Meeting Abstracts
2013 Annual Meeting Abstracts

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PAPER 01
Best Papers
Thursday, October 3, 2013 ● 2:15—2:21 PM
Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Hand
Comparison of Cortisone Injection and Percutaneous Trigger Finger Release for Diabetic Trigger Fingers in 293 Patients
Level 1 Evidence
♦ Melissa Arief, MD
♦ Mukund Patel, MD
Hypothesis: This study sought to compare the success rate of cortisone steroid injection with that of percutaneous trigger finger release in diabetic patients.
Methods: Data were collected over a 5-year period from 2008 to 2013. We studied 2 cohorts of patients with diabetes type 1 and 2 who were either treated with local corticosteroid injection (N = 191) or percutaneous trigger release under local anesthesia in the office with a sterile 18-gauge needle (N = 209). Patients were observed for at least 1 year. Patient demographics included pain, trigger finger grade, and duration of symptoms. Patients were assessed at follow-up for pain, continued triggering, need for therapy after treatment, complications, and overall satisfaction.
Results: A total of 145 patients treated with corticosteroid injection were observed for 1 year and had an overall success rate based on patient satisfaction of 75%. In this group, 4% required a second injection, 5% underwent a percutaneous trigger finger release, and 1 patient received an open release. In the percutaneous release group, 147 patients were observed for 1 year. There was an overall success rate of 95%; 1 patient received a corticosteroid injection. In both groups, there were no complications.
Summary:
• The results of this study demonstrate a greater rate of success of percutaneous trigger finger release for diabetic trigger fingers compared with the standard corticosteroid injection.
• This study demonstrated no complications for a large series of patients demonstrating the safety of the percutaneous release in the office setting.

REFERENCES

PAPER 02
Best Papers
Thursday, October 3, 2013 ● 2:25—2:31 PM
Category: Vascular/Micrvovascular
Keyword: Elbow
Composite Tissue Transplantation of the Elbow Joint in Rats
Not a clinical study
♦ Juyu Tang, MD
♦ Hainan Zhu, MD
♦ Xuson Luo, MD
♦ Speaker has nothing of financial value to disclose

PAPER 03
Best Papers
Thursday, October 3, 2013 ● 2:35—2:41 PM
Category: Nerve/Neuromuscular
Keyword: Forearm
A Collagen Conduit Versus Microsurgical Neuorrhaphy 2-Year Follow-Up of a Prospective Blinded Clinical and Electrophysiological Multicenter RCT
Level 1 Evidence
♦ Michel E. H. Boeckstyns, MD
♦ Christian Kranup, MD, FRCPC
♦ Birgitta Rosen, OT, PhD
♦ Joaquim Fores, MD
♦ Allan Ibsen Sørensen, MD
♦ Xavier Navarro, MD, PhD
Hypothesis: The hypothesis to be tested in our study was that use of the collagen nerve guide conduit for repair of traumatic short gap nerve lesions in humans is associated with reinnervation of the denervated organs and recovery of sensory and motor functions that are at least equivalent to those after conventional repair (direct suture or nerve grafting).
Methods: In a prospective randomized trial, acute section of the ulnar or median nerves was repaired with a collagen nerve conduit or with conventional microsurgical techniques (direct suture or a short autologous nerve graft). Electrophysiological tests as well as hand function using a standardized clinical evaluation instrument (the Rosen scoring system) were performed at 12 and 30 months after 1-way and 2-way analysis of variance (ANOVA) with repair type (conduit or conventional) and nerve type (median or ulnar) as factors.
Results: Forty-three patients with 44 total nerve lacerations were enrolled. Operation time using the collagen conduit was significantly shorter than performing conventional repair. There were no surgical complications in terms of infection, extrusion of the conduit, or other local adverse reaction. Thirty-two patients with 33 nerve lesions attended the 24-month follow-up. There were no differences in the amplitudes, latencies, and conduction velocities when repair with nerve conduit and suture was compared. When compared at 12 and 24 months, there was general further recovery of both motor conduction parameters ($P < .01$) and sensory conduction parameters ($P < .05$). At 1-way ANOVA, there was no difference between sensory, discomfort, or total Rosen hand function scores when guide and suture repairs were compared. The 2-way ANOVA test showed significant differences in clinical motor recovery according to nerve (median doing better than ulnar). In contrast, sensory recovery after ulnar nerve repair was better than after median nerve repair. The type of repair in itself had no influence on sensory or motor function after 24 months.

Summary:
- The hypothesis was confirmed that use of the collagen nerve guide conduit for repair of traumatic nerve lesions in humans is associated with reinnervation of the denervated organs and recovery of sensory and motor functions that are equivalent to those after conventional repair, but they were not superior.
- Use of the collagen conduits is safe in the distal forearm.
- Obvious advantages above conventional repair are the shorter operation time and less donor side morbidity, in case nerve grafting is the only other alternative.

REFERENCES
- Contracted Research: Auxilum
- Royalties/Honoraria received from: Pfizer
- Consulting Fees (e.g., advisory boards) received from: Pfizer

PAPER 04

Best Papers
Thursday, October 3, 2013 • 2:45–2:51 PM
Category: Fractures and Dislocations
Keyword: Wrist

Distal Radius Fractures in Older Men: A Missed Opportunity?
Level 4 Evidence

Carl Harper, MD
Shannon K. FitzPatrick, BS
Tamara D. Rozental, MD
Lindsay Herder, BA

Hypothesis: Distal radius fractures (DRF) are common and represent an important source of patient morbidity, yet little is known about this fracture among older men. Most of the research focusing on fracture prediction and prevention to date has focused on postmenopausal women. The purpose of this study was to compare fracture characteristics, treatment, and subsequent osteoporosis evaluation among men and women with these injuries. Our hypothesis was that older men have similar patterns of injury and lower rates of evaluation for osteoporosis than women with DRF.

Methods: We retrospectively reviewed the records of 95 men and 344 women over the age of 50 treated for DRF at a single institution over a 5-year period. Data collected included age, mechanism of injury (high- vs low-energy fall), fracture severity (according to the AO classification), associated comorbidities, as well as type of treatment. We assessed whether patients received a dual-energy x-ray absorptiometry (DXA) scan and treatment with osteoporosis medication within 6 months of injury. Results were validated with a telephone interview. Differences between men and women were assessed via chi-square, Fisher’s exact, and unpaired Student’s t-tests.

Results: Men sustained DRF at a younger age than women (64 ± 11 vs 68 ± 12; $P = .004$) but had similar associated comorbidities and mechanisms of injury (fall from a standing height). Men were less likely to have had a prior fragility fracture (8 [4%] vs 66 [19.2%]; $P = .008$) and had less severe fracture patterns than women (19 [20%] vs 18 [40%] type C; $P < .500$). Whereas 184 (53%) women had a DXA after injury, only 17 (18%) men were evaluated for bone mineral density (BMD) ($P < .001$). Among those evaluated with a DXA scan, 3 men (17.6%) and 75 women (25%) were given a diagnosis of osteoporosis. Fewer men than women were subsequently treated with medication for underlying abnormalities in BMD (17 [18%] vs 179 [52%]; $P < .000$). Fracture Risk Assessment Tool calculations for the male population revealed a 7.8% ± 4.4% 10-year risk for major osteoporotic fracture for male patients.

Summary:
- Distal radius fractures among men occur at a slightly younger average age than among women.
- Men and women with DRF have similar mechanisms of injury and medical comorbidities.
- Fewer men than women are evaluated with a DXA scan after injury and treated for abnormalities in BMD.
- Evaluation and treatment rates for osteoporosis in men with fragility fractures are unacceptably low.
- Further studies are needed to better characterize this patient population and to develop improved fracture prevention programs.

REFERENCES
- Contracted Research: ASSH, OREF, RJOS
Clinical Paper Session 1: Distal Radius  
Friday, October 4, 2013 • 8:45—8:51 AM  
Category: Evaluation/Diagnosis/Clinical Treatment  
Keyword: Hand

Fragment-Specific Fixation of Intra-articular Distal Radius: The Role of Arthroscopy to Confirm Anatomical Reduction  
Level 4 Evidence

• Mari Thiart, MBBS  
• Ajmal Ikram, MD

Hypothesis: The goal of this study was to discover whether intraoperative arthroscopy assists in the reduction of intra-articular distal radius fractures when using fragment-specific fixation.

Methods: All patients who presented at our institution with intra-articular distal radius fractures were included. A computed tomography scan was done preoperatively. Intraoperatively, the fragments were reduced and fragment-specific fixation was used. The reduction was confirmed with an image intensifier. After the reduction, a scope was inserted into the radiocarpal joint to evaluate the reduction. Other pathology was documented and treated accordingly. Seventy-one patients were included in the study. One patient needed the fracture to be reduced again and 1 had a pin repositioned because it was intra-articular. Thirty patients (42%) had other intra-articular pathology; but only 2 (3%) needed further treatment. Six patients had complications: 1 had migrating hardware (K-wires backing out) and fracture collapse, and 5 had only fracture collapse. Thus, the complication rate was 8.5% for fracture collapse and 1.4% for migrating hardware.

Results: A total of 85% of the patients had no gaps and 77% of the patients had no steps. Only 1 patient needed refixation of a fracture fragment (1.4%) and 1 had a K-wire reinserted because it was intra-articular (1.4% of patients). An array of other pathology was seen intra-articularly, including 5 osteochondral defects, 20 triangular fibrocartilage complex tears (only 1 needed to be repaired), 4 bruised scapholunate ligaments, 3 scapholunate tears, 1 capsular tear, and 1 undisplaced scaphoid fracture (open reduction internal fixation was done).

Summary:
• The use of arthroscopy intraoperatively was shown not to assist in fracture reduction. This is relevant because intraoperatively, arthroscopic assistance is controversial. To our knowledge, no study exists combining fragment-specific fixation and arthroscopy.
• The procedure allowed for a detailed inspection of the joint for other pathologies and showed that 42% of patients had additional pathology; although a large percentage did not have to be treated (97%).
• Incidentally, the main surgical approach when we used fragment-specific fixation was laterally from the radial styloid and not the traditional Henry’s approach.
• Fixating the radial styloid from laterally stabilized the fracture in most cases.
• We also found that when a second fixation was needed, we used the dorsal ulnar approach, which left the volar side completely intact.

Residual Radial Translation of Distal Radius Fractures—Defining a New Radiographic Parameter and Occult Cause of DRUJ Instability  
Level 2 Evidence

• Greg Couzens, MD  
• Livio Di Mascio, MD  
• Mark Ross, FRACS

Hypothesis: Commonly used radiographic parameters that assess distal radius fracture reduction, do not take into account radial translation of the distal fragment, a cause of distal radioulnar joint instability.1 We hypothesized that having a normal radiographic parameter for residual radial translation will equip surgeons with a reliable and reproducible tool that can identify and evaluate the extent of this problem and direct appropriate surgical management.

Methods: Anteroposterior radiographs with no evidence of an acute fracture, dislocation, or history of previous fracture or dislocation were identified. These radiographs were of skeletally mature individuals with no history of distal radioulnar instability. Radiographs were excluded if the distal 10 cm of the radius was not visible or if there was more than 5° radial or ulnar deviation of the wrist, assessed by deviation of the long axis of the middle metacarpal from that of the radius.

Radial translation was measured by drawing a line along the ulnar aspect of the radius, into the proximal row of the carpus. This line intersects the lunate. The point of intersection was evaluated by drawing a second line along the transverse width of the lunate on the anteroposterior radiograph, which was parallel to the distal radial articular surface. The point of intersection was evaluated measuring from the radial side of the lunate. A single author repeated these measurements for all radiographs studied at 2 separate sittings to evaluate for intraobserver variability. In an attempt
to evaluate for interobserver variability, 2 fellowship-trained upper limb surgeons took measurements on 25 of the radiographs. The results were collated and statistical analysis was performed.

Results: A total of 100 radiographs fulfilling the study entry criteria were identified. There were 42 females and 58 males with a mean age of 43 years (range, 18–66 y). For all individuals studied, the point of intersection left a mean of 45.48% (range, 73% to 25%) of the lunate remaining on the radial side. Good interrater (intraclass correlation coefficient, 0.967) and intrarater (intraclass correlation coefficient, 0.780) reliability was observed.

Summary:
- With the advent and increasing popularity of volar locked plating systems for use in the treatment of distal radius fractures, there is potential for the creation of a stable construct with a radial translation malreduction.
- We propose a new parameter to measure radial translation, so that distal radioulnar joint instability can be minimized after distal radius fractures.
- This radiological parameter has been found to be reliable and reproducible.

REFERENCE

PAPER 07
Clinical Paper Session 1: Distal Radius
Friday, October 4, 2013 • 9:05—9:11 AM
Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Wrist

Demonstration of an Effective Postoperative Pain Management Protocol in Distal Radius Fractures
Level 4 Evidence

▲ David L. Nelson, MD
▼ Brandon La

Hypothesis: A multimodal pain program can help pain control in a common, moderately painful procedure (open reduction internal fixation distal radius fracture with volar plate). The effectiveness was assessed by a patient-centered outcome measure. The program could serve as an index of pain management effectiveness for other hand surgery practices.

Methods: All patients undergoing open reduction internal fixation by a single surgeon for distal radius fracture within 7 days postinjury had a pain control protocol previously presented to this Society in 2002. The components included: (1) preoperative counseling regarding expected pain, (2) preoperative oral long-acting acetaminophen and long-acting nonsteroidal (celecoxib), (3) pre-incision lidocaine block, (4) intraoperative bupivicaine block, (5) non—as-needed oral long-acting acetaminophen and long-acting nonsteroid (celecoxib) for 48 hours postoperatively and thereafter as needed, (6) hydrocodone/acetaminophen 5:500 (Vicodin) Q4H for break-through pain, (7) postoperative telephone call, and (8) assessment of the efficacy of the pain management at the first follow-up visit. The outcome measure was the number of opioid doses (hydrocodone/acetaminophen 5:500) taken within 10 days of surgery. The patient alone determined whether the pain required opioid medication. The surgeon had no input into the evaluation of pain. Exclusion criteria were multiple trauma and concurrent use of opioids for other conditions. Data were verified by an independent ASSH member who: (1) examined the operative casebook (no cases were skipped), (2) reviewed patient charts (data were correct), (3) contacted patients (to verify data in charts), and (4) examined the study database (all data were entered correctly).

Results: A total of 72 consecutive patients were eligible for the study; 59 patients met inclusion criteria and 13 were excluded. There were 10 males and 49 females, and 3 bilateral fractures. The average age was 62 years (range, 20–89 years). The average number of hydrocodone/acetaminophen doses taken within 10 days of surgery was 0.68 pills. A total of 72 of patients decided that the pain did not require opioids, and therefore took none. Eight percent took 1 pill, 6% took 2, 5% took 4, and 3% took 5. No patient asked for a refill. The review by an independent ASSH member verified the collected data.

Summary: The pain management protocol resulted in low usage of narcotic analgesics. Volar plating of distal radius fractures is a common procedure and is performed in a uniform manner by most surgeons. This makes volar plating a suitable model for evaluation of pain management across different practices, without requiring significant additional time for postoperative assessment, because only 1 question is required.

▲ This presentation will discuss Celebrex by Pfizer
▼ Royalties/Honoraria received from: Orthofix

▲ Speaker has nothing of financial value to disclose
Clinical Paper Session 1: Distal Radius  
Friday, October 4, 2013 • 9:15–9:21 AM  
Category: Fractures and Dislocations  
Keyword: Wrist  

The Impact of Coronal Alignment on Distal Radioulnar Stability Following Distal Radius Fracture  
Not a clinical study

Christopher J. Dy, MD, MSPH  
Eugene Jang, MS  
Kathleen Meyers, MS  
Samuel A. Taylor, MD  
Scott W. Wolfe, MD

**Hypothesis:** It has been theorized that malalignment of the distal radial fragment in the coronal plane may compromise radioulnar stability afforded by the distal oblique bundle of the interosseous membrane (IOM). We hypothesized that anatomic reduction of coronal alignment of a distal radius fracture will decrease distal radioulnar joint (DRUJ) displacement, particularly in specimens with a distinct distal oblique bundle of the IOM.

**Methods:** An extra-articular distal radius fracture model was created in 10 cadaveric specimens. The distal radius osteotomy was created at the level corresponding to the base of the sigmoid notch and the ulnar styloid was obliquely osteotomized at the fovea. Using a volar plate, the distal radius was secured to allow the distal fragment to be shifted radially in the coronal plane by 2-mm increments. A mechanical testing apparatus was used to apply 20 N of dorsal and volar tensile load to the distal fragment with the forearm in neutral rotation, 60° pronation, and 60° supination (Arimitsu). Dorsal-volar displacement of the radius relative to the fixed ulna was measured in a control state (distal radius anatomically reduced and the ulnar styloid fixed) and in 3 positions (anatomic reduction, 2-mm shift, and 4-mm shift) with the ulnar styloid displaced. After completion of testing, the specimens were dissected to quantify the distal oblique bundle of the IOM. Repeated-measures analysis of variance was used to compare DRUJ displacement between the testing and control states, with separate analyses conducted for specimens with and without a distinct (thickness > 0.5 mm) distal oblique bundle.

**Results:** When analyzing all specimens and comparing with control, DRUJ displacement was significantly greater after a 2-mm coronal shift of the distal fragment (P = .038) (Table 1, Fig. 1A) (neutral forearm rotation) but was not significantly different after a 4-mm shift. Similar results were seen in pronation and supination. In specimens with a distinct oblique bundle, a similar significant increase in DRUJ displacement occurred after 2-mm coronal shift occurred in neutral forearm rotation (P = .02) (Fig. 1B). Specimens without a distinct oblique bundle did not show differences in DRUJ displacement with coronal shift (Fig. 1C).

**Summary:**
- In the setting of an ulnar styloid fracture, coronal plane malalignment of the distal radial fragment causes increased DRUJ displacement. This was particularly pronounced in specimens with a distinct distal oblique bundle of the IOM.
- Based on our mechanical testing, failure to achieve anatomic alignment in the coronal plane may predispose patients who have a distinct distal oblique bundle to DRUJ instability.

