to open reduction.
Table 2. Patient, fracture and treatment characteristics among patients with acceptable versus unacceptable outcomes.

<table>
<thead>
<tr>
<th></th>
<th>Acceptable Outcome</th>
<th>Unacceptable Outcome</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male (%)</td>
<td>38%</td>
<td>51%</td>
<td>0.18</td>
</tr>
<tr>
<td>Age &lt;10 years</td>
<td>83%</td>
<td>49%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Presence of Associated Injury</td>
<td>44%</td>
<td>59%</td>
<td>0.19</td>
</tr>
<tr>
<td>Preoperative Maximum Displacement</td>
<td>26±29%</td>
<td>68±38%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Preoperative Maximum Angulation</td>
<td>38±18°</td>
<td>55±22°</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Displacement is expressed as percentage of radius diameter in the plane of deformity. Data are expressed as mean±standard deviation where applicable. Maximum displacement and angulation refers to the larger value of the anteroposterior and lateral plane deformities. For definitive fixation method, closed procedure refers to any percutaneous or intramedullary technique that did not involve exposing the radiocapitellar (RC) joint. Open procedure refers to any technique in which the RC joint was opened.

**RESULTS**

In the splinting group, 16 fingers (67%) resolved, 4 fingers (17%) improved, and 4 fingers (17%) remained unchanged. Seven fingers (29%) ultimately required surgery. In the non-splinting group, 7 fingers (30%) resolved spontaneously, 1 finger (4%) improved, and 15 fingers (65%) remained unchanged. Fifteen fingers (65%) later underwent surgical release (Table 1). The rate of resolved fingers in the splinting group was statistically higher than that in the non-splinting group (p<0.05). The proportion needing surgical treatment in the splinting group was statistically lower than that in the non-splinting group (p<0.05) (Table 2).

**SUMMARY**

According to our retrospective cohort study, approximately two-thirds of fingers achieved resolution by splinting. Thus, splinting appears to be a more effective first treatment option than observation.

**REFERENCES**


**PAPER 58**

Saturday, September 8, 2012 • 2:31 – 2:37 PM
Clinical Paper Session 13: Pediatrics / Trauma

**Comparison of Splinting vs Non-splinting in the Treatment of Pediatric Trigger Finger**

Level 3 Evidence

- Hiroyuki Kato, MD, PhD
- Ritsu Shiozawa, MD, PhD
- Norimasa Iwasaki, MD
- Toshiro Itsubo, MD
- Koichi Nakamura, MD
- Shigebaru Uchiyama, MD

**HYPOTHESIS**

As pediatric trigger finger (PTF) is much less common than pediatric trigger thumb, there is no consensus on the efficacy of splinting due to the rarity of the condition and a lack of natural history and comparative therapeutic data. Our hypothesis is that splinting is an effective treatment for PTF.

**METHODS**

Twenty-four children zero to 10 years of age having a total of 47 trigger fingers were included in this study. Affected fingers comprised 4 index, 28 middle, 11 ring, and 4 little fingers. Patient age at initial examination ranged from 1 month to 9 years. Twenty-four fingers treated with a static splint and 23 observed fingers were followed for 2 to 18 years from the time of initial examination to final follow-up. Splints were fitted to fingers at zero degrees extension of the wrist, metacarpophalangeal joint, proximal interphalangeal joint, and distal interphalangeal joint. Parents were ordered to have the splints worn once or twice daily while the child napped and/or the first 2 or 3 hours of sleep at night. We evaluated all fingers at initial visit and final follow-up for non-surgical cases or immediately before surgery with the modified Sugimoto-Watanabe staging system. Fingers were classified as resolved if there were no limitations in active range of movement and no triggering. Fingers were classified as improved when the staging score improved by at least one level, or when mild triggering occurred less than twice a month and the patient did not complain of pain or request further treatment. Fingers were rated as unchanged or worse when the staging score showed no change or worsened by at least one stage, respectively.

### Table 1. Final results of the splinting and non-splinting groups

<table>
<thead>
<tr>
<th></th>
<th>Splinting group (n=24)</th>
<th>Non-splinting group (n=23)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of resolved fingers</td>
<td>16 (66.6%)</td>
<td>7 (30.4%)</td>
<td></td>
</tr>
<tr>
<td>No. of improved fingers</td>
<td>4 (16.7%)</td>
<td>1 (4.4%)</td>
<td></td>
</tr>
<tr>
<td>No. of unchanged fingers</td>
<td>4 (16.7%)</td>
<td>15 (65.2%)</td>
<td></td>
</tr>
<tr>
<td>No. of recurrent fingers</td>
<td>0 (0.0%)</td>
<td>9 (39.1%)</td>
<td></td>
</tr>
<tr>
<td>Duration from initial visit to resolution (mean)</td>
<td>5 mo* to 5 y** (10 mo)</td>
<td>3 mo to 13 y (4 y and 11 mo)</td>
<td></td>
</tr>
</tbody>
</table>

* months, ** years

There are no differences in clinical features between the two groups. The rate of fingers achieving resolution in the splinting group is significantly higher than that in the non-splinting group. The rate of fingers needing surgical release in the splinting group significantly is lower than that in the non-splinting group.