**Table 1**

<table>
<thead>
<tr>
<th></th>
<th>Neutral</th>
<th>Average</th>
<th>SD</th>
<th>P (Pairwise Comparison With Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All specimens</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
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<td>4.51</td>
<td></td>
<td>Not available</td>
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<tr>
<td>0 mm</td>
<td>13.84</td>
<td>5.26</td>
<td></td>
<td>.033</td>
</tr>
<tr>
<td>2 mm</td>
<td>14.64</td>
<td>5.26</td>
<td></td>
<td>.038</td>
</tr>
<tr>
<td>4 mm</td>
<td>12.42</td>
<td>4.07</td>
<td></td>
<td>.580</td>
</tr>
<tr>
<td>With bundle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>12.19</td>
<td>3.93</td>
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<td>Not available</td>
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<td>0 mm</td>
<td>15.95</td>
<td>4.14</td>
<td></td>
<td>.038</td>
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<td>2 mm</td>
<td>17.33</td>
<td>4.37</td>
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<td>.021</td>
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<td>4 mm</td>
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<td>.098</td>
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<tr>
<td>No bundle</td>
<td></td>
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<tr>
<td>Control</td>
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<td>0 mm</td>
<td>11.73</td>
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<td>2 mm</td>
<td>11.55</td>
<td>4.71</td>
<td></td>
<td>.004</td>
</tr>
<tr>
<td>4 mm</td>
<td>10.66</td>
<td>4.93</td>
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<td>.012</td>
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</table>

**REFERENCES**
Clinical Paper Session 1: Distal Radius
Friday, October 4, 2013 • 9:35—9:41 AM
Category: Fractures and Dislocations
Keyword: Wrist

Elderly Patient Activity Level Does Not Affect Wrist Function After Distal Radius Malunion
Level 3 Evidence

Jeffrey Stepan, BS
Daniel A. Osei, MD
Ryan Patrick Calfee, MD

Hypothesis: Prior investigations quantifying the impact of distal radius malunion have categorized elderly patients by chronologic age without consideration of patient activity level. We hypothesized that high-activity elderly patients with malunited fractures would demonstrate worse functional outcome than those with anatomically united fractures.

Methods: This cross-sectional investigation enrolled 102 patients greater than 65 years of age at a minimum of 1 year after distal radius fracture. All patients returned for a study-related office visit, at which time we collected demographic and treatment data, completed standardized bilateral physical examination measures (eg, motion, grip strength), and performed bilateral wrist radiographs (neutral posteroanterior and lateral). Validated patient-rated questionnaires were collected to evaluate disability (Quick Disabilites of the Arm, Shoulder, and Hand [DASH], Visual Analog—Pain subscale [VAS-pain], and function). Patient activity level was quantified with the validated Physical Activity Scale of the Elderly Score of the Elderly scale to define high- (< n = 40) and low-activity (n = 62) groups. A fellowship-trained hand surgeon blinded to patients’ scores and examination data reviewed digitized radiographs. A difference of greater than 4 mm ulnar variance, greater than 20° tilt on the lateral radiograph, greater than 15° radial inclination, and greater than 4 mm articular gap between the fractured wrist and the uninjured contralateral wrist defined malunions. We were adequately powered statistically (α < 0.05, β = 0.80) for analysis to determine a minimally clinically relevant change on the Quick-DASH and VAS ratings (primary outcomes).

Results: A total of 49 patients (48%) healed with a malunited distal radius. High-activity patients with malunited fractures (n = 15) demonstrated equivalent QuickDASH scores, VAS function, strength, and wrist range of motion compared with those with anatomically united fractures (n = 25). High-activity malunions reported statistically but not clinically relevant increases in VAS pain scores (Table 1). Using a linear regression analysis, neither Physical Activity Scale of the Elderly score significantly predicted QuickDASH scores, VAS pain, or other measures of function.

Table 1: Comparison of High-Activity Patients With Malunions Versus Unions

<table>
<thead>
<tr>
<th></th>
<th>High Activity (PASE &gt; 150)</th>
<th>Malunion</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Union</td>
<td>Malunion</td>
<td></td>
</tr>
<tr>
<td>Age*</td>
<td>70 (5.5)</td>
<td>68 (4.3)</td>
<td>.190</td>
</tr>
<tr>
<td>Sex, females†</td>
<td>24 (96%)</td>
<td>9 (60%)</td>
<td>.007</td>
</tr>
<tr>
<td>Surgical management‡</td>
<td>12 (48%)</td>
<td>5 (33%)</td>
<td>.510</td>
</tr>
<tr>
<td>Patient-rated outcome</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QuickDASH</td>
<td>4.5</td>
<td>4.5</td>
<td>.890</td>
</tr>
<tr>
<td>VAS Pain score (0—10 cm)</td>
<td>0</td>
<td>0.5</td>
<td>.020</td>
</tr>
<tr>
<td>VAS Function score (0—10 cm)</td>
<td>0.06</td>
<td>0.140</td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-injured—injured grip, lb force†</td>
<td>−0.78 (8.33)</td>
<td>−4.5 (14.3)</td>
<td>.370</td>
</tr>
<tr>
<td>Non-injured—injured pinch, lb force‡</td>
<td>0.13 (2.01)</td>
<td>0.71 (2.7)</td>
<td>.360</td>
</tr>
<tr>
<td>Range of motion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-injured—injured pron Supination</td>
<td>−5.0</td>
<td>−8.0</td>
<td>.490</td>
</tr>
<tr>
<td>Non-injured—injured flexion-extension‡</td>
<td>−4.8 (17.0)</td>
<td>−9.0 (14.2)</td>
<td>.430</td>
</tr>
<tr>
<td>Non-injured—injured radial-ulnar deviation</td>
<td>0</td>
<td>−7.0</td>
<td>.330</td>
</tr>
</tbody>
</table>

*Normal data for high and low active, mean (SD).
†Chi-square tests.
‡Normal data for high active group only.

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• Receipt of Intellectual Property Rights/Patent Holder with: KinematX Total Wrist Arthroplasty, Extremity Medical, NJ (S.W.W.)
• ASSH Resident/Fellow Fast Track Grant (C.J.D.)

PAPER 09
Clinical Paper Session 1: Distal Radius
Friday, October 4, 2013 • 9:25—9:31 AM
Category: Basic Science—Clinical Research
Keyword: Hand

Does Osteoporosis Increase the Risk of Mechanical Failure After Locking Plate Fixation of Distal Radius Fractures?
Level 3 Evidence

Jesse B. Jupiter, MD
Nicole Steinfelder
Daniel Rikli, MD

Hypothesis: There is evidence that osteoporotic bone is a predictor for the risk of treatment complications in elderly patients; this has yet to be substantially evaluated in clinical studies. Our prospective, multicenter, observational study set out to evaluate the influence of local bone mineral density (BMD) on the rate of mechanical failure after locking plate fixation of distal radius fractures in the elderly.

Methods: A total of 249 patients (age range, 54–88 years) with a closed distal radius fracture were treated with a volar locking plate in 6 different hospitals. Clinical and radiological examinations were scheduled at 6 weeks, 12 weeks, and 1 year. All complications were reported and functional outcome of the upper limb and wrist was evaluated using the Disabilities of the Arm, Shoulder, and Hand (DASH) and Patient-Rated Wrist Evaluation (PRWE) questionnaires, respectively. Dual-energy x-ray absorptiometry measurements from the contralateral distal radius were taken at 6 weeks to assess local cancellous BMD status. For the comparative analysis of BMD and patient outcomes, all patients were categorized as either a mechanical failure or control, based on whether they experienced a defined complication (eg, loss of reduction, delayed healing, secondary screw loosening) or not during the 1-year period, respectively.

Results: The study collective was composed of 230 women and 19 men with low BMD (mean, 0.624 g/cm2). Of 249 patients, 9 had a mechanical failure (0.561 g/cm2) was similar to that for the control group (0.626 g/cm2). Functional outcome improved throughout the 1-year period, but DASH and PRWE scores did not return to pre-injury levels, which was significantly worse DASH and PRWE scores compared with the control group (P < .001).

Conclusions: The estimated risk for elderly patients with a volar locking plate—treated distal radius fracture to experience a mechanical failure complication is low, and in line with already published data. No association could be shown between BMD and mechanical failure risk. This outcome is expected in older patients with lower BMD compared with the general population, and supports the theory that factors other than BMD have a greater role in the occurrence of mechanical failure complications associated with distal radius fractures in the elderly.

• Contracted Research with: AO Foundation grant
• Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: OHK company
• Consulting Fees (eg, advisory boards) received from: OHK company
• Receipt of Intellectual Property Rights/Patent Holder with: Trimed Co.
(β = −0.003, 95% confidence interval: −0.006 to 0.000) nor malunion (β = 0.31 95% confidence interval: −0.16 to 0.78) predicted QuickDASH scores after accounting for age, sex, and treatment. Examining only fractures displaced at presentation, there were no differences between surgically (n = 46) and nonsurgically (n = 21) managed patients on any outcome measures except decreased grip strength in operatively managed patients (Table 2).

Summary:
- Distal radius malunion has minimal impact on elderly patients.
- Even among the highly active elderly, there was no difference in motion, strength, or patient-rated disability between patients with malunions and those with anatomically united fractures.
- Nonsurgical management of distal radius fractures may be appropriate for elderly patients regardless of activity level.

<table>
<thead>
<tr>
<th>Table 2: Comparisons of Displaced Distal Radius Fracture Undergoing Surgery Versus Nonsurgical Treatment*</th>
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<tbody>
<tr>
<td>Displaced Distal Radius Fractures</td>
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<tr>
<td>Surgery (n = 46) No Surgery (n = 21) P</td>
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<tr>
<td>Age</td>
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<td>Sex, females*</td>
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<tr>
<td>Malunion†</td>
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<td>Patient-rated outcome†</td>
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<tr>
<td>QuickDASH</td>
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<tr>
<td>VAS Pain score (0–10 cm)</td>
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<tr>
<td>VAS Function score (0–10 cm)</td>
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<tr>
<td>Strength</td>
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<tr>
<td>Non-injured—jogged grip strength, lb force</td>
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<td>Non-injured—jogged grip strength, lb force</td>
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<tr>
<td>Range of motion</td>
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<td>Non-injured—jogged pronosupination</td>
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<td>Non-injured—jogged flexion-extension</td>
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<tr>
<td>Non-injured—jogged radial-ulnar deviation</td>
</tr>
</tbody>
</table>

*Mean (SD).
†Chi-square tests.
§Non-normal data (median values used).

REFERENCES


● Other Financial/Material Support received from: Grant support received from Physician Services Incorporated Foundation (Nelson)

PAPER 11

Clinical Paper Session 2: Tendon—Basic Science  
Friday, October 4, 2013 • 8:45–8:51 AM
Category: Basic Science — Lab Research  
Keyword: Hand

Bone Marrow—Derived Mesenchymal Stem Cell Augmentation of Rabbit Flexor Tendon Healing

Not a clinical study

◆ Alphonso K. Chong, MD
◆ Min He, PhD
◆ Aaron Gan, MD

Hypothesis: Mesenchymal stem cell (MSC) treatment is a potential treatment option to augment tendon healing. Our hypothesis was that bone marrow–derived mesenchymal stem cells have beneficial effects on flexor tendon healing by attenuating adhesion formation and enhancing tendon regeneration.

Methods: A rabbit flexor tendon injury and repair model was used. The flexor digitorum profundus equivalent tendon in the middle of zone II was completely divided using a surgical blade. All injured tendons were repaired with a prolene 5–0 suture under loupe magnification using a modified Kessler’s repair. Proximally, the tendon was divided at the common tendon origin to unload the repair. The tendon sheath was left uncut and the skin wound was closed. In the control group, 100 µL fibrin sealant was administered immediately to the site of injury. In MSC groups, 1 million autologous MSCs, 1 million allogeneic MSCs, or 4 million allogeneic MSCs were administered to the site of injury, using 100 µL fibrin sealant as a cell carrier. The rabbits were killed at 3 or 8 weeks after surgery. Biomechanical testing of repaired tendons was performed. The expression of collagen I was studied by immunohistochemistry and the range of motion of the digits was measured.

Results: Implantation of allogeneic or autologous MSCs did not induce evident immune response in flexor tendons. Both autologous and allogeneic MSCs increased collagen I expression 3 weeks after surgery. However, MSC implantation did not enhance the biomechanical properties of injured flexor tendons. Mesenchymal stem cell implantation at high concentration (4 million cells in 100 µL fibrin sealant) increased range of motion 3 weeks after surgery.

Summary:
- Mesenchymal stem cell implantation attenuated adhesion formation at the early stage of flexor tendon healing in this animal model.
- Mesenchymal stem cell implantation also enhanced collagen I expression, but it did not influence the biomechanical properties of flexor tendons.
- Further studies are needed to confirm whether MSC therapy has beneficial effects on flexor tendon healing in humans.

REFERENCES

Clinical Paper Session 2: Tendon—Basic Science
Friday, October 4, 2013 • 8:55—9:01 AM
Category: Tendon
Keyword: Hand

Platelet-Rich Plasma for Flexor Tendon Repair
Not a clinical study

* Katie K. Jegapragasan, BS
* Erin M. Parsons, MS
* Jerry I. Huang, MD

Hypothesis: Autologous platelet-rich plasma (PRP) has shown promise in improving tendon healing, notably in rotator cuff and Achilles tendon repairs. We hypothesized that PRP would similarly benefit zone II flexor tendon repair in a rabbit model by increasing ultimate strength while minimizing scar tissue formation.

Methods: Thirty New Zealand White rabbits were divided into treatment with PRP (Arthrex, Naples, FL) or control groups. The flexor digitorum profundus tendons of the fourth toes in the left forepaws were incised and repaired in zone II using a 4-strand technique with 6–0 prolene. In the treatment group, 0.5 mL of autologous PRP was applied intraoperatively. Tendons were killed at 2, 4, or 8 weeks postoperatively. Five tendons from contralateral paws were incised and repaired as day 0 controls. Tendon glide was assessed with measurements of angular range of motion (ROM) over the metacarpophalangeal and proximal interphalangeal joints as well as tendon excursion. Tendons were then dissected free from the sheath and surrounding peritendinous scar. The ultimate tensile strengths were determined using a custom materials testing system. An R2000 hexapod robot (Mikrolab, Boston, MA) was used to apply tensile loads to the tendon construct until failure at a constant velocity of 0.2 mm/s. The force was recorded with an in-line LCFD-10 (Omegadyne, Sunbury, OH) load cell, with a reported accuracy of ±0.067 N. A 1-way analysis of variance was carried out on excursion, ROM, and ultimate strength. Categories with P < .050 were further analyzed with Tukey’s honestly significant difference.

Results: The tendency strength increased significantly in the control and PRP groups between 4 and 8 weeks (P = .002 and P = .004). No significant differences existed between time points or treatment groups for excursion (P = .300), metacarpophalangeal ROM (P = .970), proximal interphalangeal ROM (P = .880), or total ROM (P = .770). There was a trend toward lower tensile strength at 2 weeks and higher ROM and excursion at 8 weeks in the PRP group, but these were not statistically significant. There was no significant difference in ultimate tensile strength between the control and PRP groups at 2 weeks (P = .990), 4 weeks (P = 1), or 8 weeks (P = .980).

Summary:
- Platelet-rich plasma did not have a significant effect on the ultimate strength, excursion, or ROM in a rabbit flexor tendon model, with no difference at 2, 4, or 8 weeks.
- In contrast to published studies on tendon repair, PRP did not seem to enhance intrinsic tendon healing or minimize scar formation in flexor tendon repair.

<table>
<thead>
<tr>
<th>Table 1: Biomechanical Measurement Results</th>
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<tr>
<td><strong>Group/measure</strong></td>
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<tr>
<td><strong>Excursion, mm</strong></td>
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<tr>
<td>Excursion, mm</td>
</tr>
<tr>
<td>Range of motion (MP), degrees</td>
</tr>
<tr>
<td>Range of motion (total)</td>
</tr>
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</table>
PAPER 14

Clinical Paper Session 2: Tendon—Basic Science
Friday, October 4, 2013 • 9:15 – 9:21 AM
Category: Basic Science—Lab Research
Keyword: Hand

Hypoxia Drives Tenocyte Differentiation
Not a clinical study

Rowena McBeath, MD, PhD
Andrzej Fertala, PhD
Makarand Risbud, PhD
Irving Shapiro, PhD
Lee Osterman, MD

Hypothesis: Oxygen content in connective tissues varies. At the tendon—bone interface, oxygen levels are low. Interestingly, human tenocytes lose their phenotype when cultured repeatedly in normal (normoxic) oxygen tension in vitro. Given the low oxygen levels in the region of the tendon as it joins the enthesis in vivo, we hypothesized that oxygen content may be responsible for tendon cell differentiation in vitro. Furthermore, given that oxygen levels affect activity of the Rho family of small GTPases, we hypothesized that oxygen tension drives tenocyte differentiation through differential activity of RhoA and Rac1 GTPase.

Methods: Normal and dedifferentiated human tendon cells were grown in normoxic (atmospheric) and hypoxic (1%) oxygen concentrations. Cells were harvested at varying times and analyzed for markers of tenocyte differentiation by immunofluorescence and reverse-transcription—polymerase chain reaction of collagen I, tenomodulin, and scleraxis. Cells were also harvested for RhoA and Rac1 activity to examine whether the Rho family of small GTPases affected the differentiation choice. Pharmacologic inhibition of RhoA or Rac1 activity was performed via administration of the ROCK inhibitor Y-27632 or Rac1 inhibitor NSC23766 to tenocytes in normoxic conditions.