Table 2. Finger profiles and comparison of both treatment groups

<table>
<thead>
<tr>
<th></th>
<th>Splinting group (n=24)</th>
<th>Non-splinting group (n=23)</th>
<th>Statistical evaluation method</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age at first visit</td>
<td>2 y** and 1 mo*</td>
<td>2 y and 2 mo</td>
<td>t-test</td>
<td>0.39</td>
</tr>
<tr>
<td>No. of fingers in male patients</td>
<td>11</td>
<td>10</td>
<td>χ² test</td>
<td>0.41</td>
</tr>
<tr>
<td>No. of fingers in the right hand</td>
<td>11</td>
<td>12</td>
<td>χ² test</td>
<td>0.66</td>
</tr>
<tr>
<td>No. of fingers with unilateral hand affected</td>
<td>7</td>
<td>8</td>
<td>χ² test</td>
<td>0.68</td>
</tr>
<tr>
<td>No. of fingers at stage II</td>
<td>9</td>
<td>10</td>
<td>χ² test</td>
<td>0.46</td>
</tr>
<tr>
<td>No. of fingers evaluated as resolved (%)</td>
<td>16 (66.6%)</td>
<td>7 (30.4%)</td>
<td>χ² test</td>
<td>0.01</td>
</tr>
<tr>
<td>No. of fingers requiring surgery (%)</td>
<td>7 (29.2%)</td>
<td>15 (65.2%)</td>
<td>χ² test</td>
<td>0.01</td>
</tr>
</tbody>
</table>

* months, ** years

Speaker has nothing of financial value to disclose.
Internal Fixation of Unstable In Situ Osteochondritis Dissecans Lesions of the Capitellum

Level 4 Evidence

♦ William P. Henrikus, BA
Lyle J. Michel, MD
♦ Peter M. Waters, MD
Donald S. Bae, MD

INTRODUCTION

Many surgical treatment options have been proposed for unstable in situ osteochondritis dissecans lesions of the capitellum, ranging from debridement to fixation to osteochondral transplantation, though limited information exists regarding expected outcomes.

The objective of this investigation was to assess the clinical and radiographic outcomes of internal fixation for unstable in situ OCD.

HYPOTHESIS

Internal fixation is safe and effective in younger patients with smaller, contained lesions.

METHODS

A retrospective analysis was performed of 30 elbows undergoing internal fixation for unstable in situ OCD lesions. Mean age at surgery was 13.9 ± 1.6 years. One-third of patients had open distal humeral physes; 61% were male. Most patients developed OCD due to baseball (40%) and gymnastics (33%). Indications for surgery included pain, mechanical symptoms, and radiographic OCD instability. Fixation was performed with bioresorbable barbed nails (63%), bioresorbable smooth pins (24%), or smooth Kirschner wires (10%). Mean clinical and radiographic follow-up was 24 and 20 months, respectively. Functional outcomes were assessed using the Mayo Elbow Performance (MEPS), Timmerman, and Pediatric Outcomes Data Collection Instrument (PODCI) scores.

RESULTS

Mean height, width, and depth of OCD lesions were 11.5, 11.5, and 5.2 mm, respectively. 57% of lesions were contained, and 24% elbows had evidence of radiocapitellar subluxation. While 33% underwent internal fixation of an isolated lesion, 67% of elbows had additional loose bodies requiring debridement and/or drilling. Mean pre-operative elbow flexion-extension was 16 - 123 degrees. Mean post-operative elbow motion was 4 - 132 degrees, for average improvement of 21 degrees (p<0.01). Clinical and radiographic healing was seen in 69% of elbows. Healing rates were not affected by physeal status or OCD location. Mean time to return to unrestricted sports was 25 weeks. Additional surgery was performed in 37% of patients, including planned K-wire removal (n=3), revision fixation (n=1), or debridement and salvage procedures (n=6). Complications included 1 posterior interosseous nerve injury and 2 cases of bioresorbable implant breakage. At most recent follow-up, MEPS were excellent in 79% and good in 21%. In 21 patients, 11 patients had excellent final Timmerman scores, 5 good, 2 fair, and 3 poor. In 21 patients, mean PODCI upper extremity and sports scores were 98 and 93.

SUMMARY POINTS

- Internal fixation for thin, unstable, in situ OCD lesions is safe and effective, though the need for additional surgery is common.
- In this analysis, lesion location or skeletal maturity did not influence healing potential.
- Consulting Fees / Advisory Boards / Consultancies: POSNA; ASSH; JBJS; JHS (Bae)
- Royalties Support: Lippincott Williams and Wilkins (Bae, Waters)
- Contracted Research: POSNA; ASSH (Bae)
SUMMARY
Pulmonary function parameters were not affected significantly in long-term although diaphragm paralysis still exists in most of phrenic nerve transferred patients. Preoperative evaluation and postoperative care is helpful to minimize the abnormality of the respiratory function.