Results: Human tenocytes grown in normoxic conditions dedifferentiated in culture, whereas those grown in hypoxic conditions retained the tenocyte phenotype, as seen by collagen I immunofluorescence as well as reverse-transcription—polymerase chain reaction of collagen I, tenomodulin, and scleraxis. Interestingly, culture of dedifferentiated tenocytes in hypoxic conditions reversed the dedifferentiated phenotype, causing increased collagen I, tenomodulin, and scleraxis expression in human dedifferentiated tenocytes. Furthermore, examination of the signaling pathways responsible for tenocyte dedifferentiation revealed high Rac1 activity but low RhoA activity to be key determinants of the tenocyte differentiated state. Similarly, pharmacologic inhibition of Rac1 but not RhoA activity decreased tenogenic differentiation.

Summary:
- The differentiated state of human tenocytes is maintained in a low oxygen environment, such as that which exists in the joint or the tendon—bone interface (enthesis).
- Human tenocytes dedifferentiate when grown in normoxic conditions.
- Dedifferentiated tenocytes regain their phenotype when grown in hypoxic conditions.
- High Rac1 and low RhoA activity is necessary for tenocyte redifferentiation to occur.
- Knowledge of the intracellular signaling pathways required for tenocyte differentiation lends insight to tissue engineering strategies for tenocyte propagation, and thus tendon regeneration.

REFERENCES

Contracted Research: Multiple federal grants (J.C.)
Royalties/Honoraria received from: grant from VA Rehabilitation Research and Development Merit Review Grant (C.W.); Elsevier (J.C.)
Consulting Fees (eg, advisory boards) received from: Tendon Bone Innovations; Zone 2 Surgical (J.C.)
Intelectual Property Rights/Patent Holder: Patent for Decellularized Tendon-Bone Constructs (J.C.)
Other Financial Relationships: Grant support received from VA RR&D Merit Review Grant VA-FF4382R (A.K.)

PAPER 15

Clinical Paper Session 2: Tendon—Basic Science
Friday, October 4, 2013 • 9:25–9:31 AM
Category: Basic Science—Lab Research
Keyword: Hand

Decellularized Human Tendon—Bone Grafts for Composite Flexor Tendon Reconstruction
Not a clinical study

Paige M. Fox, MD, PhD
Simon Farnebo, MD, PhD
Derek P. Lindsey, MS
Julia Chang
Taliah Bosque, MD
James Chang, MD

Hypothesis: Restoration of biomechanical strength after surgical reconstruction of tendon insertion tears is challenging because these injuries typically heal as fibrous scars. In addition, tendon injuries or tendon loss along the entire flexor tendon sheath creates a challenge for hand surgeons. We hypothesized that decellularized human flexor digitorum profundus (FDP) and distal phalanx tendon—bone grafts could be used as a potential option for flexor tendon reconstruction by replacing the entire injured zone. We hypothesized that tendon, bone, and tendon—bone interface strength would remain comparable to native constructs and would exceed the strength necessary for postoperative rehabilitation.

Methods: Paired human cadaver forearms were dissected to obtain the FDP tendon with an attached block of distal phalanx. Tendons were then pair-matched from each arm and digit and divided into 2 groups: decellularized (group 1) and untreated (group 2). Grafts in group 1 were subjected to physiochemical decellularization according to a previously described protocol. Pair-matched tendons, decellularized and untreated, were placed back into the flexor tendon sheath. Distally, the distal phalanx bone block was secured to the host distal phalanx using a tie-over button. Proximally, the FDP was woven into the flexor digitorum superficialis tendon in the distal forearm. Each construct was cycled and then pulled to failure on a custom rig using a materials testing system. The strength (ultimate failure load) of repair, stiffness, and location of failure were determined. Statistical analysis was completed using paired Student’s t-test.

Results: Decellularized tendon—bone grafts in group 1 demonstrated no significant difference in ultimate failure load compared with untreated grafts.
Experimental Study in Rats
Keyword: Hand
Category: Basic Science
Friday, October 4, 2013

Results: Data was performed using a paired Student t-test. At 12 weeks, both TBI grafts and pullout repairs had regained stiffness equal to native tissue (18.5 ± 5.1 and 16.6 ± 3.9 N/mm², P = .380 vs 18 N/mm² native). Histology showed a more organized extracellular matrix in the TBI graft group at the early time points. Repopulation of the decellularized grafts increased over time. At 12 weeks, the insertion point was richly populated with morphology similar to that in the native tissue.

Summary:
- Decellularized TBI grafts are stronger (UFL) compared with conventional pullout repairs at 2 and 4 weeks.
- Decellularized TBI grafts and pullout repairs are as strong as and have stiffness equal to native tissue after 12 weeks.
- A more organized extracellular matrix and different collagen composition in the early time points may explain the differences in strength at early time points.
- In the future, tissue-engineered TBI grafts may be used to repair complex TBI tears in the flexor tendon, as well as other tendon and ligament injuries in the hand.

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PAPER 16
Clinical Paper Session 2: Tendon—Basic Science
Friday, October 4, 2013 ● 9:35—9:41 AM
Category: Basic Science—Lab Research
Keyword: Hand

Reconstruction of the Tendon—Bone Insertion Is Stronger With Decellularized Tendon—Bone Composite Grafts
Compared to Conventional Pullout Repairs—An Experimental Study in Rats
Not a clinical study

Simon Farnebo, MD, PhD
Colin Y. L. Woon, MD
Maxwell Y. Kim, BS
James Chang, MD

Hypothesis: Flexor tendon injuries involving the tendon—bone insertion (TBI) are difficult to address. Standard techniques typically lead to diminished strength of the healed insertion site. We hypothesized that these injuries would benefit from being reconstructed with decellularized composite grafts. To test this hypothesis, decellularized composite grafts (TBI grafts) were compared with conventional pullout repairs in an in vivo animal model.

Methods: Forty-eight Wistar composite TBI grafts (Achilles—calcaneus tendon insertion) were harvested. Grafts were physicochemically decellularized according to a previously described protocol. Tendon—bone insertion graft and pullout reconstructions of Achilles tendon detachment from the calcaneus insertion were compared using a pair-matched design (Figs. 1, 2). The ultimate failure load (UFL), ultimate tensile stress (UTS), and stiffness were evaluated using a materials testing system at 2, 4, 8, and 12 weeks. Histological analysis of insertion morphology and cellular infiltration was evaluated after death. Statistical analysis of biomechanical data was performed using a paired Student’s t-test.

Results: There was a significant increase in UFL (35 ± 11 vs 24 ± 7 N; P = .030) and UTS (1.5 ± 0.3 vs 1.0 ± 0.4 N/mm²; P = .030) of the TBI grafts compared with pullout repairs at 2 weeks. These differences remained at 4 weeks; UFL (54 ± 17 vs 43 ± 19 N; P = .046), UTS (2.9 ± 1.0 vs 2.0 ± 0.7 N/mm²; P = .030). At 12 weeks, both TBI grafts and pullout repairs were as strong as native tissue UFL (75 ± 16 and 65 ± 19 N, P = .250, vs 76 N native), although with a decreased relative strength: UTS (4 ± 1.6 and 2.8 ± 0.7 N/mm², P = .040 vs10 N/mm² native). At 12 weeks, both TBI grafts and pullout repairs had regained stiffness equal to native tissue (18.5 ± 5.1 and 16.6 ± 3.9 N/mm², P = .380 vs 18 N/mm² native).

Summary:
- Decellularized TBI grafts are stronger (UFL) compared with conventional pullout repairs at 2 and 4 weeks.
- Decellularized TBI grafts and pullout repairs are as strong as and have stiffness equal to native tissue after 12 weeks.
- A more organized extracellular matrix and different collagen composition in the early time points may explain the differences in strength at early time points.
- In the future, tissue-engineered TBI grafts may be used to repair complex TBI tears in the flexor tendon, as well as other tendon and ligament injuries in the hand.
Proximal radioulnar synostosis after elbow injuries can produce debilitating contractures. 1–3 The arc of pronation-supination required for performing many activities of daily living is 100°: 50° of both pronation and supination. 4 We hypothesized that excision of heterotopic bone and anconeus flap interposition could restore and maintain at least 100° of pronation-supination in patients with proximal radioulnar synostosis.

Methods: A retrospective database review from 1997 to 2011 was performed to identify patients treated with proximal radioulnar synostoses. Patients were subdivided into 2 main categories based on etiology; after biceps tendon repair or repair of complex proximal forearm trauma. All patients underwent excision of the synostosis through a posterior approach as described by Pankovich, 5 and interposition of an anconeus flap. Clinical follow-up and motion assessment were performed by the operative surgeon. Student’s t-test was used to compare mean motion preoperatively and postoperatively.

Results: A total of 25 patients (16 male and 9 female) were included, with a mean age of 46 years and mean clinical follow-up of 33 months. Mean arc of motion improved from 19° to 127°, pronation increased from 11° to 64°, and supination increased from 8° to 62° (P < .0001) (Fig. 1). Patients with biceps tendon rupture (n = 8) had larger but not significantly greater improvements than those with a traumatic etiology (n = 17) (Fig. 2). Complications included hematoma formation in 3 patients, 2 of whom required operative evacuation. Summary:

- Anconeus interposition flap for management of proximal radioulnar synostosis produces significant and reliable clinical improvement in elbow arc of motion, pronation, and supination (P < .001).
- Consistent with previous reports, 5 patients with biceps tendon rupture etiology had a trend toward greater motion improvements than those with a traumatic etiology, while having a lower incidence of complications.
- The degree of improvement seen would provide near-full restoration of functional motion and minimal limitations in activities of daily living. 4

REFERENCES

- Contracted Research with: Auxilium Pharmaceuticals, Inc.
demographics, workers’ compensation claims, onset of symptoms, duration of symptoms, resolution of symptoms, and treatment modalities were recorded. Mean follow-up was 21 months for TSA, 15 months for RSA, and 12 months for RCR. Descriptive statistics were calculated.

**Results:** Postoperatively, 10.5% of TSA, 9.2% of RSA, and 3.4% of RCR patients were diagnosed with DPN. The incidence of DPN was significantly higher for shoulder arthroplasty (TSA/RSA) compared with RCR, but there was no difference between the types of arthroplasty. Patient age, sex, and workers’ compensation claim did not correlate with DPN. The most common form of neuropathy was CubTS/CTS for TSA, CubTS for RSA, and CTS for RCR. After nonsurgical treatment, complete symptom resolution occurred in 50% of TSA patients at a mean of 197 days, 50% of RSA patients at a mean of 255 days, and 65% of RCR patients at a mean of 129 days. However, 17% of TSA patients with DPN, 13% of RSA patients with DPN, and 12% of RCR patients with DPN required surgical treatment of their neuropathy. Eighty percent of the patients undergoing surgical decompression had complete resolution of symptoms.

**Summary:**
- Patients undergoing TSA, RSA, or RCR are at risk for postoperative DPN and should be counseled about DPN as a potential complication of surgery.
- Although most DPN resolves postoperatively, a subset of patients will require surgical decompression.
- Consulting Fees (eg, advisory boards) received from: Tornier.

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**PAPER 19**

**Clinical Paper Session 3: Shoulder/Elbow**
Friday, October 4, 2013 • 10:50–10:56 AM
Category: Fractures and Dislocations
Keyword: Elbow

**A Comparison of Open Reduction Internal Fixation with Nonsurgical Treatment for Displaced Particular Articular Fractures of the Radial Head**

**Level 3 Evidence**

- Graham J. King, MD, FRCS(C)
- Ruby Grewal, MSc, MD, FRSC(C)
- Albert Yoon, MBChB

**Hypothesis:** The purpose of this study was to test the hypothesis that there is no difference in outcomes for displaced partial articular radial head fractures treated with open reduction and internal fixation (ORIF) versus nonsurgical treatment, using validated outcome measures at a minimum of 2 years postinjury.

**Methods:** We retrospectively compared patients with isolated, displaced, partial articular radial head fractures, who received either nonsurgical treatment or ORIF at our institution. Patients were followed up at a minimum of 2 years (mean, 3 y 9 mo) with the Patient-Rated Elbow Evaluation used as the primary outcome measure. Evaluation also included the Mayo Elbow Performance Score, the Quick-Disabilities of the Arm, Shoulder, and Hand, the 12-item Short Form survey, and a clinical examination for all patients, and a radiographic evaluation of the elbow in those who consented. Inclusion criteria were a partial articular radial head fracture that was displaced greater than 2 mm but less than 5 mm. Patients managed nonsurgically were encouraged to begin range of motion exercises within 1 week of injury, whereas those undergoing ORIF were treated with a minimum of 2 countersink screws and early elbow mobilization.

**Results:** The 2 groups were similar except for age and fracture displacement. Twenty-seven patients were treated nonsurgically and were reviewed at a mean of 3 years, and 30 patients were treated with ORIF and were reviewed at a mean of 4.5 years. There was no significant difference in the primary outcome measure (Patient-Rated Elbow Evaluation) between groups, but a significant difference was found in the Mayo Elbow Performance Score favoring the nonsurgical group (93 vs 86; \(P = .029\)). In the nonsurgical group, 1 patient developed complex regional pain syndrome and 1 developed heterotopic ossification of the elbow. In the operative group, there were 8 cases of heterotopic ossification and 2 instances of early hardware failure.

**Summary:**
- No significant clinical benefit with ORIF could be found compared with nonsurgical management of isolated partial articular radial head fractures with displacement greater than 2 mm but less than 5 mm.
- However, the groups were dissimilar in terms of age and fracture displacement. A well-designed randomized trial will provide more information as to the best treatment of these fractures.
- Royalties/Honoraria received from: Wright Medical Technology, Tornier Inc, Tenet Medical
- Consulting Fees (eg, advisory boards) received from: Tornier Inc., Wright Medical Technology

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**PAPER 20**

**Clinical Paper Session 3: Shoulder/Elbow**
Friday, October 4, 2013 • 11:00–11:06 AM
Category: Arthroscopy
Keyword: Elbow

**Nerve Injuries Following Elbow Arthroscopy**

**Level 4 Evidence**

- Sameer Lodha, MD
- Suhail K. Mithani, MD
- Ramesh C. Srinivasan, MD
- Marc J. Richard, MD
- Fraser J. Leversedge, MD
- David S. Ruch, MD

**Hypothesis:** A relatively low incidence of nerve injuries after elbow arthroscopy has been reported in the literature. However, multiple case reports have detailed severe nerve injuries after elbow arthroscopy. Clinical experience with these types of injuries referred to our institution suggests a higher incidence of severe nerve injury than previously reported. The purpose of this study was to survey the ASSH membership to determine the nature and distribution of nerve injuries treated after elbow arthroscopy.

**Methods:** An online survey was sent to all members of the ASSH under an institutional review board–approved protocol. Collected data included the number of nerve injuries observed (per nerve) over a 5-year period, the type of arthroscopic procedure being performed during the injury, the portal associated with the injury, the nature of treatment required for the injury, and outcomes observed after any intervention. Responses were anonymous and results were securely compiled.

**Results:** A total of 349 responses were obtained and 190 nerve injuries were reported. The most injured nerves reported were the ulnar, posterior interosseous, and radial nerves (40%, 20%, and 18%, respectively). The procedures most commonly associated with nerve injury were debridement of osteoarthritic synovectomy, and capsular release (29%, 19%, and 16%, respectively). A significant proportion of patients with an injury required operative intervention, including nerve graft, tendon transfer, or nerve repair (22%, 16%, and 12%, respectively). Of patients who sustained an injury, 67% had limited or no recovery.

**Summary:**
- Nerve injuries are likely under-reported in the literature.
- This study indicates that the number of severe nerve injuries may be much higher than previously thought.
- With the expanding practice of elbow arthroscopy, understanding the nature and sequelae of significant complications is vital.

**REFERENCES**

Simultaneous Bilateral Versus Unilateral Carpal Tunnel Release: A Prospective Comparison of Early Functional and Economic Impact in Patients With Bilateral Carpal Tunnel Syndrome

Level 2 Evidence

Daniel A. Osei, MD
• Martin I. Boyer, MD, FRCS(C)
• Jeffrey Stepan, BS
• Richard H. Gelberman, MD
• Charles A. Goldfarb, MD
• Ryan Patrick Caffee, MD

Hypothesis: The degree of patients’ perceived impairment and loss of income during the first month after surgery would be greater in patients undergoing bilateral simultaneous carpal tunnel release (CTR) compared with patients undergoing unilateral CTR.

Methods: This prospective, dual cohort study enrolled 85 patients with electrophysiological study–confirmed bilateral carpal tunnel syndrome; all were candidates for bilateral CTR. Patients were offered a choice of either staged unilateral CTR (n = 40) or bilateral simultaneous CTR (n = 45) and completed validated patient self-rated questionnaires (QuickDisabilities of the Arm, Shoulder, and Hand [QuickDASH] and Levine Katz Symptom Severity scores) preoperatively. After surgery, patients completed a daily log rating difficulty with activities of daily living (ADLs) for the first 7 postoperative days. The QuickDASH and Levine Katz questionnaires were administered at 7 and 28 days after surgery. To determine income loss, patients completed a validated survey detailing the salary-equivalent costs of lost time at work at 28 days’ follow-up. This study was powered ($\alpha = 0.05, \beta = 0.9$) to detect a clinically meaningful difference in QuickDASH and Levine Katz scores using appropriate parametric and nonparametric analysis.

Results: There was no significant difference in DASH score between groups at baseline and 7 and 28 days’ follow-up (Table 1, Fig. 1). In addition, QuickDASH scores were significantly improved from baseline in both groups at 7 and 28 days. Mean ADL scores were not significantly different during the first week after surgery. Patients who underwent bilateral CTR had no greater levels of difficulty with activities required for independent living (bathing, dressing, eating, or self-care) at all time points (Fig. 2). A total of 27% of patients in the unilateral group required assistance with personal hygiene, compared with 36% in the bilateral group ($P = .7$). At 1 month after surgery, patients undergoing bilateral CTR demonstrated no greater number of days out of work compared with unilateral CTR patients.

Summary: Patients treated with simultaneous bilateral CTR have no greater short-term impairment compared with patients who elect to undergo unilateral CTR as part of a planned staged release.

Each groups’ DASH scores improved significantly at both 7 and 28 days compared with baseline.

When comparing performance in ADLs required for independence, patients in both cohorts demonstrated levels of impairment that were not statistically different (Table 1, Fig. 1).