REFERENCES

PAPER 61
Saturday, September 8, 2012 • 2:23 – 2:29 PM
Clinical Paper Session 14: Nerve

Patient Specific Functional Scale: Establishment of Validity in Patients with Upper Extremity Nerve Injury
Level 3 Evidence

Christine B. Novak, PT, PhD
Dimitri J. Anastakis, MD
Dorcas E. Beaton, OT, PhD
Susan E. Mackinnon, MD
Joel Katz, PhD

HYPOTHESIS
Disease specific questionnaires using standardized items are often used to assess disability in musculoskeletal disorders. However patient selected items may more accurately identify specific upper extremity functional limitations. This study evaluated the validity of the Patient Specific Functional Scale (PSFS) in patients with traumatic upper extremity nerve injury. We hypothesized that the PSFS would be lower in patients with brachial plexus nerve injury and strongly associated with pain and the disability.

METHODS
Following REB approval, we included: English-speaking adults, greater than 6 months after upper extremity nerve injury. Patient reported questionnaires included: PSFS, SF-36, DASH, Pain Catastrophizing Scale (PCS) and Pain Disability Index (PDI). The PSFS allowed each patient to identify three activities that were difficult to perform. Each item was ranked on a 10 cm visual analog scale (lower score indicated more difficulty). Statistical analyses evaluated the relationships among the questionnaires and the independent variables (age, gender, nerve injured, time from injury, work status, worker’s compensation/litigation). Linear regression was used to evaluate the variables associated with the PSFS.

RESULTS
There were 158 patients (mean age 41 ± 16 years; median time from injury of 14 months). Preliminary data analyses revealed mean ± sd scores: PSFS 3.1 ± 2.3, DASH 44 ± 22, PCS 16 ± 15, VAS pain intensity 4.2 ± 3.0, pain rating index 13 ± 11, PDI 28.3 ± 17.6 and SF-36 component scores physical (41.8 ± 8.7) mental (45.9 ± 12.6). There was a significant correlation between the PSFS and the DASH (r = -0.37), SF-36 physical component score (r = -0.27), PDI (r = -0.27) and pain intensity (r = -0.18). The PSFS was significantly lower in brachial plexus injuries than in distal nerve injuries (p = .001) and in those unemployed than working (p = .02). The final regression model which predicted the PSFS explained 21% of the variance and included; DASH (Beta = -0.32, p < .001), nerve injured (Beta = -0.23, p = .005) and age (Beta = .125, p = .099).

SUMMARY
The results provide preliminary evidence for the construct validity of the PSFS for patients with upper extremity nerve injury. The PSFS provides a method to assess individual functional limitations, can be completed in a shorter period of time than the DASH and was more acceptable to the patients than the DASH. Future studies will assess the reliability and responsiveness of the PSFS in patients with nerve injury.

• Grant received from AAHS Research Grant; CIHR Doctoral Fellowship Award (Novak)
PAPER 62
Saturday, September 8, 2012 • 2:31 – 2:37 PM
Clinical Paper Session 14: Nerve
30 Years After Median and Ulnar Nerve Repair in Childhood and Adolescence – Functional Outcome and Nerve Conduction Studies
Level 3 Evidence

● Anette Chemnitz, MD
Anders Björkman, MD, PhD
Birgitta Rosen, OT, PhD
Gert Andersson, MD, PhD
Lars Dahlin, MD, PhD

HYPOTHESIS
Age at injury is believed to be a strong factor influencing outcome after peripheral nerve injury. However, the long-term outcome following peripheral nerve injury in childhood has not been studied previously. The aim of this study was to investigate the long-term outcome following median and ulnar nerve injury to the forearm sustained in childhood and adolescence and to investigate if the superior clinical recovery in childhood injuries can be explained by changes in the peripheral nervous system.

METHODS
Functional outcome was examined in 45 patients at a median time of 31 years after a complete median or ulnar nerve injury to the forearm. Forty-four of these patients also performed a nerve conduction study. The functional outcome was classified with the total Rosen score, DASH, sensitivity to cold and locogonia, together with the patient’s estimation of overall outcome and impact on their education, work and leisure activities.

We compared the results after nerve injuries sustained in childhood (age<12 years) and adolescence (age 12-20 years). Statistical comparisons were made between childhood and adolescent injuries, and between the nerves injured (median nerve, ulnar nerve or both).

RESULTS
Functional recovery expressed as total Rosen score was significantly better for injuries sustained in childhood than in adolescence (87% and 67% of normal function respectively, p<0.001). No significant differences were seen in comparisons of different nerve injuries, even when both nerves were injured. Motor function was close to normal and cold sensitivity was not a major problem in either group. The DASH score was within normality and did not vary between the groups. The nerve conduction studies showed reduced motor and sensory amplitudes, with the motor amplitudes less reduced than the sensory ones. Sensory and motor conduction velocities were similarly reduced in either age or nerve group and the distal motor latencies were increased overall.