Although the salary-related financial cost to patients is similar in both groups, the ultimate cost of staged unilateral CTR would likely be substantially higher because a second operation would be required.

Table 1: Mean Change in QuickDASH Score at 7 and 28 Days

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Mean Difference</th>
<th>SD</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td>QuickDASH POV1-preoperative</td>
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<tr>
<td>Unilateral</td>
<td>−4.55</td>
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<td>.923</td>
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<td>Bilateral</td>
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<tr>
<td>QuickDASH POV2-preoperative</td>
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<tr>
<td>Unilateral</td>
<td>−17.07</td>
<td>18.39</td>
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<tr>
<td>Bilateral</td>
<td>−22.88</td>
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</tbody>
</table>

Also see Figure 1.

Figure 1: Mean change in QuickDASH score at 7 and 28 days (also see Table 1).

Figure 2: Patient-reported activity of daily living log; activities required for independence.

REFERENCES

8. Gummesson C, Ward MM, Atroshi I. The shortened disabilities of the arm, shoulder and hand questionnaire (QuickDASH): validity and reliability based on responses within the full-length DASH. BMC Musculoskelet Disord. 2006;7:44.

- Contracted Research: PI on NIH grant, Barnes-Jewish Hospital Foundation (R.H.G.)
- Royalties/Honoraria received from: Medartis (Gelberman); Wolters Kluwer (R.H.G., C.A.G.)
- Ownership Interest (stocks, stock options, or options other than ownership interest excluding diversified mutual funds) with: OrthoHelix, LLC, MiMedX, LLC (M.I.B.).
- Consulting Fees (e.g. advisory boards) received from: MiMedX LLC, OrthoHelix LLC (M.I.B.)
- Other Financial Relationships: Synthes (M.I.B.)

**PAPER 22**

Clinical Paper Session 4: Value in Hand Surgery
Friday, October 4, 2013 ● 10:40—10:46 AM
Category: Nerve/Neuromuscular
Keyword: Hand

**Carpal Tunnel Syndrome: Current Trends in Diagnosis, Treatment, and Prognosis**
Not a clinical study

- Mikael Starecki, MD
- Ashley Olson, MD
- Nina Kohn, PhD
- Lewis B. Lane, MD

**Hypothesis:** Evidence supporting select AAOS carpal tunnel syndrome guidelines was not consistently from high-level studies, and some recommendations were controversial. The investigators postulated that a survey of ASSH members would provide insight into:
1. Practice patterns among surgeons treating carpal tunnel syndrome
2. The extent to which concern about medicolegal ramifications resulting from the guidelines influences practice behavior.

**Methods:** A questionnaire of 28 questions, including detailed, commonly observed clinical scenarios (demographics: 6; workup/indications: 15; prognosis: 7); was developed, pretested, and approved by institutional review board and ASSH Web site chair. Anonymous electronic survey was emailed to ASSH members. Comparisons between demographic factors and responses and between pairs of responses were made using chi-square test or Fisher’s exact test, as appropriate.

**Results:** Of 3,001 members identified as eligible, 301 were self-screened, 2,650 e-mailed surveys, and 5 declined; 714 responded within 8 weeks.
Primary specialty: orthopedics: 78.8%, plastics: 13.2%, and other: 7.7%.
Years in practice: 67.9% were greater than 10 years.
Carpal tunnel releases (CTR) performed “last year”: 0 to 25: 11.8%; 26 to 50: 17.6%; 51 to 100: 32.1%; and greater than100: 38.3%.
Questions asked:
- Is there sufficient justification to indicate CTR (in addition to classic history/exam):
  - When complete relief after cortisone injection:
    - Never/rarely: 27.9%; sometimes/usually/always: 72.1%.

- In this situation is (electrodiagnostic testing) energy-dispersive x-ray (EDX) needed ALSO:
  - Never/rarely: 46.6%; sometimes: 21.5%; usually/always: 31.9%

Association between responses to these questions, chi-square: $P < .001$ (Table 1)

**Summary:**
- Most respondents were more likely to order EDX based on AAOS Guidelines.
- A total of 57.3% were because of potential medicolegal ramifications.
- Despite guidelines recommending EDX before surgery, most reported:
  - Positive response to cortisone injection is sufficient indication for CTR
  - Use of EDX is not necessary in these cases
  - Would perform CTR in face of normal EDX, if cortisone helped completely.

**Table 1: Treatment for Carpal Tunnel Syndrome**

<table>
<thead>
<tr>
<th>Question</th>
<th>Never/Rarely</th>
<th>Sometimes</th>
<th>Usually/Always</th>
<th>Total</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. (Question 9) In addition to supporting history and examination, a cortisone injection to temporarily resolve symptoms is sufficient for indication for surgery?</td>
<td>175</td>
<td>228</td>
<td>224</td>
<td>627</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>2. (Question 11) In addition to the above, an electrodiagnostic study is also needed for indication for surgery?</td>
<td>292</td>
<td>135</td>
<td>200</td>
<td>627</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>3. People who responded never/rarely to question 11 responded to question 9 with the following frequencies.</td>
<td>62 (21.2%)</td>
<td>87 (29.8%)</td>
<td>143 (49.0%)</td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>4. People who responded to question 11 responded to question 9 with the following frequencies.</td>
<td>25 (18.5%)</td>
<td>66 (48.9%)</td>
<td>44 (32.6%)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>5. People who responded usually/always to question 11 responded to question 9 with the following frequencies.</td>
<td>88 (44.0%)</td>
<td>75 (37.5%)</td>
<td>37 (18.5%)</td>
<td>&lt;.0001</td>
<td></td>
</tr>
</tbody>
</table>

- Speaker has nothing of financial value to disclose
AAOS Guidelines: Concern about Medico-legal Ramifications?

More likely to order electrodiagnostic studies based on guidelines?

- Sometimes/Usually/Always: 64%
- Never/Rarely: 36%

If yes, is this the result of potential medico-legal ramifications created by the guidelines?

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>67%</td>
<td>33%</td>
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</table>

P < .005

REFERENCES


PAPER 23

Clinical Paper Session 4: Value in Hand Surgery
Friday, October 4, 2013 • 10:50—10:56 AM
Category: Nerve/Neuromuscular
Keyword: Hand

Revision Carpal Tunnel Surgery: A 10-Year Review of Intraoperative Findings and Outcomes

- Kristen M. Davidge, MD, MSc
- Lawrence Zieske, BA
- Gregory C. Ebersole, MSc
- Ida Fox, MD
- Susan E. Mackinnon, MD

Hypothesis: This study sought to evaluate intraoperative findings and outcomes of revision carpal tunnel release (CTR), and to identify predictors of pain outcomes.

Methods: A retrospective cohort study was performed of all adult patients undergoing revision CTR (2001–2012). Patients were classified according to whether they presented with persistent, recurrent, or new symptoms. Study groups were compared on baseline characteristics, intraoperative findings, and outcomes (strength and pain). Within each group, changes in postoperative pinch, grip strength, and pain from baseline were analyzed. Predictors of postoperative average pain were examined using both multivariable linear regression analyses and univariable logistic regression to calculate odds ratios of worsened/no change in pain.

Results: Revision CTR was performed in 97 extremities (87 patients). Symptoms were classified as persistent in 42 hands (43%), recurrent in 19 (20%), and new in 36 (37%). The recurrent group demonstrated more diabetes and a longer interval from primary CTR, and was less likely to present with pain (p1 prior CTR (P = .015) had higher odds of worsened/no change in postoperative pain. Higher preoperative pain (P = .008), use of pain medication (P = .002), and workers’ compensation (P = .033) were significant predictors of higher postoperative average pain in multivariable analyses.

Summary: Carpal tunnel surgery can have devastating consequences. Most patients improve after revision CTR, but a methodical approach to diagnosis and adherence to safe surgical principles are critical to success. Symptom classification, number of prior CTR, baseline pain, pain medications, and workers’ compensation status are important predictors of pain outcomes in this population.

REFERENCE


PAPER 24

Clinical Paper Session 4: Value in Hand Surgery
Friday, October 4, 2013 • 11:00—11:06 AM
Category: Congenital/Pediatric
Keyword: Hand

Fanconi Anaemia: Examining Guidelines for Testing All Patients With Radial Ray or Thumb Anomalies

- Anthony G. Barabas, FRCS (Plas)
- Gillian D. Smith, FRCS (Plas)

Hypothesis: Do all patients with thumb or radial ray anomalies, without a causative genetic disorder known, need referral to a geneticist (cost: £500/$752 US) or directly for peripheral blood chromosome breakage testing (PB-CBT) (cost: £282/$439 US) to screen for Fanconi Anaemia (FA), as suggested by the new United Kingdom guidelines released in 2008?

Methods: Over 3 years (January 1, 2009 to December 31, 2011), 169 patients from all departments at Great Ormond Street Hospital were tested for FA by diepopentane PB-CBT. Features that had precipitated testing in each case were examined. Over the same period, 195 new patients were referred to the congenital hand service with a new diagnosis of a thumb or radial ray anomaly, only 9 of whom were referred directly for PB-CBT.

Results: Contrary to the guidelines, only 5% (n = 9) of the 195 patients seen in the congenital hand department were referred on for PB-CBT, 1 of whom (0.005%) was positive for FA. No other patient developed FA. Adherence to the new guidelines would produce £93,000/$140,000 in costs for genetic outpatients referrals, or £52,452/$81,700 in direct PB-CBT referrals. Of the 169 patients referred for PB-CBT, 43 (25%) had upper limb anomalies. These included thumb hypoplasia (n = 17), thumb duplications (n = 14), and radial ray dysplasia (n = 11). Other features that precipitated testing were non–upper limb skeletal anomalies (n = 16), craniofacial anomalies (n = 49), short stature (n = 20), abnormal skin pigmentation (n = 39), visceral abnormalities (n = 20), and blood dyscrasias/anemia (n = 40).

Of the 169 patients, 13 (8%) were positive for FA. Three FA positive patients had upper limb anomalies: 1 with bilateral radial ray dysplasia and 2 with thumb duplications (1 bilateral and 1 unilateral). However, all 3 patients had other serious visceral, skeletal, or hematological anomalies, all of which were features found to have a far greater association with FA than upper limb anomalies (hand anomaly: 23%; microcephaly: 31%; short stature: 31%; consanguinity: 39%; renal/cardiac abnormalities: 46%; abnormal skin pigmentation: 46%; and blood dyscrasias: 62%).

Conclusions: None of the 13 positive FA patients had an isolated upper limb anomaly in the absence of other FA features. The guidelines add considerable extra cost to patients with thumb or radial ray anomalies, and add significant financial and clinical service implications. This study does not support FA testing for isolated radial ray or thumb anomalies in the absence of other concerning features.

REFERENCES

Results of Treatment of Delta Triphalangeal Thumbs by Excision of the Extra Ossele

Hypothesis: We aimed to examine the results of treatment of delta triphalangeal thumbs by excision of the delta ossicle alone. We hypothesized that these thumbs would have good range of motion (ROM) and no pain at the interphalangeal (IP) joint in the long term.

Methods: We retrospectively reviewed charts to identify study patients who had Woods type I delta triphalangeal thumbs, and who underwent treatment by excision of the extra ossicle. These patients were then called in prospectively for examination, measurement of ROM, and radiographs.

Results: We identified 21 thumbs in 14 patients. All patients but 1 who had bilateral thumb involvement were treated at the same surgery. The average age at surgery was 26 months (range, 5 to 69 mo). Seven patients had an additional congenital anomaly that minorly affected the surgical thumb. Only 2 patients had tip radial angulation preoperatively, averaging 52°. The other 19 thumbs were deviated tip ulnarily with an average preoperative angulation of 40° (range, 20° to 85°). All patients had an IP pin placed for an average of 4.5 weeks, and 16 thumbs had collateral ligament repair at the time of surgery. The average follow-up was 4.7 years (range, 1 mo to 17 y). Average ROM at final follow-up was less than 1° extension (range, 0° to 5°) to 52° flexion (range, 20° to 82°). Average clinical angulation was less than 1° (range, 0° to 10°) and average radiographic angulation was 6° (range, 0° to 25°). There were no reports of pain and 1 patient had persistent IP instability.

Summary: Delta triphalangeal thumbs treated by excision of the extra ossicle can be expected to yield good results with acceptable thumb IP ROM and no pain. Clinical appearance of the thumb with regard to angulation tends to be superior to radiographic findings.

In Apert Syndrome Is Timing of Surgical Release of Third Web Syndactyly Important?

Hypothesis: Kim et al1 postulated that delayed release of the complex syndactyly of the third web in Apert syndrome patients causes compression on epiphyses, with early epiphyseal closure, leading to symphalangism and reduced capitapit ossification. Those authors examined 7 patients. We wanted to see whether we could demonstrate this in a larger set of patients.

Methods: We reviewed radiographs of 44 patients (77 hands) with Apert syndrome admitted to our department, between 1992 and 2012 for syndactyly release. Patients underwent surgical release in a staged fashion with the third web release left until last. Using the same methodology, we measured the size of the capitapit ossification center relative to that of the hamate and determined the relative position of the middle finger metacarpal relative to the ring finger metacarpal. We compared each Apert syndrome hand with 3 different hands with an age- and sex-matched control of healthy children whose radiographs were taken after minor trauma.

Results: In all of our patients, the middle finger metacarpal radiologically migrated proximally, applying pressure on the carpalts. There was a delay in ossification of the capitapit in particular, with catch-up growth after release of the third web. We also noted the timing of the radiological appearance of symphalangism and fourth/fifth metacarpal synostosis and incidence of abnormal radial angulation of the index finger and the little finger ulnarily. Capito-hamate fusion and a diamond-shaped configuration were common among our patients, and we believe that there may be a correlation with delayed release of the third web syndactyly.

Summary: Consistent findings of delayed ossification of the capitapit and evidence of proximal migration of the third metacarpal, taken together with...
the appearance of catch-up growth after surgical release, add support to the hypothesis that retention of complex syndactyly of the third web in these patients creates pressure on the epiphyses that produces a risk of premature closure. Accordingly, we speculate that we need to consider earlier release of the third web.

REFERENCE


PAPER 27

Clinical Paper Session 5: Congenital/Pediatric
Friday, October 4, 2013  •  1:20–1:26 PM
Category: Congenital/Pediatric
Keyword: Hand

The Transverse Bone in Cleft Hand: A Case Cohort Analysis of Outcome After Surgical Reconstruction

Level 4 Evidence

◆ Alexander W. Aleem, MD
◆ Lindley Wall, MD
◆ Jennifer Steffen, BA
◆ Mary Claire Manske, MD
◆ Charles A. Goldfarb, MD

Hypothesis: A transverse bone in cleft hand is associated with a worse aesthetic and functional outcome compared with hands without a transverse bone.

Methods: This is a retrospective review of 23 hands in 18 patients after surgical reconstruction of cleft hand. Eleven hands had a transverse bone component (transverse phalanx or bifid metacarpal) and 12 hands did not. Patients and their families were contacted to assess overall satisfaction after reconstruction. Clinical and radiographic records were reviewed to assess aesthetic and functional outcomes, the need for additional surgery, and radiographic divergence angles. Statistical analysis was performed on all on objective data collected comparing the 2 groups. Chi-square variable was used for dichotomous variables, and Student’s t-test was used for continuous variables. P < .05 was used for statistical significance.

Results: The average age at reconstruction was 15 months for the transverse bone group versus 20 months for the nontransverse group. There was no difference in aesthetic or functional postoperative outcomes. Five hands (2 transverse) continued to use the cleft for pinching. Eleven hands (5 transverse) had abnormalities of the index MP joint. Eleven hands (4 transverse) required additional surgery to address abnormal function or posture of the index and ring fingers. Preoperative radiographic divergence angles were larger in the transverse bone group (37° and 45°) versus the nontransverse group (31° and 32°), whereas postoperative divergence angles were nearly equivalent. There was no statistically significant difference in any objective outcome measure between groups.

Summary:

◆ The presence of a transverse bone in a cleft hand was not associated with worse aesthetic or functional outcomes.
◆ Early excision of the transverse bone may prevent worsening of the deformity.
◆ Preoperative narrowing of the thumb web space and postoperative index finger MP abnormality are associated with worse functional outcomes.

REFERENCES


Table 1:

<table>
<thead>
<tr>
<th>Patient</th>
<th>Transverse Bone?</th>
<th>Side</th>
<th>Type</th>
<th>Functional limitations</th>
<th>Primary Pinch</th>
<th>Cleft Use Postoperatively?</th>
<th>Index Finger MP Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N</td>
<td>R</td>
<td>I</td>
<td>None</td>
<td>Thumb/index</td>
<td>None</td>
<td>Normal</td>
</tr>
<tr>
<td>2</td>
<td>Y*</td>
<td>L</td>
<td>II</td>
<td>None</td>
<td>Thumb/index</td>
<td>None</td>
<td>Normal</td>
</tr>
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<td>3</td>
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<td>R</td>
<td>II</td>
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<td>Normal</td>
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<td>4</td>
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<td>R</td>
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<td>Basketball</td>
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<td>7</td>
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<td>R</td>
<td>IIB</td>
<td>None</td>
<td>Thumb/index</td>
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<td>Limited flexion at MP</td>
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<tr>
<td>8</td>
<td>Y</td>
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<td>Difficulty with coins, snaps, tying shoes</td>
<td>Thumb/index</td>
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</tr>
<tr>
<td>9</td>
<td>Y</td>
<td>L</td>
<td>I</td>
<td>Difficulty with coins, snaps, tying shoes</td>
<td>Thumb/index with ring for stabilization</td>
<td>None</td>
<td>Laxity at MP</td>
</tr>
<tr>
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<td>III</td>
<td>None</td>
<td>Thumb/index</td>
<td>None</td>
<td>Radial deviation at MP</td>
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<td>IIB</td>
<td>None</td>
<td>Thumb/index</td>
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<td>12</td>
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<td>14</td>
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*Bifid metacarpal.

◆ Speaker has nothing of financial value to disclose
### Nontransverse Bone Group

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<tr>
<th>Patient</th>
<th>Side</th>
<th>Preoperative Final</th>
<th>Postoperative Final</th>
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</table>

Average: 31.17 \( P = .013 \) 32.15 \( P = .004 \)

*Bi metacarpal.

### Transverse Bone Group

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<thead>
<tr>
<th>Patient</th>
<th>Side</th>
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Average: 37.15 \( P < .001 \) 45.14 \( P < .001 \)

*Bi metacarpal.

### REFERENCES

PAPER 29

Clinical Paper Session 6: Nerve
Friday, October 4, 2013 • 1:40–1:46 PM
Category: Nerve/Neuromuscular
Keyword: Hand

Use of Peripheral Nerve Transfers in Tetraplegia: Case Series and Preliminary Results
Level 4 Evidence

Kristen M. Davidge, MD
Christine B. Novak, PT, MS
Lorna C. Kahn, PT
Susan E. Mackinnon, MD
Ida K. Fox, MD

Hypothesis: Adaptation and use of traditional tendon transfers to improve upper extremity function in cervical spinal cord injury (SCI) patients is limited. We hypothesized that the novel use of peripheral nerve transfers in this setting is feasible and has a low perioperative complication profile.

Methods: A prospective clinical outcomes study design was used. After approval from our institutional ethics review board, all patients with cervical SCI referred for assessment of upper extremity dysfunction by the Physical Medicine and Rehabilitation Service were recruited for inclusion. Patients were observed for at least 3 months after initial evaluation. Demographic and medical data (SCI level, comorbidities, previous procedures, and baseline function) were collected. Physical examination and electrodiagnostic testing were performed to establish suitability for possible nerve transfer procedures. Patients meeting all criteria for a nerve transfer procedure were invited to participate in the study. Data regarding the results of intraoperative nerve stimulation, procedure performed, and postoperative complications were collected.

Results: A total of 14 patients (13 male and 1 female) were referred by the Physical Medicine and Rehabilitation Service (12-mo study period) and 11 were candidates for nerve transfer. To date, 7 patients have had surgical treatment (mean age, 28 ± 9.9 y; mean time from SCI injury, 5.1 ± 5.2 y) (Table 1). One patient underwent staged bilateral procedures, for a total of 8 extremities treated. Figure 1 shows a representative schematic of the surgery. All patients had intact volitional biceps and brachialis (with or without brachioradialis) to power elbow flexion and no volitional hand function. The nerve to the brachialis muscle was used as the expendable donor in all cases. Recipient nerves included the anterior interosseous nerve, to restore volitional prehension, as well as nerve branches to the flexor carpi radialis and flexor digitorum superficialis. Two patients underwent additional nerve transfers: 1 had supinator to extensor carpi ulnaris; the second had deltoid to triceps. Table 1 presents the procedure(s) performed and complications. No patients had loss of baseline upper extremity function. Four patients had perioperative complications, all of which resolved.

Summary:
- Nerve transfers provide a means to reestablish volitional control of hand function in people with cervical-level SCI.
- This surgery does not downgrade existing function, uses expendable donor nerve, and has minimal perioperative down time for patients, which might make it a more viable option than traditional tendon transfers for tetraplegia.

Table 1: Patient Demographic, Surgical, and Postoperative Data

<table>
<thead>
<tr>
<th>Patient/Extremity</th>
<th>Time Since SCI</th>
<th>Nerve Transfer(s) Done</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/Left 22 1</td>
<td>1</td>
<td>Brachialis to AIN</td>
<td>Minor; hypesthesia</td>
</tr>
<tr>
<td>1/Right 22 1</td>
<td>1</td>
<td>Brachialis to AIN</td>
<td>Minor; hypesthesia</td>
</tr>
<tr>
<td>2/Right 31 10</td>
<td>FCR/FDS</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>3/Left 15 3</td>
<td>Exploration; no transfer done</td>
<td>Insufficient donors available</td>
<td></td>
</tr>
<tr>
<td>4/Left 47 &lt; 1 (7 mo)</td>
<td>FCR deltoid to triceps</td>
<td>Major systemic; urosepsis (1 wk postoperatively)</td>
<td></td>
</tr>
<tr>
<td>5/Right 22 1.5</td>
<td>Brachialis to ECU</td>
<td>Minor; seroma (drained in office)</td>
<td></td>
</tr>
<tr>
<td>6/Right 28 12</td>
<td>Brachialis to FCR</td>
<td>Major systemic; prolonged stay owing to concern for urinary tract infection Minor; parasthesia thumb</td>
<td></td>
</tr>
</tbody>
</table>

AIN, anterior interosseous nerve; FCR, flexor carpi radialis; FDS, flexor digitorum superficialis; ECU, extensor carpi ulnaris.

Patient number, operative extremity, age at time of surgery, time since initial spinal cord injury, surgical procedure with specific nerve transfer(s) performed, and postoperative complications (minimum follow-up of 3 mo postsurgery) are listed.

PAPER 30

Clinical Paper Session 6: Nerve
Friday, October 4, 2013 • 1:50–1:56 PM
Category: Nerve/Neuromuscular
Keyword: Hand

The Supercharge End-to-Side Anterior Interosseous to Ulnar Motor Nerve Transfer for Restoring Intrinsic Function: Clinical Experience
Level 4 Evidence

Kristen M. Davidge, MD
Susan E. Mackinnon, MD

Hypothesis: To review our initial clinical experience with the supercharge end-to-side anterior interosseous to ulnar motor nerve (SETS) transfer, and to refine our indications for this technique.

Methods: A retrospective cohort study was performed of all patients undergoing the SETS procedure between August 2009 and December 2012. Preoperative (diagnosis, comorbidities, clinical presentation, and electrodiagnostic findings) and intraoperative data were reviewed and related to clinical successes and failures with regard to recovery of ulnar intrinsic function. General functional outcomes, including strength, pain, and Disabilities...
of the Shoulder, Arm and Hand questionnaire, were also documented. Pre- and post-comparisons were performed using paired t-tests.

**Results:** A total of 62 patients (71% male; mean age at surgery, 48.0 ± 17.8 y) underwent the SETS procedure. Diagnoses were varied, but all patients presented with clinically significant ulnar intrinsic weakness and electrodiagnostic evidence of acute or chronic denervation of the first dorsal interosseous muscle. The SETS transfer was performed at a mean distance of 8.1 ± 1.1 cm from the wrist crease. Of 42 patients, 32 (76%) with adequate follow-up demonstrated recovery of ulnar intrinsic function at a mean of 5.3 ± 2.7 months postoperatively. In 7 patients undergoing concomitant ulnar nerve decompression, intrinsic recovery was too rapid to be attributable to the SETS procedure. Failures of the SETS procedure were most commonly seen in patients in whom the anterior interosseous nerve had also been injured.

**Summary:** The SETS transfer is a useful technique for augmenting intrinsic muscle function for second- and third-degree axonometric (in-continuity) lesions of the ulnar nerve. The best probability of success is seen in patients with acute ulnar nerve injuries with an intact, uninjured donor nerve. Clinical determination of the proportion of intrinsic recovery attributable to the SETS transfer is challenging, and perhaps may be only confirmed by electrophysiologic evaluation in future studies.

**REFERENCES**


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**PAPER 31**

**Clinical Paper Session 6: Nerve**

**Friday, October 4, 2013 • 2:00–2:06 PM**

**Category: Tendon**

**Keyword: Shoulder**

**Contralateral Trapezius Transfer in Patients With Brachial Plexus Injuries to Restore Shoulder Function**

*Level 4 Evidence*

**Eric Wagner, MD**

**Bassem T. Elhassan, MD**

**Hypothesis:** The purpose of this study was to evaluate the outcome for contralateral trapezius transfer to restore shoulder external rotation in patients with brachial plexus injuries.

**Methods:** Nine patients were included in this study. All patients had a history of persistent shoulder paralysis as a result of traumatic brachial plexus that failed to recover spontaneously or after nerve reconstruction. Furthermore, these patients all had compromised ipsilateral lower trapezius muscle as a result of either the original trauma or prior spinal accessory nerve transfer. Indications for surgery included weakness in shoulder external rotation resulting in marked activity limitations, as well as some degree of shoulder pain from instability. On physical examination, all patients had internal rotation contractures with no active external rotation, whereas most also demonstrated significant loss of shoulder abduction and flexion. Each patient underwent contralateral lower trapezius transfer prolonged with lumbar fascia to the ipsilateral infraspinatus tendon. The shoulder was then immobilized in external rotation with shoulder spica cast for 8 weeks; active assisted range of motion was performed for 6 weeks, followed by progressive strengthening for 8 weeks and unrestricted activities after 6 months.

**Results:** At an average follow-up of 23 months, all patients had significant improvement of active shoulder external rotation from no motion preoperatively (ie, no ability to move the hand away from the abdominal level) to 20° external rotation (ie, 110° from the abdomen) postoperatively (*P < .01*). Seven of 9 patients reported pain levels as moderate or severe preoperatively, whereas only 1 of 9 reported moderate or severe pain after surgery (*P < .01*). The Constant Shoulder Score improved from 24, with a relative score of 31% preoperatively, to 55, with a relative score of 60% postoperatively (*P < .01*). The shoulder subjective value was 15% preoperatively to 45% postoperatively (*P < .01*). The Disabilities of the Arm, Shoulder, and Hand score improved from 64 to 42 points (*P < .01*). All patients reported successful retraining of the transferred muscles within the first year after surgery. No patients reported any noticeable difference in function of the nonparalyzed shoulders. All patients were satisfied with the outcome of surgery and reported their shoulder as better or significantly better than preoperatively.

**Summary:** This study demonstrates that contralateral lower trapezius transfer is effective in improving ipsilateral shoulder external rotation. This transfer adds an option for tendon transfer to restore shoulder external rotation when no other ipsilateral muscle is available for transfer.

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**PAPER 32**

**Clinical Paper Session 7: Potpourri Wrist/Ligament**

**Saturday, October 5, 2013 • 8:45–8:51 AM**

**Category: Nerve/Neuromuscular**

**Keyword: Hand**

**Retrospective Study Concerning Isolated Motor Ulnar Nerve Compression at the Wrist: Diagnosis and Prognosis in 20 Cases**

*Level 4 Evidence*

**Pierre Croutzet, MD**

**Colin de Cheveigné, PhD**

**Hypothesis:** There are many types of ulnar nerve compression; among them, motor-only compression at the wrist is one of the least well known. Considering difficulty and delay in recognizing the condition, we studied the diagnostic criteria (age, clinical signs, and electromyography benefits) and the efficiency of surgical treatment.

**Methods:** We reviewed all patients operated on for isolated motor ulnar compression at the wrist over 22 years (n = 20).

**Patients included in this retrospective study were selected according to different criteria:**

- Motor ulnar nerve palsy of the first interosseous muscle always had to be present
- Associated ulnar nerve palsy at the wrist and at the elbow were excluded
- Ulnar nerve palsies with sensory symptoms were excluded
- Secondary compressions were excluded (wounds, tumors, cycling, etc)

**Analysis criteria were age, gender, time before surgery, importance of the motor palsy (ulnar claw, and segmentar strength scale [one fifth] of the first dorsal interosseous muscle and hypothenar muscles), associated factors (diabetes, smoking, and carpal tunnel syndrome), and electromyographic signs. Clinical results were evaluated with different criteria: satisfaction, pain, time and quality of strength recovery, and grasp strength.**

**Results:** There were 6 females and 14 males. The mean age was 52 years. Time before surgery was 8 months (range, 3–15 mo). Among the 20 patients, none had bilateral symptoms. 2 had an associated carpal tunnel syndrome, and 14 had no motor deficit of the hypothenar muscles. Five patients only had positive electromyographic signs that were found only when the first interosseous muscle was tested, or on selective examination of the hypothenar muscles. Mean follow-up was 6 years. Seventeen patients were very satisfied, 16 patients recovered full strength in the first interosseous muscle, 3 had only partial recovery, and 1 had no recovery. Mean time for recovery was 7 months (range, 3–15 mo).

**Summary:**

- In our study, most patients had only a partial hypothenar muscle deficit.
- Electromyography was positive only when carried out thoroughly, including the first interosseous muscle.
- Diagnosis delay was always superior to 5 months; nevertheless, 16 of 20 patients had a full recovery.
- However, the diagnostic delay was the only negative factor. Indeed, poor to bad results were found in patients with a diagnostic delay exceeding 1 year.
- In our study, clinical examination was more efficient than electromyography in diagnosing isolated motor ulnar nerve compressions at the wrist.
- The recovery score was mainly excellent (16 of 20 patients) but a diagnosis delay superior to 1 year was a negative prognostic factor.
REFERENCES

PAPER 33
Clinical Paper Session 7: Potpourri Wrist/Ligament Saturday, October 5, 2013 • 8:35—9:01 AM
Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Wrist

Reverse Wedge Osteotomy of the Distal Radius in Madelung Deformity: About 12 Cases
Level 4 Evidence

♦ Florence Mallard, MD
♦ Yann Saint Cast, MD
♦ Guy Raimbeau, MD
♦ Bruno D. Cesari, MD
♦ Fabrice Rabarin, MD

Hypothesis: Surgical procedures to improve aesthetics and function for Madelung deformity are numerous and difficult to assess because the disease is uncommon. The authors evaluated an original technique based on reverse wedge osteotomy of the distal radius in a retrospective study of 12 cases, and attempted to modelize the procedure.

Methods: Seven women with bilateral Madelung deformity were treated from 1992 to 2011. The 12 cases (5 bilateral and 2 unilateral) were reviewed with an average follow-up of 8 years (range, 7 mo to 18.9 y). Surgery was motivated by aesthetic and functional discomfort at the average age of 27 years, before any complication. Reverse wedge osteotomy was developed to reorient the radial joint surface while reducing overall radius length as little as possible. Osteotomy was performed through an antero-radial or radial approach with an average time of 106 minutes. The wedge was harvested from the excess cortical on the dorsal and radial aspect of the radius. The wedge was then removed, turned round, and put back into the osteotomy to ensure closing on cortical excess and lengthening on the opposite side. Fixation was achieved by an anterior plate. An associated osteotomy of the ulna was necessary to avoid an ulnar-cam conflict for 3 cases with severe deformity. Objective (morphology of the wrist, range of motion, and grip strength) and subjective (Quick Disabilities of the Arm, Shoulder, and Hand and Patient-Rated Wrist Evaluation) data were analyzed. Radiological settings were taken from McCarron et al. A vector model of the procedure was established to determine osteotomy angles from 2 indexes from McCarron et al. The nonparametric Wilcoxon test (α = 0.05) was used for statistical analysis.

Results: All cases achieved fusion at 3 months. Eight of 12 patients had the plate removed. There was no complication except for hypoesthesia on the radial side of the thenar eminence in 2 cases. Aesthetics and range of motion improved. Improvement was significant for flexion, pronation, and supination, as well as the radiological parameters of McCarron et al: significant correction of the palmar and ulnar deviation of the radial epiphysis, as well as rising of the lunate and palmar displacement of the carpus. Average Quick-Disabilities of the Arm, Shoulder, and Hand and Patient-Rated Wrist Evaluation scores were less than 30 out of 100 at review. All patients were satisfied aesthetically and functionally.

Summary: The corrective power of reverse wedge osteotomy is well adapted to severe Madelung deformity. Clinical and radiological results are convincing and meets patients’ expectations. Reverse wedge osteotomy has a special place among the techniques proposed so far. Vector model allows preoperative planning that should optimize realization.

REFERENCES

PAPER 34
Clinical Paper Session 7: Potpourri Wrist/Ligament Saturday, October 5, 2013 • 9:05—9:11 AM
Category: Instability
Keyword: Hand

Outcomes After Repair of Subacute-to-Chronic Grade III Metacarpophalangeal Joint Collateral Ligament Injuries in the Lesser Digits Are Poor
Level 4 Evidence

♦ Justin Carmine Wong, MD
♦ Kevin F. Lutsky, MD
♦ Pedro K. Beredjiklian, MD

Hypothesis: Injury to the metacarpophalangeal (MCP) joint collateral ligament of the lesser digits is less common than corresponding injuries in the thumb. Outcomes after thumb MCP joint collateral ligament repair are generally favorable. This study examines the outcome after primary repair of subacute-to-chronic grade III collateral ligament injuries of the MCP joints of the lesser digits. Our hypothesis was that the outcome after surgical treatment of these injuries is suboptimal.

Methods: We retrospectively reviewed all patients who underwent primary repair of a lesser digit MCP collateral ligament over a 3-year period. Postoperatively, we assessed disability outcomes using Disabilities of the Arm, Shoulder, And Hand (DASH) scores and evaluated range of motion and grip strength. These measures were compared with preoperative data to assess results.

Results: A total of 25 digits in 23 patients underwent surgical treatment of complete MCP joint collateral ligament tear. All ligaments were of sufficient quality to permit primary repair using a suture anchor. The time from injury to surgery averaged 14.2 weeks (range, 6—52 wk). Average follow-up was 21 months (range, 12—34 mo). Average patient age was 47 years (range, 17—67 y). Eighty percent of injuries involved the dominant hand. The radial collateral ligament was involved in 18 of 25 fingers (72%), with the little finger radial collateral ligament being the most common injury. The average preoperative DASH score was 45.9 (range, 17—77) in the 10 patients (11 fingers) where this was available. Intraoperative findings revealed complete tears in all cases. Collateral ligament disruption occurred at the
Hypothesis: Traditionally wrist arthroscopy consists of evaluation of both radiocarpal and midcarpal joints, but the use of midcarpal arthroscopy has not been evaluated critically in the literature. Our hypothesis was that midcarpal arthroscopy: (1) resulted in changing the preoperative diagnosis and/or (2) resulted in changing the planned procedure performed.

Methods: The study was a retrospective review from 2008 to 2013 of 66 patients who underwent 67 wrist arthroscopic procedures by 3 orthopedic hand surgeons at our institution. Patients were included only if both the midcarpal and radiocarpal joints were evaluated arthroscopically. Patients were stratiﬁed into groups based on preoperative diagnosis of scapholunate (SL) pathology, triangular fibrocartilage (TFC) pathology, or both concomitantly, based on physical exam and magnetic resonance imaging. Office notes and operative reports were used to determine whether midcarpal arthroscopy was performed: (1) resulted in changing the preoperative diagnosis and/or (2) resulted in changing the planned procedure performed.