SUMMARY POINTS
Thirty-one years after nerve repair in the forearm, functional outcome is significantly better in those injured in childhood with almost full sensory and motor recovery. Nerve conduction studies showed similar results regardless of age at injury or affected nerve. This indicates that the better outcome after nerve injuries sustained in childhood cannot be explained by superior peripheral nerve regeneration. Instead, other mechanisms, such as greater plasticity of the young brain, might explain the superior outcome in those injured in childhood.

REFERENCE

• Grant received from Swedish Medical Research Council, Region Skåne (ALF) (Chemnitz)

PAPER 63
Saturday, September 8, 2012 • 2:39 – 2:45 PM
Clinical Paper Session 14: Nerve
Functional Recovery of Elbow Flexion Following Median and/or Ulnar Nerve Fascicle Transfer in Upper Trunk Neonatal Brachial Plexus Palsy
Level 4 Evidence

◆ Kevin J. Little, MD
Francisco Soldado, MD, PhD
◆ Dan A. Zlotolow, MD
Roger Cornwall, MD
Scott H. Kozin, MD

HYPOTHESIS
Nerve transfers using ulnar and/or median nerve fascicles to restore elbow flexion have been widely used following traumatic brachial plexus injury, but their utility following neonatal brachial plexus palsy (NBPP) remains uncertain. The current multi-center study tests the hypothesis that such transfers to restore elbow flexion in NBPP are safe and reliable.

METHODS
Medical records of 37 patients at 3 institutions who had undergone ulnar and/or median nerve fascicle transfer to the biceps and/or brachialis branches of the musculocutaneous nerve after NBPP were respectively reviewed. Indications for surgery included poor elbow flexion recovery (Active Movement Scale (AMS)=3) in the setting of late presentation, dissociative recovery (shoulder recovery without elbow flexion), nerve root avulsions or incomplete recovery after prior nerve grafting. Choice of donor nerve(s) was determined by surgeon preference. Demographic information, donor nerve(s), recipient nerve(s), distribution of injury, age at surgery, and any previous or concomitant surgeries were recorded. Patients were followed for at least 18 months post-operatively or until achievement of full elbow flexion (AMS=7), whichever occurred first. Pre- and postoperative AMS for elbow flexion and supination were compared among patients using Mann-Whitney tests and linear regression analysis with statistical significance set at p=0.05.

RESULTS
Of the 37 patients, 31 (84%) obtained functional elbow flexion (AMS=6), and 27 (73%) had full flexion recovery (AMS=7). Combined ulnar and median nerve fascicle transfers resulted in full elbow flexion (AMS=7) in 6 of 6 patients, whereas single fascicle transfer resulted in functional flexion (AMS=6) in only 25 of 31 patients (81%, p = 0.002). Of the 32 patients for whom supination recovery was recorded, 11 (34%) obtained functional recovery (AMS=6). Supination recovery was better with combined ulnar and median nerve fascicle transfers than with single nerve transfer (AMS=6 in 100% vs. 22%, respectively; p=0.002). Age at surgery (range 3-20 months) was inversely correlated with recovery of

◆ Speaker has nothing of financial value to disclose
both elbow flexion (-0.58, p<0.001) and supination (-0.56, p<0.001).
Patients with nerve root avulsions or upper trunk palsy were statistically more likely to improve elbow flexion and supination than those with dissociative recovery or extended upper trunk palsy. One patient sustained a transient AIN palsy after median nerve fascicle transfer.

**SUMMARY POINTS**
- Ulnar and/or median nerve fascicle transfers restore functional elbow flexion in the majority of patients following NBPP.
- Supination recovery is less reliable unless combined transfers are used.
- Combined transfers of ulnar and median nerve fascicles results in superior recovery of both elbow flexion and supination following NBPP.

**REFERENCES**

**PAPER 64**

Saturday, September 8, 2012 • 3:35 – 3:40 PM
Clinical Paper Session 15: Distal Radius

Complications Associated with Operative vs Non-operative Treatment of Distal Radius Fractures in Patients Aged 65 Years and Older
Level 3 Evidence

 Saúde Kristina H. Lutz, MD
Kwan M. Yeh, MBBS, FRACS (Orth)
Caitlin Symonette, MD, MSc
Joy C. MacDermid, BScPT, MSc, PhD
Ruby Grewal, MD, MSc, FRCS

**HYPOTHESIS**
The purpose of this study was to compare complication rates between Distal Radius Fractures (DRF) treated operatively and non-operatively in patients aged 65 years and older with a retrospective matched cohort study. We hypothesized that although surgical intervention may result in better fracture alignment based on x-ray findings, it would be associated with more complications and an equivalent functional outcome to non-operative intervention.

**METHODS**
A prospective database and retrospective chart review were used to identify patients aged 65 years and older who sustained a DRF. Patients were matched based on fracture type (AO type A/B/C1 vs. C2/C3), age, gender, and energy of fracture. Charts were retrospectively reviewed using a validated complications checklist (1). A sample size of 276 was needed to achieve 80% power (α=0.05) based on previously reported complication rates of 20% (non-operative) and 35% (operative patients) (2). Patient outcomes (based on PRWE scores) were compared between groups using a t-test. The overall complication rates and incidence of complications resulting in re-operation were compared using a chi-square test.