Results: There were 40 males and 26 females in the study, with average age of 38.8 ± 12.3 years, with no signiﬁcant differences among groups (SL, TFC, or both) with regard to age or sex (P = .934 and .375, respectively). In the SL group, 11 of 23 patients had a change in diagnosis and 10 of 23 patients had a change in procedure performed. In the TFC group, 12 of 24 patients had a change in diagnosis and 4 of 24 patients had a change in procedure performed.

The group that combined both had 7 of 20 patients with a diagnosis change and 3 of 20 with a procedure change. There were no signiﬁcant differences between the groups with regard to diagnosis change (P = .570), whereas there was a signiﬁcant difference with regard to procedure change (P = .048). The surgeon was more likely to change the procedure performed for patients with a preoperative diagnosis of isolated SL pathology compared with patients with any other diagnosis preoperatively (P = .014).

Summary: In patients with suspected SL tears, performance of midcarpal arthroscopy often leads to a change in diagnosis, and also a change in procedure performed (nearly 50%). In patients with TFC pathology preoperatively, there was an equivalent change in diagnosis with only a 17% change in procedure. The performance of midcarpal arthroscopy may not be clinically relevant in patients with TFC pathology, but appears necessary in treating SL pathology. All wrist arthroscopic procedures performed for SL pathology should include an evaluation of the midcarpal joint.

REFERENCES

PAPER 35

Does Midcarpal Arthroscopy Alter Diagnosis and Treatment of Scapholunate or Triangular Fibrocartilage Injuries?
Level 3 Evidence

◆ Mark C. Shreve, MD
◆ Ajay K. Balarangam, MD
◆ Rachel Goldstein, MD
◆ Anthony Sapienza, MD
◆ Nader Paksima, DO, MPH

Hypothesis: Traditionally wrist arthroscopy consists of evaluation of both radiocarpal and midcarpal joints, but the use of midcarpal arthroscopy has not been evaluated critically in the literature. Our hypothesis was that arthroscopic evaluation of the midcarpal joint did not lead to a change in either diagnosis or procedure for certain injury patterns.

Methods: The study was a retrospective review from 2008 to 2013 of 66 patients who underwent 67 wrist arthroscopic procedures by 3 orthopedic hand surgeons at our institution. Patients were included only if both the midcarpal and radiocarpal joints were evaluated arthroscopically. Patients were stratiﬁed into groups based on preoperative diagnosis of scapholunate (SL) pathology, triangular fibrocartilage (TFC) pathology, or both concomitantly, based on physical exam and magnetic resonance imaging. Office notes and operative reports were used to determine whether midcarpal arthroscopy was performed: (1) resulted in changing the preoperative diagnosis and/or (2) resulted in changing the planned procedure performed.

Results: There were 40 males and 26 females in the study, with average age of 38.8 ± 12.3 years, with no signiﬁcant differences among groups (SL, TFC, or both) with regard to age or sex (P = .934 and .375, respectively). In the SL group, 11 of 23 patients had a change in diagnosis and 10 of 23 patients had a change in procedure performed. In the TFC group, 12 of 24 patients had a change in diagnosis and 4 of 24 patients had a change in procedure performed.

The group that combined both had 7 of 20 patients with a diagnosis change and 3 of 20 with a procedure change. There were no signiﬁcant differences between the groups with regard to diagnosis change (P = .570), whereas there was a signiﬁcant difference with regard to procedure change (P = .048). The surgeon was more likely to change the procedure performed for patients with a preoperative diagnosis of isolated SL pathology compared with patients with any other diagnosis preoperatively (P = .014).

Summary: In patients with suspected SL tears, performance of midcarpal arthroscopy often leads to a change in diagnosis, and also a change in procedure performed (nearly 50%). In patients with TFC pathology preoperatively, there was an equivalent change in diagnosis with only a 17% change in procedure. The performance of midcarpal arthroscopy may not be clinically relevant in patients with TFC pathology, but appears necessary in treating SL pathology. All wrist arthroscopic procedures performed for SL pathology should include an evaluation of the midcarpal joint.

Figure 1: Change in diagnosis and procedure for each preoperative diagnosis group, by percentage.

◆ Royalties/Honoraria received from: Stryker Orthopaedics
◆ Ownership Interest (stocks, stock options, or other ownership interest excluding diversiﬁed mutual funds) with: Small Bone Innovations (SBI)
◆ Consulting Fees (eg, advisory boards) received from: Stryker Orthopaedics, IMDS

PAPER 36
Clinical Paper Session 8: Congenital/Pediatrics Saturday, October 5, 2013 8:45–8:51 AM Category: Nerve/Neuromuscular Keyword: Wrist

Is Tendon Transfer Surgery in Upper Extremity Cerebral Palsy More Effective Than Botulinum Toxin Injections or Regular Ongoing Therapy?
Level 2 Evidence

◆ Ann E. Van Heest, MD
◆ Anita Bagley, PhD
◆ Michelle A. James, MD

Hypothesis: For children with upper extremity cerebral palsy who meet standard clinical indications for tendon transfer, those who receive surgical treatment would have greater improvement in function than either children receiving botulinum toxin injections or those receiving regular ongoing treatment, as measured by validated appropriate assessment tools.

Methods: Using a prospective randomized control trial with patient preference arm, 38 children with hemiplegic cerebral palsy, who were 5 to 15 years of age and were surgical candidates for ﬂexor carpi ulnaris (FCU) to...
extensor carpi radialis brevis transfer, pronator teres (PT) release, and extensor pollicis longus rerouting with adductor pollicis (AP) release, were prospectively randomized into 1 of 3 treatment groups: (1) surgery; treated with standard tendon transfer surgery; (2) botulinum toxin: treated with a series of 3 botulinum toxin injections to FCU, PT, and AP over a 6-month period; and (3) therapy: treated with a home therapy program and continuation of regular ongoing therapy interventions. Seven pediatric orthopedic hospitals participated. Assessment tools included the Assisting Hand Assessment, the Shriners Hospitals Upper Extremity Evaluation (SHUEE), box and blocks, pinch and grip strength, Pediatric Outcomes Data Collection Instrument, Canadian Occupational Performance Measure, and Children’s Assessment of Participation and Enjoyment. Assessment was done at entry into the study and at 6 and 12 months. Because of high rates of refusal of randomization, a patient preference option was added in 2010 to enable families to choose their child’s treatment group.

Results: For the therapy group, significant improvement in hand function as measured by the Assisting Hand Assessment was noted between baseline and 12 months. For the surgery group, significant improvement in hand function as measured by the SHUEE Dynamic Positional Analysis was noted between baseline and 12 months. The SHUEE Dynamic Positional Analysis value at 12 months was significantly greater in the surgery group than in the botulinum toxin or therapy groups.

Summary: For children with upper extremity cerebral palsy who are candidates for FCU to extensor carpi radialis brevis transfer, PT release, and extensor pollicis longus rerouting with AP release, surgical treatment provides greater improvements in upper extremity limb positioning than botulinum A toxin injections or regular ongoing therapy at 12-months’ follow-up.

This presentation will discuss Botox by Allergan
• Contracted Research: Shriners Hospitals for Children; POSNA/OREF

PAPER 37

Clinical Paper Session 8: Congenital/Pediatrics
Saturday, October 5, 2013 • 8:35—9:01 AM
Category: Congenital/Pediatrics
Keyword: Elbow

Long-Term Results Following Surgical Treatment of Elbow Deformity in Patients With Cerebral Palsy

Level 4 Evidence

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

Hypothesis: We believe that surgical treatment for elbow flexion deformity in cerebral palsy can be selected based on the degree of contracture. In this long-term study, we hypothesized that our approach to treatment would lead to enduring improvements in elbow extension and flexion angle during ambulation without compromising maximum flexion.

Methods: A total of 86 patients (90 elbows) were treated for elbow spasticity resulting from cerebral palsy. Twenty-seven patients (28 elbows) were available for long-term follow-up. Twenty-three patients with fixed elbow contractures less than 45° were treated with partial elbow muscle lengthening (biceps partial lengthening and brachialis, and brachioradialis proximal release). Four patients with fixed elbow contractures of 45° were treated with a full elbow release (biceps z-lengthening, partial brachialis myotomy, and brachioradialis proximal release). Active range of motion, passive range of motion, and elbow flexion posture during ambulation were measured at each follow-up. Longitudinal results were compared using repeated-measures analysis of variance or Friedman’s 2-way analysis of ranks, with pairwise comparisons made after Bonferroni correction for statistical significance.

Results: Follow-up averaged 113 months (range, 66–169 mo) and 124 months (range, 74–160 mo) for the partial lengthening and full elbow release cohorts, respectively. After partial lengthening, active extension and flexion posture angle during ambulation improved 12° (P < .001) and 63° (P < .001), respectively, with 8° loss of active flexion (P = .002). (Fig. 1). Active extension improved 29° after full elbow release (P = .042) in the 5 patients with long-term follow-up, but this did not meet the Bonferroni-adjusted threshold for statistical significance (Fig. 2). Post-hoc power analysis revealed this group to be underpowered to detect a statistically significant difference.

Summary: Carefully selected soft tissue releases of the anterior elbow, guided by the amount of preoperative contracture, can provide significant lasting improvements in active extension and flexion posture during ambulation in patients with cerebral palsy. Our long-term findings substantiate previously reported short-term results.

Table 1: Functional Scores at Baseline and 12 Months, Mean (SD)

<table>
<thead>
<tr>
<th></th>
<th>Box and Blocks</th>
<th>AHA</th>
<th>SHUEE SFA</th>
<th>SHUEE DPA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery</td>
<td>14.6 (8.1)</td>
<td>15.6 (5.9)</td>
<td>55.2 (8.8)</td>
<td>56.4 (8.4)</td>
</tr>
<tr>
<td>Botulinum toxin</td>
<td>11.0 (7.7)</td>
<td>10.0 (10.0)</td>
<td>48.1 (11.3)</td>
<td>49.7 (9.1)</td>
</tr>
<tr>
<td>Therapy</td>
<td>12.5 (8.0)</td>
<td>13.8 (9.3)</td>
<td>54.8 (4.7)</td>
<td>57.3 (4.6)</td>
</tr>
<tr>
<td><strong>12 mo</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery</td>
<td>14.6 (8.1)</td>
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<td>55.2 (8.8)</td>
<td>56.4 (8.4)</td>
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<td>54.8 (4.7)</td>
<td>57.3 (4.6)</td>
</tr>
</tbody>
</table>

*Difference between surgery and botulinum toxin, and between surgery and therapy, P < .01.
†Difference between baseline and 12 months, P < .01.

Figure 1: Partial lengthening (n = 23).

Figure 2: Full elbow release (n = 5 for active extension and active flexion; n = 3 for flexion posture during ambulation).

© Speaker has nothing of financial value to disclose
Does the Trapezius Play a Role During Upper Extremity Motion in Patients With Obstetrical Brachial Plexus Birth Palsy?

**Level 4 Evidence**

- Donato Perretta, MD
- Alice Chu, MD
- Viswanath Aluru, MD
- Preeti Raghavan, MD
- Alex Sher

**Hypothesis:** The purpose of this study was to determine whether the upper and lower trapezius muscles have a role during gross shoulder and elbow movements in patients with obstetrical brachial plexus birth palsy (OBBPP).

**Methods:** Eight patients with OBBPP were evaluated with simultaneous 3-dimensional motion analysis, 16-channel electromyography (EMG), and video monitoring. Age at initial presentation to our institution, history of previous treatment, including prior surgery, botulinum toxin injections and/or casting, comorbidities and other known diagnoses, and social circumstances were recorded. Mallet score and detailed neurological examination were performed. Electromyelogram data were obtained at the time of presentation. In several patients, radiographic studies and a diagnostic EMG with nerve conduction were performed as well.

**Results:** The average age was 12.2 years (range, 7.6–18.1 y). Five were female and 3 were male; 7 were affected on the left side. One patient had known denervation of the trapezius muscle as an infant during nerve transfer surgery; 2 others potentially had the surgery but did not have any available surgical records. None of the patients were in active litigation. Modified Mallet score categorization was an average of 16.3 (range, 12–22). Neurological examination classification was 6 (primarily C5-6-7 involvement); 2 (global).

Data were recorded from both the affected and unaffected sides. Movements were analyzed from the shoulder (flexion-abduction/external-external rotation) and elbow (flexion-extension/pronation-supination). With the exception of elbow flexion and extension, the total arc of motion was markedly reduced on the affected side. Electromyogram data from the unaffected side showed significant levels of activity from the upper and lower trapezius muscles during most shoulder and elbow motions. The same patterns existed on the affected side, but were diminished in patients who had trapezius inactivity.

**Summary:**
- This study reveals a significant level of EMG activity from the upper and lower trapezius muscles during gross motor movements of the affected as well as unaffected upper extremities in pediatric patients with OBBPP.
- Spinal accessory nerve transfer surgery, resulting in trapezius denervation, is one of the initial treatments for OBBPP. This may cause compensatory patterns of muscle activity.

**Table 1: Improvement in Total Arc of Motion**

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Patients, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 100</td>
<td>4 (13)</td>
</tr>
<tr>
<td>71 to 100</td>
<td>5 (16)</td>
</tr>
<tr>
<td>51 to 70</td>
<td>8 (25)</td>
</tr>
<tr>
<td>20 to 50</td>
<td>12 (38)</td>
</tr>
<tr>
<td>0 to 20</td>
<td>3 (9)</td>
</tr>
<tr>
<td>Loss of motion</td>
<td>None</td>
</tr>
</tbody>
</table>

**Table 2: Mean Range of Motion After Contracture Release, According to Etiology**

<table>
<thead>
<tr>
<th>Patients, n</th>
<th>Extension</th>
<th>Flexion</th>
<th>Total Arc of Motion</th>
<th>Improvement in Total Arc of Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex fracture-dislocation</td>
<td>10</td>
<td>11</td>
<td>135</td>
<td>125</td>
</tr>
<tr>
<td>Intra-articular fracture</td>
<td>5</td>
<td>18</td>
<td>132</td>
<td>114</td>
</tr>
<tr>
<td>Extra-articular fracture</td>
<td>11</td>
<td>10</td>
<td>136</td>
<td>127</td>
</tr>
<tr>
<td>Radial head/neck fracture</td>
<td>4</td>
<td>6</td>
<td>134</td>
<td>128</td>
</tr>
<tr>
<td>Nontraumatic contracture</td>
<td>2</td>
<td>13</td>
<td>125</td>
<td>113</td>
</tr>
<tr>
<td>Total/means</td>
<td>32</td>
<td>11</td>
<td>135</td>
<td>123</td>
</tr>
</tbody>
</table>

**REFERENCE**


- *Contracted Research with: Auxilium Pharmaceuticals, Inc.*
- *Speaker has nothing of financial value to disclose*
Hypothesis: Reliable reconstruction of nerve gaps in the hand and digits remains a challenge to the hand surgeon. This prospective study investigated the outcomes of digital nerve reconstructions using processed nerve allograft for defects measuring 5 to 30 mm.

Methods: A total of 17 patients with 21 digital nerve lacerations in the hand underwent digital nerve reconstruction with processed nerve allograft.

Outcome data for 14 patients with 18 digital nerve lacerations were available for analysis. Postoperative testing was done at regular intervals through a minimum of 12 months, with an average of 15 months. The average nerve gap measured 11 mm (range, 5–30 mm). Outcome measures included postoperative sensory examination, as assessed by Semmes-Weinstein monofilaments and static and moving 2-point discrimination. Pain was graded using a visual analog scale. In addition, patients completed the Quick—Disabilities of the Arm, Shoulder, and Hand (QuickDASH) survey preoperatively and postoperatively to qualify their pain perception and functional impairment.

Results: The Taras outcome measure was used to determine excellent, good, and fair results. Using this criterion, 8 of 18 (44%) had good results, 3 of 18 (17%) had fair results, and 7 of 18 (39%) had an excellent outcome. At 12 months, 8 of 18 (44%) had good results, 3 of 18 (17%) had fair results, and 0 of 18 (0%) had poor results. At final follow-up, average static 2-point discrimination results were 7.11 mm (range, 5–8 mm), and average moving 2-point discrimination results were 5.44 mm (range, 2–8 mm). Initial QuickDASH scores recorded at the patient’s first postoperative visit averaged 44.8 (range, 2.3–79.5), and final QuickDASH scores averaged 26.1 (range, 2.3–43.2). There were no signs of infection, extrusion, or graft reaction.

Summary: The data suggest that processed nerve allograft provides a safe and effective option for the reconstruction of peripheral sensory nerve deficits in the hand measuring up to 30 mm.

References


Speaker has nothing of financial value to disclose.
Results: The subgroup analysis for mixed/motor nerve repairs in the upper extremities included 17 subjects having 18 nerve repairs with sufficient recovery time for quantitative outcomes analysis. This subset included 14 mixed nerves in the forearm and 4 motor nerves in the upper extremities. The mean ± SD age was 39 ± 21 years (range, 18–77 y). The mean time to repair was 97 ± 160 days (0–379 d). The most common mechanism of injury was lacerations. The average gap length was 30 ± 13 mm (10–50 mm). Recovery was assessed for the intrinsic and extrinsics of the hand, biceps, deltoid, and trapezius, as well as extension and flexion of the forearm and wrist where applicable. Return of appropriate grip strength and/or range of motion were observed in 16 of the 18 nerve repairs. Seven repairs reported an M3, 5 reported an M4, and 4 reported an M5. There were no reported adverse events related to the nerve allograft.

Summary:
- Processed nerve allografts provided functional motor recovery when used for mixed and motor nerve repairs in the upper extremity in gap lengths between 10 and 50 mm.
- Outcomes compare favorably with historical controls from available literature for nerve autograft.
- Continuation of this study will provide additional clinical evidence on the expanding role of processed nerve allografts in these repairs.

REFERENCES

PAPER 42
Clinical Paper Session 9: Nerve/Microsurgery
Saturday, October 5, 2013 • 9:05–9:11 AM
Category: Vascular/Microvascular
Keyword: Hand

Onycho-Osteocutaneous Defects of the Thumb Reconstructed by Partial Toe to Hand
Level 4 Evidence

◆ Francisco Del Piñal, MD
◆ Eduardo Moraleda, MD
◆ Guillermo H. De Piero, MD
◆ Carlos Galindo, MD
◆ Jaime S. Ruas, MD

Hypothesis: To present our experience in very distal thumb amputations reconstructed by partial toe to hand, with special emphasis on manual workers.

Methods: A total of 25 patients who had amputation of the thumb distal to the interphalangeal (IP) joint, excluding pure soft tissue losses, were included in the study. Except for 3, all were manual workers. All were reconstructed in less than 2 weeks after the accident (most in less than 48 h), except for 5 who were referred late. The bony defect varied from just the tuft of the phalanx to most of the distal phalanx. In 3 cases, the IP joint had an associated fracture that was treated concomitantly, and in all the IP was reconstructible. The toes were based on the proper digital artery (18 cases), an associated fracture that was treated concomitantly, and in all the IP was reconstructible. The toes were based on the proper digital artery (18 cases), the intermetatarsal artery (6 cases), and the dorsalis pedis (in 1 early case).

Results: All transferred toes survived without complications. At a minimum follow-up of 1 year (range, 14–1), active range of motion at the IP joint was superior to 55° in every case except 2 that had an IP arthrodesis, 1 of which was referred with the arthrodesis done. Two-point discrimination was normal in dorsal oblique amputations and 7 to 11 mm in the rest. One case had a moderate nail deformity, whereas in the rest fairly normal growth (subjectively 9.5 on a visual analog scale) was appreciated. Patient satisfaction was high from a functional and aesthetic standpoint 9.5 and 9.5 (over 10). All patients returned to work from 2 to 4.5 months after the injury. One patient referred late and with an intra-articular fracture of the IP joint, which developed septic arthritis and was treated by IP arthrodesis. Delayed donor site healing was noted in 4 cases.

Summary: In contrast to classic teaching, which recommends stump closure for cases of distal thumb amputations, we attained excellent results with partial toe transfer in manual workers. In our experience, the thumb can be restored nearly to original condition with acceptable donor site sequela. The best indication is for cases of dorsal oblique amputations, because thumb sensibility is preserved. Early transfer is strongly recommended.

PAPER 43
Clinical Paper Session 9: Nerve/Microsurgery
Saturday, October 5, 2013 • 9:15–9:21 AM
Category: Basic Science—Lab Research
Keyword: Other

Use of a Light-Activated Stent for Sutureless Vascular Anastomosis
Not a clinical study

◆ Prabhu Senthil-Kumar, MD
◆ Joanna Ng, MD
◆ Amanda Meppelink, BS
◆ Doris Ling, MS
◆ Mark A. Randolph, MAS
◆ Hatice Bodugoz-Senturk, PhD
◆ Orhun K. Muratoglu, PhD
◆ Robert Redmond, PhD
◆ Jonathan M. Winograd, MD

Hypothesis: Vascular repair with suture remains the reference standard, but can lead to inflammation and thrombosis, especially in peripheral vessels. Use of clips and rings can minimize this risk, but they are difficult to use on the microsurgical scale. Photochemical tissue bonding (PTB) is a technique that covalently links protein without thermal damage to tissue, and has been employed by our group in cornea, skin, tendon, and peripheral nerve.3–6 We hypothesized that use of PTB over a biocompatible intra-luminal stent would result in a watertight seal with minimal endothelial inflammation.

Methods: Thirty-five rats underwent unilateral femoral artery transection and were randomized to repair with 10-0 nylon microsuture (SR), stent plus SR, or stent plus PTB. For PTB, a 1-mm overlapping cuff was painted with 0.1% Rose Bengal, and then illuminated with a 532-nm green light laser for 60 seconds on each side. One dose of heparin (100 U/kg) was administered before removal of the vessel clamps in all animals. Repair time and vessel patency (immediately and at 1 h) were assessed. Histology

◆ Speaker has nothing of financial value to disclose
was performed at 1 week to assess for endothelial damage and thrombus formation.

Results: There was no difference in repair time ($P = .10$). All 3 groups were patent immediately. At 1 hour, the SR and stent plus SR groups demonstrated 100% patency, with 93% patency in the stent plus PTB group. At 1 week, there was no hematoma or aneurysm formation in any of the groups.

Summary: We demonstrated the development and use of an intraluminal stent in successful microvascular anastomosis. Photochemical tissue bonding creates an immediate watertight and sutureless vascular anastomosis with the intraluminal stent. Using a nondissolvable intraluminal stent causes thrombosis occasionally. We are currently developing a dissolvable stent to create a successful sutureless microvascular anastomosis using the PTB technique.

![Figure 1: Stent used for microvascular anastomosis.](image1)

![Figure 2: Confocal microscopy of the stent used in the study.](image2)

![Figure 3: Sutureless anastomosis of rat femoral artery with PTB with stent in situ.](image3)

![Figure 4: Anastomosis time.](image4)

REFERENCES


PAPER 44

Clinical Paper Session 10: Tumors
Saturday, October 5, 2013 ● 9:25—9:31 AM
Category: Congenital/Pediatric
Keyword: Hand

Long-Term Follow-Up and Natural History Study of Osteochondromas of the Hand in Patients With MHE
Level 4 Evidence

Julie Colantoni, MD
R. Glenn Gaston, MD

Hypothesis: We theorized that the prevalence of osteochondromas in the hand would be increased around the ulnar digits and metacarpal joints (2+5). Long-term, natural history data will show greater change and increase in number, angulation, shortening during periods of increased skeletal growth with a plateau of the number and deformity as patients reach skeletal maturity.

Methods: Retrospective x-ray review of 83 hands (46 patients) with multiple hereditary osteochondromatosis assessed the location, type, number of lesions as well as angulation and shortening of the involved bones of the hand. We then reviewed the same data along with long-term follow-up x-rays of 23 hands. These data was analyzed based on age of presentation for overall changes in location, number, and deformity of bones over time. Three age groups were defined based on age at initial presentation: group 1: ages 2 to 6 years; group 2: ages 7 to 10 years; and group 3: ages 11 years and older. Statistical analysis was carried out through Microsoft Excel programming.

Results: A total of 83 hands (46 patients) were evaluated; average age was 11 years (range, 3–34 y). The average number of tumors was 13.1 per hand; the most affected finger was the little finger, at 3.3 tumors per finger, followed by the index (2.96 tumors/finger), middle (2.95 tumors/finger), ring (2.7 tumors/finger), and thumb (1.63 tumors/finger). The most common type was small, sessile lesions affecting less than 50% of bone (98%). There...
was an average of 5 bones per hand and 2 with regard to angulation and shortening, seen most commonly in the ring and little finger metacarpals.

There were 23 hands in 13 patients, with average age at final follow-up of 14.1 years and average follow-up time of 4.6 years. Overall change in tumors was +2.7 per hand (range, −8 to +16 per hand). Most gains were seen in the ring finger (1.7 tumors/hand) and individually in the ring and little finger metacarpals (0.5 tumors/bone) (Fig. 1).

Summary:
1. This was the largest study of osteochondromas of the hand (83 hands) and largest long-term follow-up study (23 hands).
2. The ulnar side of the hand was more affected and showed the most angulation and shortening, centering on the metacarpophalangeal joints. The thumb was the least affected. Some bones had no tumor present but had shortening or angulation.
3. Most were sessile, affecting less than 50% of bone.
4. Large changes were seen in the number of tumors over a period of time; the most change was seen from age 4 years to follow-up at age 12 years. Trends were present but wide variations were seen between patients.
5. As patients became older than age 12, less change was seen in all categories, which indicates a decrease in change as patients approach skeletal maturity.

### References


<table>
<thead>
<tr>
<th>Average Age at Presentation</th>
<th>Average Age at Follow-Up</th>
<th>Average Change in Tumors/Hand</th>
<th>Change in Bones With Shortening</th>
<th>Change in Bones With Angulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1: 6 patients, 10 hands, 14.5 y</td>
<td>12.2 y 7.7 y</td>
<td>+2.8 tumors/hand</td>
<td>+1.2 bones/hand</td>
<td>+0.7 bones/hand</td>
</tr>
<tr>
<td>Group 2: 2 patients, 4 hands, 10 y</td>
<td>13 y 3 y</td>
<td>−0.2 tumors/hand</td>
<td>+0.2 bones/hand</td>
<td>0 bones/hand</td>
</tr>
<tr>
<td>Group 3: 5 patients, 9 hands, 14.9 y</td>
<td>16.8 y 1.9 y</td>
<td>+0.1</td>
<td>−0.1</td>
<td>0</td>
</tr>
</tbody>
</table>

involvement on AP radiographs and the presence of fracture. The median (range) percentage of longitudinal bone involvement for the fracture and non-fracture outcomes was 53.8 (29.9–93.6) and 41.5 (22.2–87.9), respectively.

Summary: Enchondromas are the most common primary bone tumor of the hand, often found incidentally at presentation. Conservative treatment with observation and serial radiographs is frequently successful, but a subset of patients exist who will go on to develop a pathologic fracture. Objective criteria to predict the likelihood of fracture in these patients are currently lacking, which makes it difficult for clinicians and patients to arrive at appropriate treatment decisions. This investigation provides evidence that age, the affected finger, the affected bone, and the percentage of the bone occupied by the pathologic lesion on AP radiographs can be used as objective criteria to predict fracture risk and guide clinical decision making.

REFERENCES


Consulting Fees (eg, advisory boards) received from: Arthrex, Inc
Other Financial/Material Support received from: Arthrex, Inc

PAPER 46

Clinical Paper Session 10: Tumors
Saturday, October 5, 2013 • 9:45–9:51 AM
Category: Tumor
Keyword: Hand

Giant Cell Tumors of the Tendon Sheaths in the Hand: Review of 96 Patients With an Average Follow-Up of 12 Years

Level 4 Evidence

Romain Lancigu, MD
Guy Raimbeau, MD
Bruno Cesari, MD
Fabrice Rabarin, MD

Hypothesis: Giant cell tumors of the hand are relatively common and have a good prognosis, but the risk of recurrence is high. The goals of this study were to evaluate the long-term clinical results of a consecutive series of patients and to determine the risk factors for recurrence.

Methods: This was a retrospective study of 96 patients (57 women and 39 men) operated on between February 1982 and October 2005 for giant cell tumors of the tendon sheaths in the hand. The average age at the time of the procedure was 47.7 ± 14.5 years (range, 13–75 y). All patients were reviewed by an independent surgeon.

The tumor was located in the index finger in 29 cases, middle finger in 23, thumb in 21, ring finger in 11, little finger in 11, hypothenar area in 2, and thenar area in 1. In all cases, the lesion was isolated. The swelling was palmar in 27 cases, dorsal in 20, and medial or lateral in 59. The most common joint location was the distal interphalangeal joint (35% of cases).
The swollen area was sensitive in 12 cases. Time from the appearance of the tumor to physician consultation ranged between 1 month and 7 years. Before surgery, standard x-rays were taken in all patients; ultrasonography was also performed in 8 patients and magnetic resonance imaging in 1 patient. The tumor had an average diameter of 15.8 ± 2.6 mm (range, 5–30 mm). Histological analysis revealed a multilobed lesion with multinucleated giant cells, with or without encapsulation.

**Results:** Average follow-up at the time of review was 12.1 ± 3.8 years (range, 5–29 y). There were 8 recurrences in 7 patients (8.3%). The average time to recurrence was 2.75 ± 2 years (range, 1–6.5 y). In every case of recurrence, there had been intra-articular tumor development and/or tendon destruction ($P < .01$). There was 1 functional complication: 1 distal interphalangeal joint fusion resulting from 1 of the recurrences. The average Quick-Disabilities of the Arm, Shoulder, and Hand score was 2.3 out of 100 (range, 0–31).

**Summary:** Giant cell tumors of the synovial sheaths in the hand are benign lesions in which recurrence is the primary risk. The recurrence typically occurred within 36 months of the excision. Intra-articular tumor development, marginal resection, and tendon involvement seem to contribute to recurrence. No correlation was found between the histological type of tumor (encapsulated or not) and recurrence.

**REFERENCES**


**PAPER 47**

Clinical Paper Session 10: Tumors
Saturday, October 5, 2013 • 9:55–10:01 AM
Category: Tumor
Keyword: Wrist

**Hyperlaxity and Dorsal Carpal Ganglia: A Prospective Case-Control Study**

**Level 3 Evidence**

*Kathleen E. McKeon, MD*  
*Daniel A. Ose, MD*  
*Richard H. Gelberman, MD*  
*Charles A. Goldfarb, MD*  
*Martin I. Boyer, MD, FRCS(C)*  
*Daniel A. London, BA*  
*Ryan Patrick Caffe, MD*

**Hypothesis:** Generalized ligamentous hyperlaxity, defined by a Beighton score greater than or equal to 4, has been associated with musculoskeletal pathology. We hypothesized that the presence of generalized ligamentous hyperlaxity is associated with the presence of symptomatic dorsal carpal ganglia.

**Methods:** A total of 96 patients (61 females) presenting to hand surgeons for a symptomatic dorsal carpal ganglion were prospectively enrolled in this case-control investigation. Beighton scores were calculated to quantify generalized ligamentous laxity in each patient (Table 1) and a scaphoid shift test (scapholunate ligamentous laxity evaluation) was performed. A positive scaphoid shift test was defined as the presence of both pain and a palpable clunk during testing. Ninety-six individuals without ganglion cysts (past or present) were then enrolled to form an age and sex frequency-matched control cohort. The control group was similarly assessed for Beighton score and scaphoid shift test. Binary logistic regression was performed to assess the association of ganglion cysts with generalized ligamentous laxity (Beighton score ≥ 4) while accounting for effects of age and sex.

**Results:** Patients with symptomatic dorsal carpal ganglia demonstrated significantly increased rates of generalized ligamentous hyperlaxity. Among those with ganglia, 27 of 96 patients (28.1%) exhibited generalized ligamentous hyperlaxity, compared with 12 of the 96 age- and gender-matched individuals in the control group (12.5%) ($P = .007$). Patients with symptomatic dorsal carpal ganglia were also significantly more likely to demonstrate scapholunate laxity with a positive scaphoid shift test (25% positive scaphoid shift test with ganglia vs 1% in controls; $P < .001$). In logistic modeling, patients with a dorsal carpal ganglion had 2.9 times greater odds of generalized ligamentous hyperlaxity (95% confidence interval, 1.3–6.2) compared with patients without a dorsal carpal ganglion after accounting for patient age and sex (Table 2).

**Summary:**

- Symptomatic dorsal carpal ganglia are associated with generalized ligamentous hyperlaxity even when accounting for effects of patient age and sex.
- Patients with symptomatic dorsal carpal ganglia are more likely to have localized scapholunate ligament hyperlaxity compared with controls.

### Table 1: Examination and Scoring for Beighton Assessment of Generalized Hyperlaxity

<table>
<thead>
<tr>
<th>Beighton Score</th>
<th>L touching thumb to ipsilateral volar forearm</th>
<th>L wrist hyperextension</th>
<th>L elbow hyperextension</th>
<th>L knee hyperextension</th>
<th>Palms toward floor with knees extended</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive thumb apposition</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>9 points</td>
</tr>
<tr>
<td>Passive hyperextension of fifth MCP joint</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>9 points</td>
</tr>
<tr>
<td>Elbow hyperextension</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>9 points</td>
</tr>
<tr>
<td>Knee hyperextension</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>9 points</td>
</tr>
<tr>
<td>Both palms touch floor</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>1 point</td>
<td>9 points</td>
</tr>
</tbody>
</table>

**MCP, metacarpophalangeal.

### Table 2: Variables in Final Logistic Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Wald $\chi^2$</th>
<th>$\beta$</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of ganglion</td>
<td>7.6</td>
<td>1.1</td>
<td>3.0</td>
<td>1.4–6.5</td>
</tr>
<tr>
<td>Female sex</td>
<td>4.2</td>
<td>0.88</td>
<td>2.4</td>
<td>1.0–5.6</td>
</tr>
<tr>
<td>Patient age, y</td>
<td>8.3</td>
<td>−0.046</td>
<td>0.96</td>
<td>0.93–0.99</td>
</tr>
<tr>
<td>Constant</td>
<td>−1.274</td>
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</table>

**REFERENCES**


**Speaker has nothing of financial value to disclose**
The Impact of Suture Caliber and Core Suture Strands on Intrasynovial Flexor Tendon Repair

Not a clinical study

Daniel A. Osei, MD
Richard H. Gelberman, MD
Jeffrey Stepan, BS
Martin I. Boyer, MD, FRCS(C)
Ryan Potter, MS
Ryan Patrick Calfee, MD

Hypothesis: There is little consensus regarding whether the number of core suture strands or the caliber of the core suture has a greater impact on tensile properties. Our hypothesis was that a 3-0, 4-strand repair would have similar tensile properties as a 4-0, 8-strand repair.

Methods: This investigation was powered (α = 0.05, β = 0.80) to detect a relevant change in maximum load (30%) between repair groups. All mechanical testing was performed using a materials testing machine (Instron 5866).

This study was conducted in 2 stages. First, we tested the maximum load to failure of 2 suture calibers most commonly used in flexor tendon repair (3-0 and 4-0 Supramid). Next, we tested the 0 ex vivo mechanical properties of 40 cadaveric flexor digitorum profundus tendons after zone II repair with 1 of 3 techniques: (1) 3-0, 4-strand core repair; (2) 4-0, 8-strand repair; or (3) 4-0, 4-strand repair. Tendon repairs were made into a clinically relevant model by adding a circumferential epitendinous suture (5-0 Prolene). Tensile properties were measured for the 3 repair methods. All continuous paired data were analyzed using Student’s t-test.