**RESULTS**
The study cohort (n=258) included 129 operatively treated patients and 129 treated non-operatively. There were no differences in patient reported pain and disability at 1 year between the operative (PRWE 16.1 ± 22.2) and non-operative group (PRWE 15.8 ± 17.6) (p=0.9) indicating minimal pain and disability in both groups. There was a significant difference in overall complication rates between patients treated operatively (28.7%) and non-operatively (17.1%) (p=0.03). The re-operation rate was 10.9% for operative patients and in non-operative patients was 5.4% (p=0.1). Re-operations were performed to treat median nerve compression, severe DRUJ incongruity, tendon rupture, and malunion. With respect to X-ray evidence of malunion, 25.6% of non-operative patients had a severe malunion compared to the 4.2% of non-operative patients (p<0.05). Furthermore, the complication rate was similar between the malunions (22.3%) and unions (23.1%) (p=0.8).

**SUMMARY POINTS**
Elderly patients with DRF who undergo surgery appear to have higher complication rates and do not appear to have better clinical results with respect to function.

**REFERENCES**

**Speaker has nothing of financial value to disclose**
injury. Patients were allocated to an unstable group or stable group according to the presence of intra-operative DRUJ instability. Overall wrist functions and subjective wrist pain were assessed at 12 months postoperatively.

RESULTS
Nineteen (22%) of the 84 study subjects were allocated to the unstable group and 65 (78%) to the stable group. The incidences of acute DRUJ instability and acute TFCC tears were found to be unaffected by the presence of an ulnar styloid base fracture. The incidences of acute TFCC tears, especially of type IB, were significantly higher in the unstable group. No significant difference was observed between the two groups in terms of overall wrist functional outcomes or subjective wrist pain.

SUMMARY POINTS
Acute DRUJ instability does not affect overall wrist function as long as DRFs are fixed by a volar locking plate and managed with well controlled postoperative immobilization.

PAPER 66
Saturday, September 8, 2012 • 3:49 – 3:54 PM
Clinical Paper Session 15: Distal Radius

Accurate Intraoperative Evaluation of Dorsal Screw Prominence after Polyaxial Volar Plate Fixation of Distal Radius Fractures Utilizing the Hoya View: A Cadaveric Study

Not a clinical study

Scott G. Edwards, MD
Donnie Dolce, MD

HYPOTHESIS
After volar plating include tenosynovitis and extensor tendon rupture which can be attributed to dorsal screw prominence. We propose that a new intraoperative technique, the Hoya View, will allow for quick and accurate assessment of dorsal cortical screw penetration during volar plating of distal radius fractures.

METHODS
Eight fresh frozen human cadaveric wrists underwent application of volar distal radius plating. Utilizing a mini C-arm, AP, lateral, and Hoya views were obtained with notation of any dorsal screw penetration by independent observers. Dorsal dissection allowed for direct visual evaluation of any screw penetration. The distal locking screws were then exchanged sequentially for screws 2 mm longer than their initial measurements. All three fluoroscopic views repeated; any dorsal cortical penetration was recorded and subsequently validated with direct dorsal visualization.

RESULTS
After plating, dorsal wrist dissections revealed 6 of 64 screws (9.4%) penetrated the dorsal radial cortex. The average screw protrusion was 1.08 mm (range 0.5-2 mm) and was most frequently encountered at the two most radial screw positions of the distal and proximal rows (83.3%); this region corresponded with the 1st and 2nd dorsal compartments. On lateral views none of the 6 screws which were prominent were able to be detected compared to the Hoya view where 6 of 6 prominent screws were detected. With the distal and proximal rows of locking screws exchanged for screws 2 mm longer, 49 of 64 of the screws, or 76.6%, violated the dorsal cortex. The lateral and Hoya views were repeated with 24.5% detected on the lateral image versus 100% with the Hoya view. On lateral images, the most frequently visible prominent screws were in the two most ulnar screw positions of the distal and proximal locking rows (75%), with an averaged dorsal protrusion of 1.63 mm.

SUMMARY POINTS
• It is difficult to accurately detect prominent screws with standard AP and lateral fluoroscopic images.
• This study supports the intraoperative use of the Hoya view to accurately assess proper screw length and any dorsal cortical screw penetration with the use of volar-plate fixation of distal radius fractures.
• The Hoya view was most effective in detecting screw prominence within the distal 2 cm of the distal radius and was able to detect 100% of all prominent screws with no false negative results.

PAPER 67
Saturday, September 8, 2012 • 3:56 – 4:01 PM
Clinical Paper Session 15: Distal Radius

Arthroscopic Treatment of Intercarpal Ligament Injuries Associated with Distal Radius Fractures

Level 4 Evidence

Jong Pil Kim, MD
Kyung Joon Lee, MD
Joon Yeul Lee, MD

HYPOTHESIS
The incidence of intercarpal ligament injuries associated with distal radius fractures has been reported to be as high as 54%. If these ligamentous injuries are left untreated, the resulting chronic alteration in wrist kinematics will ultimately lead to carpal instability with chronic wrist pain. We reviewed our experience with the arthroscopic management of intercarpal ligament injuries associated with distal radius fractures and assessed related radiologic factors for these ligament injuries at the time of the fractures.

MATERIALS AND METHODS
Fifty-seven patients who underwent arthroscopic surgery for intercarpal ligaments injuries associated with distal radius fractures were enrolled. Forty-six patients had a scapholunate interosseous ligament injury (SLIL) and 31 patients had a lunotriquetral interosseous ligament (LTIL) injury. Among them, 23 patients had both SLIL and LTIL injuries. Carpal ligament injuries were graded according to the Geissler classification and treated with arthroscopic debridement alone for grade I and II injuries (group 1) and arthroscopic reduction and percutaneous pinning for grade III and IV injuries (group 2). Patients were reviewed after a minimum of two years of follow-up for evaluation of the radiologic and functional outcomes.

RESULTS
In patients with LTIL injuries, mean radial inclination of group 2 (9 patients) at the time of injury was measured as 15.8 ± 9.0°, which
was significantly different from 20.4 ± 5.1° of group 1 (22 patients), (p=0.036). Extra-articular fracture type was common in group II (7 of 9 patients), (p=0.004).

At follow-up radiographs, group 1 (19 patients) treated with debridement alone for SLIL injuries showed a greater scapholunate interval than group 2 (27 patients) treated with arthroscopic reduction and percutaneous pinning, which were measured as 2.2 ± 0.3 mm and 1.7 ± 0.5 mm, respectively (p=0.034). Among group 1 with SLIL injuries, the patients with grade II injury demonstrated a significant increase of scapholunate interval than the patients with grade I injury. With regard to lunotriquetral interval, this study yielded no difference between two groups.

SUMMARY POINTS
- The prevalence of complete tear of LTL combined with distal radius fractures is associated with a loss of radial inclination and extra-articular fracture type at the time of initial presentation.
- Complete tears of the SLIL can be adequately stabilized by an arthroscopic reduction and percutaneous pinning without direct repair.
- Arthroscopic debridement alone is not recommended for the treatment of grade II or more SLIL injuries.

REFERENCES

PAPER 68
Saturday, September 8, 2012 • 4:03 – 4:08 PM
Clinical Paper Session 15: Distal Radius

Early Initiation of Bisphosphonate does not Affect Healing and Outcomes of Volar Plate Fixation of Osteoporotic Distal Radius Fractures
Level 2 Evidence

Hyun Sik Gong, MD
Young Ho Lee, MD
Seung Hwan Rhee, MD
Hyuk Jin Lee, MD
Min Bom Kim, MD
Goo Hyun Baek, MD

HYPOTHESIS
Bisphosphonates can affect fracture healing because they inhibit osteoclastic bone resorption, thus it is unclear when bisphosphonate medication can be initiated safely in those who just experienced a distal radius fracture. The purpose of this randomized, prospective study was to determine whether the early use of bisphosphonate affects fracture healing and outcomes of osteoporotic distal radius fractures treated by volar locking plate fixation.

METHODS
Fifty women older than 50 years of age that underwent volar locking plating for distal radius fractures and were indicated for osteoporosis medication were randomized to Group I (n=24, initiation of bisphosphonate at 2 weeks after operation) or Group II (n=26, initiation of bisphosphonate at 3 months). Patients were assessed for radiographic union and radiographic parameters at 2, 6, 10, 16, and 24 weeks, and for clinical outcomes at 24 weeks which included disabilities of the arm, shoulder, and hand (DASH) scores, wrist ranges of motion, and grip power. The two groups were compared for time to radiographic union, radiographic parameters and clinical outcomes.

RESULTS
No significant differences were observed between the two groups with respect to radiographic or clinical outcomes. All patients achieved fracture union and mean times to radiographic union in groups I and II were similar (6.7 weeks vs. 6.8 weeks, respectively; p=0.65). Furthermore, time to radiographic union was not found to be related to osteoporosis severity or fracture type in patients treated by volar locking plate fixation.

SUMMARY POINTS
- In patients with an osteoporotic distal radius fracture treated with volar locking plating, the early initiation of bisphosphonate does not affect fracture healing or clinical outcomes.
- Future investigation should focus on whether the immediate initiation of medication actually results in increased osteoporosis treatment rate.

REFERENCES

PAPER 69
Saturday, September 8, 2012 • 3:35 – 3:41 PM
Clinical Paper Session 16: Pediatrics / Congenital

Safety and Efficacy of Derotational Osteotomy for Congenital Radioulnar Synostosis
Level 4 Evidence

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Speaker has nothing of financial value to disclose
HYPOTHESIS
The historical complication rate following derotational osteotomy for congenital radioulnar synostosis exceeds 35% and includes a high risk of compartment syndrome and loss of fixation. Standardization of surgical technique can improve the safety and efficacy of this procedure by significantly diminishing the risk of neurovascular compromise and loss of fixation.

METHODS
A retrospective evaluation of consecutive patients who underwent derotational osteotomy for congenital radioulnar synostosis at a single institution between 1995 and 2011 was performed. Patients with substantial functional limitations secondary to excessive pronation were indicated for surgery with a goal correction to 0 to 20 degrees of pronation. All patients were treated with a standardized surgical technique including careful subperiosteal elevation, rotational osteotomy at the level of the radioulnar synostosis, control of the osteotomy fragments, appropriate pinning techniques (with 2 to 4 Kirschner-wires), and prophylactic forearm fasciotomies. Pre-operative radiographs were reviewed to confirm the diagnosis. Electronic medical records were evaluated for pre-operative and post-operative forearm position, elbow motion, post-operative complications, and need for additional surgery. Post-operative radiographs were assessed for union.

RESULTS
During the collection period, a derotational osteotomy utilizing the standardized technique was performed in 31 forearms in 26 children (13 bilateral, 13 unilateral) with a mean age of 6.8 years (range 3.0-18.8 years). The mean clinical follow-up was 30 months. The mean initial pronation deformity was 85 degrees (range 60-100 degrees). The mean correction achieved was 77 degrees (range 40-95 degrees), resulting in a mean final position of 8 degrees of pronation (range 0-30 degrees). All patients successfully achieved union by 8 weeks. There were no cases of compartment syndrome, vascular compromise, or loss of fixation. The overall complication rate was 12% (3 transient nerve palsies, 1 symptomatic muscle herniation). Two transient anterior interosseous nerve palsies were identified, with both occurring in patients with rotational corrections exceeding 80 degrees. One transient radial nerve palsy was observed, and was attributed to retractor placement.

SUMMARY POINTS
- Derotational osteotomy can be safely and effectively performed in patients with congenital radioulnar synostosis.
- Meticulous technique, including careful soft tissue handling, stable pin fixation, and prophylactic forearm fasciotomies, reduces the incidence of post-operative vascular compromise and compartment syndrome.
- Transient anterior interosseous nerve palsies do occur, and may be related to large rotational corrections.

PAPER 70
Saturday, September 8, 2012 • 3:43 – 3:49 PM
Clinical Paper Session 16: Pediatrics / Congenital
Outcome Measures of Microsurgical Toe Transfers for Reconstruction of Congenital Hand Anomalies
Level 4 Evidence
♦ Jesse Kaplan, BS
Neil F. Jones, MD

HYPOTHESIS
Outcomes data for children undergoing surgical reconstruction of their hand anomalies has been used infrequently or not at all. Some surgeons even contend that children with total absence of their digits or hands function perfectly well. Therefore the purpose of this study was to evaluate the functional outcomes of children who had undergone microsurgical toe-to-hand transfers for reconstruction of congenital hand anomalies and comparison with the normal pediatric population.

METHODS
The Pediatric Outcomes Data Collection Instrument (PODCI) is a widely used questionnaire to provide subjective assessment of six dimensions of functional abilities of pediatric patients with musculoskeletal conditions. This survey has never been used in the unique population of pediatric patients undergoing toe-to-hand transfers. Nine adolescents and thirteen parents of pediatric and adolescent patients were assessed using the PODCI survey. Surveys were distributed to parents of children, parents of adolescents and adolescent patients themselves either in English or an approved Spanish translation during routine clinic visits or via mail. Age, diagnosis and congenital classification were analyzed in relation to the functional outcomes obtained from the survey. Results were compared using paired t-tests divided by survey group and PODCI dimension against normal pediatric population values.

RESULTS
The PODCI survey proved to be a useful survey of both patient and parent-reported functional outcomes. Of the three survey groups and six functional dimensions, there was no statistically significant difference in function between the toe transfer children and the normal pediatric population in 13 out of the 18 groups (72%). Statistically significant (P<.05) differences between toe transfer children and the normal pediatric population were only reported five times (28%). Self-responses from the adolescent patients reported decreased upper extremity function in their transfers and parents of adolescents reported decreased upper extremity function, sports/physical function and global functioning.

SUMMARY
Children with congenital missing or hypoplastic digits who undergo reconstruction by microsurgical toe-to-hand transfer can achieve remarkable gains in function, sensation and ability to perform daily activities. Objective documentation of this functional improvement by both children and their parents has been lacking. This preliminary study confirms that a significant percentage of children undergoing reconstruction by microsurgical toe-to-hand transfers have similar functional outcomes assessments when compared with the normal pediatric population.
REFERENCES


PAPER 71

Saturday, September 8, 2012 • 3:51 – 3:57 PM
Clinical Paper Session 16: Pediatrics / Congenital

Type A Ulnar Polydactyly of the Hand – A Classification System and Clinical Series
Level 4 Evidence

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HYPOTHESIS
To radiographically classify type A ulnar polydactyly of the hand, and describe patients’ characteristics.

METHODS
We identified 49 patients with type A ulnar polydactyly of the hand who were seen in our institution during a period of 20 years. Patients’ medical records and radiographs were retrospectively reviewed. Radiographs of the involved hands were also used to form a morphological, clinically relevant, classification.

RESULTS
Ninety six percent of the deformities (64/67) were allocated to one of the five subgroups of our suggested classification, which was based on the skeletal origin of the supernumerary digit, the metacarpophalangeal joint type was the most common one. Sixty nine percent of patients in our series (34/49) had either bilateral type A ulnar polydactyly of the hand or a contralateral type B, and 63 percent (31/49) had ulnar polydactyly of one or both feet. Twenty four percent of patients (12/49) were diagnosed with syndromes or had associated congenital anomalies that involved areas other than fingers and toes, and the most common syndrome was chondroectodermal dysplasia (n=3). Sixty five percent of the patients (32/49) were Caucasians, 20% were Hispanics (10/49), 12% were African Americans (6/49), and one was Asian. The percentage of African Americans in our series was similar to that in the general patient population seen in our institution.

SUMMARY
The majority of type A ulnar polydactyly can be classified into one of five morphological subtypes that have potential clinical relevance regarding operative treatment. Associated hand and foot polydactyly are common, and ethnic distribution is distinct. Syndromic association was only identified in a minority of the cases in our series.

REFERENCES


Table 1: Subtypes of Type A postaxial polydactyly of the hand

<table>
<thead>
<tr>
<th>Type A postaxial polydactyly subgroup</th>
<th>Metacarpal type</th>
<th>Metacarpophalangeal type</th>
<th>Phalangeal type</th>
<th>Interphalangeal type</th>
<th>Fully developed type</th>
<th>Unclassified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>19</td>
<td>20</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>49*</td>
</tr>
<tr>
<td>Number of involved fingers</td>
<td>26</td>
<td>20</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>3</td>
<td>67</td>
</tr>
<tr>
<td>Patients with bilateral type A postaxial polydactyly</td>
<td>12 (63%)</td>
<td>4 (20%)</td>
<td>1 (25%)</td>
<td>2 (40%)</td>
<td>3 (75%)</td>
<td>1</td>
<td>18**</td>
</tr>
<tr>
<td>Patients with same subgroup type bilaterally</td>
<td>7</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Patients with contralateral type B postaxial polydactyly</td>
<td>7</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>Patients with combined postaxial polydactyly of the feet</td>
<td>10</td>
<td>10</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>31***</td>
</tr>
</tbody>
</table>

* Because of bilateral type A cases that involve two different subtypes, the total number of patients does not match the summation of the different subtypes.
** Because bilateral type A cases can involve two different subtypes, the total number of patients does not match the different subtypes.
*** Because bilateral type A cases can involve two different subtypes, the total number of patients does not match the summation of the different subtypes.
Abductor Digiti Minimi Myocutaneous Opponensplasty for Hypoplastic Thumb

Huber introduced opponensplasty using pedicled abductor digiti minimi (ADM) muscle for Blauth type II hypoplastic thumb in 1921. We transferred ADM as a pedicled myocutaneous flap for the opponensplasty in the hand with varieties of thumb hypoplasia to improve both function and appearance.

METHODS
An elliptically shaped skin flap is designed on the lateral aspect of hypothenar over ADM muscle avoiding dorsal hairy skin area. ADM myocutaneous island flap is elevated based on the neurovascular branches of the ulnar artery and nerve. An incision along the line connecting radial aspect of MP joint and pisiformis is made over hypoplastic thenar area. The ligamentous insertion of the ADM is detached and the flap is set in the defect created in the thenar area and the detached ligament is weaved into the ligamentous tissue around the radial base of the proximal phalanx of the thumb with an appropriate tension. Three weeks after surgery, the thumb is mobilized. We started this procedure based on our original idea in March 1996 for the Blauth type II hypoplastic thumb. This procedure was applied to 18 hands in 16 cases (8 male and 8 female) by 2010. This series included 7 Blauth type II, 6 type III, 3 type IV (after reconstructive procedures) and 5 type V (after pollicization). The age at operation ranged from 1 year 1 month to 8 years 3 month with an average of 4 years 11 months. The postoperative time was 1 years and 6 months to 14 years 11 months with an averaged of 7 years and 6 months. All of the patients had thumb hypoplasia of different degree on the other side.

RESULTS
All 18 transfers survived and were successful in improving thumb opposition and appearance. The reconstructed thumb was opposable to little finger in 67% and to ring in 100%. Pulp pinch was equivalent to the opposite hand and key pinch was 125% of the opposite. Open transfer avoided vascular compression to the pedicle and augmented the flat thenar soft tissue improving the appearance of the hand.

SUMMARY
ADM myocutaneous flap transfer for the hypoplastic thumb successfully improved both function and appearance. This procedure can avoid transfer in the subcutaneous tunnel transfer in the original Huber ADM muscle transfer and allow utilization of redundant cutaneous tissue in the hypothenar area with ADM muscle for the creation of thenar bulk.

REFERENCES