Results: The maximum load to failure of 3-0 polyfilament caprolactam suture was 49% higher than that of 4-0 polyfilament caprolactam suture (Fig. 1). The cross-sectional area of 3-0 Supramid was 38% greater than that of 4-0 Supramid. The 4-0, 8-strand repair produced greater maximum load to failure compared with the 2 4-strand techniques (82.2 vs 58.2 N [3-0 suture] vs 49.8 N [4-0 suture], P = .0004) (Fig. 2). Load at 2-mm gap (P = .003), stiffness (P = .025), rigidity (P = .024), resilience (P = .010), and toughness (P = .014) were significantly higher in the 4-0, 8-strand repair compared with the 3-0, 4-strand repair.

Summary:
- Failure force is directly proportional to suture cross-sectional area: Increasing caliber from 4-0 to 3-0 increases failure force by 49%; increasing the number of strands from 4 to 8 theoretically increases the failure force by 100%.
- These suture testing trends were maintained when incorporated into a repair construct; compared with a 4-0, 4-strand repair, a 3-0, 4-strand repair is 16% stronger and a 4-0, 8-strand repair is 67% stronger.
- A 4-0, 8-strand repair significantly outperformed a 3-0, 4-strand repair, which indicates that although suture caliber and suture—tendon interaction affect repair strength, the number of core repair strands is of greater impact.

Figure 1: Material properties for Supramid suture, 3-0 and 4-0 caliber.

Figure 2: Maximum load to failure for 3 repair techniques.

REFERENCES

The Knotless Tendon Repair With a Resorbable Unidirectional Barbed Suture Device: An In Vivo Comparison in the Turkey Foot

Not a clinical study

Tim S. Peltz, MD
Peter Scougall, FRCS
Rema S. Oliver, PhD
Mark P. Gianoutsos, MD
Nicky Bertollo, PhD
William R. Walsh, PhD

Hypothesis: With recent commercialization of barbed suture materials and reports of the use of these materials for tendon repairs, we felt the need to design a specific repair method to draw the best use from this material. In previous ex vivo studies, we could show superior biomechanical performances of our new knotless barbed suture tendon repair compared with conventional knotted tendon repairs. The aim of this present study was to investigate whether this superior repair stability applies to an in vivo scenario in a healing tendon.

Figure 1: Material properties for Supramid suture, 3-0 and 4-0 caliber.
Methods: Forty male Meleagris gallopavo (turkeys) were used. The middle toe of the right leg was operated on, while the left served as the contralateral control. Two groups were operated on:

1. Repair of 20 turkey feet (right middle toe deep flexor tendon) at zone II with a 4-strand, knotted, cross-locked cruciate repair (Adelaid repair) with 4-0 Ethibond and running circumferential repair with 6-0 Prolene.
2. Repair of 20 turkey feet (right middle toe deep flexor tendon) at zone II with 4-strand, knotless, barbed suture repair (3-dimensional repair) with a resorbable 4-0 V-Loc 180 suture device and running circumferential repair with 6-0 Prolene.

Histological analysis was carried out at 1, 3, and 6 weeks and 10 repairs in each group were tested biomechanically after 6 weeks.

Results: In vivo surgery on the turkey deep flexor apparatus is practicable and procedures are comparable to clinical scenarios in humans. Animals tolerate casting and show similar functional recovery of operated digits to human postoperative recoveries. Histology shows similar healing phases compared with human tendon repairs. Biomechanically, the barbed suture repairs could not reach the same stability as the conventional knotted repairs. More tendon repair failures were noted in the barbed suture group compared with the conventional knotted repair group. Also, biomechanical testing after 6 weeks showed more stable repairs in the conventional repair group compared with the barbed suture group.

Summary: This is the first in vivo investigation of a knotless barbed suture repair. Our aim was to prove whether a barbed suture repair could achieve similar results in an in vivo setting as the conventional reference standard in 4-strand tendon repairs. This could not be proven. Unfortunately, no non-resorbable, permanent barbed suture is currently commercially available in suitable small sizes. Resorption of the barbs on the suture surface of the currently available resorbable barbed sutures causes inferior repair stability and increased repair failures compared with conventional repairs in an in vivo setting.

REFERENCES

PAPER 50
Clinical Paper Session 11: Tendon
Saturday, October 5, 2013 • 9:45–9:51 AM
Category: Tendon
Keyword: Hand

Early and Late Mobilization After a Flexor Tendon Injury in Children—A Long-Term Follow-Up
Level 4 Evidence

Illugi Fanndal Birkisson, MD
• Lars B. Dahlin, MD, PhD
• Hans-Eric Rosberg, MD, PhD

Hypothesis: Our hypothesis was that late mobilization in children, because of lack of cooperation, would not affect long-term results after a flexor tendon injury in fingers, in contrast to adults. We evaluated the functional outcome after repair of a flexor tendon injury and early or late mobilization in children.

Methods: A retrospective follow-up study was conducted in 29 children, aged 1 to 16 years at the time of injury, with a flexor tendon injury. All patients were operated on at our department during 2003–2009 with repair of 1 or several flexor tendon injuries in fingers, excluding the thumb, using 2- or 4-strand core sutures, depending on the size of the tendon. During the rehabilitation, early (n = 18; active mobilization; 12 boys and 6 girls; median, 13 y; range, 7–16 y) or late mobilization (n = 11; cast immobilization for 3–4 wk; 4 boys and 7 girls; median, 4 y; range, 1–10 y) was used, depending on the cooperation of the patient. Functional and cosmetic subjective results were evaluated by a visual analog scale (VAS) (0–100; 100 indicated best results). Grip strength was recorded and range of motion (ROM) in metacarpophalangeal, proximal interphalangeal, and distal interphalangeal (DIP) joints was measured.

Results: There were no ruptures of any flexor tendon repair. One patient was operated on 3 weeks after an open fracture and tendon injury with DIP joint arthrodesis, and was excluded from the DIP joint range of motion evaluation. The mean functional VAS scores in the early and late mobilization groups were 80 and 78, respectively. The corresponding values for the cosmetic VAS were 79 and 77, respectively. The mean ROM (ratio of the contralateral side) for the early mobilization group in metacarpophalangeal, proximal interphalangeal, and DIP joints was 95%, 86%, and 79%, respectively, compared with 103%, 86%, and 65% for the late mobilization group. Grip strength (ratio of the contralateral side) was 96% and 93% in the early and late mobilization groups (median; ranges, 53% to 116% and 78% to 112%, respectively). However, despite lower age in the late mobilization group, there were no statistical differences in the subjective or functional outcomes between the early and late mobilization groups after a flexor tendon injury in children.

Summary: No differences were detected in the subjective or functional outcomes after a flexor tendon repair between early rehabilitation in older children compared with late mobilization in young children. The findings suggest that initiation of an early rehabilitation program after a flexor tendon repair is not necessary in young children.

• Contracted Research with: Auxillium, Pfizer, Pergamum
• Consulting Fees (eg, advisory boards) received from: Auxillium, Pfizer, Pergamum

Speaker has nothing of financial value to disclose
Rehabilitation Following Zone II Flexor Tendon Repairs: A Change to Splinting Practice Using the Manchester Short Splint

Level 3 Evidence

© Chye Ng, MBChB(Hons), FRCS(T&O), DSEM, BDHS, EBHSD
© Fiona Peck, MCSP
© Alison Roe, MCSP
© Christopher G. Duff, FRCSPlas
© Duncan A. McGrouther, MD, FRCS
© Vivien C. Lees, MD, FRCS

Null Hypothesis: There is no statistically significant difference in the outcomes (range of motion and rupture rate) after zone II flexor tendon repairs, when comparing the traditional forearm-based splint and a newly designed short splint.

Methods: We performed a historical cohort study of patients with primary zone II flexor tendon lacerations, repaired using multi-strand suture techniques. The results of rehabilitation using a traditional forearm-based splint (Fig. 1) were compared with the Manchester short splint (Fig. 2). The short splint was fabricated to permit maximal wrist flexion and up to 45° wrist extension with a block to 30° metacarpophalangeal joint extension. Rehabilitation began on the fourth or fifth postoperative day, using early combined passive and active motion, and patients were offered weekly therapy appointments. All patients were instructed to wear the splints for a period of 6 weeks. Range of motion of the injured digit was measured by a clinical specialist hand therapist using a digital goniometer at 6 and 12 weeks postoperatively.

Results: In 2011, 62 patients (76 digits) (mean age, 34 y; range, 14–58 y) with acute, uncomplicated zone II flexor tendon injuries were rehabilitated using the forearm-based splint (group A). In 2012, 40 patients (45 digits) (mean age, 31 y; range, 15–71 y) with the same injuries were rehabilitated using the Manchester short splint (group B).

At 6 weeks postoperatively, group B had significantly less mean flexion contractures at the proximal interphalangeal (PIP) joints (mean ± SD, 18° ± 14°) than group A (29° ± 18°) (t-test; P < .001). The mean arc of PIP joint motion was also greater in group B than group A (53° ± 23° vs 41° ± 24°; P = .008). Similarly, at the distal interphalangeal joints, group B had significantly less mean flexion contractures than group A (6° ± 9° vs 10° ± 10°; P = .034).

At 12 weeks postoperatively, group B continued to have significantly less mean flexion contractures than group A at the PIP joints (10° ± 11° vs 19° ± 16°; P = .002). During the study period, there were 3 ruptures (3.9%) in group A and 2 (4.4%) in group B (chi-square test with Yates’ correction; P = .735).

Summary:
- The Manchester short splint appears to be a safe, simple, and effective splint for rehabilitation of patients with zone II flexor tendon repairs.
- Patients had significantly fewer flexion contractures at the PIP joints and regained greater range of active motion of the digits at 12 weeks postoperatively.
- The rupture rate remains within published acceptable levels (4%).

Speaker has nothing of financial value to disclose
A First-Year Update and Reflection of the 21 Center NIH-Funded Wrist and Radius Injury Surgical Trial (WRIST)

Not a clinical study

Kevin C. Chung, MD, MS
Melissa J. Shauver, MPH
Sunita Malay, MPH

Hypothesis: The National Institutes of Health-funded Wrist and Radius Injury Surgical Trial (WRIST) is a historic collaboration of 21 hand surgery centers in the United States, Canada, and Singapore (Fig. 1). This multi-center clinical trial was initiated after the seminal systematic review by Margalioth et al1 and the Cochrane report that indicated marked deficiencies in the quality of evidence in the distal radius fracture (DRF) literature, specifically in the case of volar locking plate use in patients over the age of 55 years.2 The WRIST team was created to answer questions about treatment of DRF in elderly patients with outcomes of function and patient-rated items including satisfaction and quality of life.

Methods: The Wrist and Radius Injury Surgical Trial is a 21-center National Institute of Arthritis and Musculoskeletal and Skin Diseases—and National Institute on Aging—funded, randomized, controlled trial evaluating DRFs in a patient group age 60 years and over. Participants are randomly allocated to 1 of the 3 surgical procedures: internal fixation with volar locking plate, external fixation, and percutaneous pinning. Those who opt out of surgery are observed in an observation group. Outcomes include the Michigan Hand Outcomes Questionnaire, the Short Form-36, grip and pinch strength, and wrist range of motion. The Wrist and Radius Injury Surgical Trial received National Institutes of Health approval to begin screening in January 2012.

Results: The WRIST team experienced setbacks, including obtaining regulatory approval across all sites. Any changes to the protocol must be reviewed at every site. It took nearly a year for all sites to obtain approval from their institutional review or ethics board. This severely limited the time available for recruitment. Furthermore, WRIST has screened 252 patients. Among these, 154 patients were excluded owing to noneligibility (61%). Of the 98 eligible patients, 40 were enrolled into the study, for an enrollment rate of only 16%. When calculating sample size, we had anticipated a 50% refusal rate. We were not prepared for the large number of ineligible patients. However, with the incorporation of additional sites within and outside the United States, we expect to increase the number of patients screened, and thus to meet our recruitment goals.

Summary:
- A multicenter clinical trial with the ambition of the WRIST team is the cornerstone for the future of hand surgery research.
- Despite the initial setbacks, lessons learned from this trial will be valuable to design additional large-scale studies in hand surgery.
- New methods of site engagement, patient screening, and participant retention are being actively sought and put into action to increase WRIST potential for success.

REFERENCES

PAPER 53

Corrective Osteotomies in Malunions of the Distal Radius, Using Preoperative 3-Dimensional Computer Planning and Patient-Specific Surgical Guides

Bianca Impelmanns, MD
Roger van Riet, MD, PhD
Frederik Verstreken, MD

Hypothesis: Preoperative 3-dimensional computer planning and patient-specific surgical guides allow precise reconstruction in malunions of the distal radius.

Methods: A total of 18 patients with a malunion of the distal radius had a corrective osteotomy, using preoperative 3-dimensional computer planning and patient-specific surgical guides. Fourteen patients had an isolated extra-articular malunion, 3 had a combined extra- and intra-articular malunion, and 1 had an isolated intra-articular malunion. Surgeicase software (Materialise, Belgium) was used for 3-dimensional planning of the corrective osteotomy, using the mirror image of the unaffected side as a template. Based on this planning, patient-specific surgical guides were manufactured. Three independent observers measured radial tilt, radial inclination, ulnar variance, and articular congruency on the preoperative radiographs, on the computer planning, and on the postoperative radiographs.

Results: The clinical and radiographic results of 17 patients were evaluated, with a mean follow-up of 15.2 months (± 4.6 mo). At the final follow-up, there was significant improvement (P = .80) for all criteria used to assess distal radius anatomy. The goal was to restore alignment of the radius to within 5° angular deformity (radial tilt and radial inclination) and 2 mm ulnar variance, compared with the opposite uninjured wrist. In 14 of 17 patients, all 3 measurements were within the planned limits. In 2 patients, correction of radial tilt was incomplete and 1 patient had incomplete correction of ulnar variance. When an intra-articular malunion was corrected (4 patients), residual articular incongruity on the postoperative radiographs was less than 2 mm in all patients.

Summary:
- Preoperative 3-dimensional computer planning and the use of patient-specific surgical guides allows precise correction of distal radius malunion.
- The radiographic outcome compares favorably with reported results of more conventional techniques.1,2
- Clinical results were excellent, with significant improvement of function in all patients and a low complication rate.
Hypothesis: To investigate a computer-assisted surgical (CAS) technique for antegrade insertion of percutaneous scaphoid screws and compare insertion time, accuracy, and radiation exposure with the traditional technique. We hypothesized that CAS navigation of dorsal percutaneous scaphoid screw placement would improve accuracy, reduce actual K-wire insertion time, and decrease radiation exposure to the operating room staff.

Methods: Ten right fresh cadaveric limbs sectioned at the mid humerus were randomized to either CAS or traditional dorsal percutaneous scaphoid screw placement by a single surgeon. Custom thermoplastic thumb spica splints were applied to the CAS arms, followed by intraoperative computed tomography (CT) scan, which was used for navigation planning and 3-dimensional guidance. Time was recorded for the portion of setup that required surgeon input, ideal guide wire placement, and actual fluoroscopy time used. Number of K-wire attempts was also recorded. Postoperative CT scans of the CAS arms were obtained to compare the planned virtual screw location with that of the final actual screw position. Two-tailed unpaired Student’s t-tests were used to analyze the outcome variables.

Results: Setup time for the traditional method was 0, whereas the computer-assisted group required on average 4.8 ± 0.8 minutes (P < .001). The actual time for placement of the guide wire in the ideal position was 4.6 ± 1.5 minutes in the CAS group versus 11.8 ± 4.4 minutes for the traditional group (P = .008). Total time from setup to final K-wire placement was 9.4 ± 1.3 minutes for the CAS group versus 11.8 ± 4.3 minutes for the traditional group (P = .280). Radiation exposure for K-wire placement was 18.4 ± 3.6 seconds for the CAS group versus 113.6 ± 37.5 seconds for the traditional group (P = .001). The CAS groups had 1.2 ± 0.4 attempts for ideal wire placement versus 1.8 ± 0.4 attempts for the traditional group (P = .070). Postoperative CT scans of the CAS wrists were superimposed with their preoperative CT scans and demonstrated 1.5 ± 0.56 mm deviation from the planned ideal screw. No significant differences were found in the accuracy of either method. No cortical perforations were detected in either group.

Summary: Computer-assisted surgical navigation of dorsal percutaneous scaphoid screw placement (Figs. 1, 2) took on average 5 minutes longer to set up but led to significantly reduced guide wire placement time, resulting in no significant differences in overall procedural time. Computer-assisted surgical navigation was as accurate as the traditional method and no cortical perforations were seen. Radiation exposure to the operating room staff was reduced approximately 6-fold with use of navigation.

REFERENCE

Consulting Fees (eg, advisory boards) received from: Stryker Orthopedics, Acumed Orthopedics, Axogen Corporation

Figure 1: The current trajectory of the smart drill guide is superimposed on the preplanned virtual screw. Once the current trajectory correctly matches the preplanned screw, the targeting guide on the bottom right corner will turn green.

Figure 2: Computer-assisted navigation (arm 0268): anteroposterior, lateral, and hyperpronated oblique views.
PAPER 55

Clinical Paper Session 12: Wrist: Distal Radius and Scaphoid
Saturday, October 5, 2013 ● 10:40—10:46 AM
Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Wrist

Can Scaphoid Nonunions Be Predicted?
Not a clinical study

♦ Joan Francis Arakkal, FRCS
♦ Abbey Perumpananni, DPhil Oxf

Hypothesis: The main finding of this study is that optical density gradients across scaphoid fracture can be used to predict the risk of nonunion in the early weeks after a fracture. Previous researchers in their quest for predictors of nonunion have looked at radiological hallmarks such as sclerosis, rounding of the edges, or cyst formation.

Methods: The study looked at optical density gradients within scaphoid x-rays with a view to investigating their correlation with the pathophysiology of fracture healing. The study found temporally evolving, spatially varying optical density gradients in scaphoid bones with fractures. These fracture-induced gradients behave differently from early on, depending on whether they are headed for union or nonunion.

Results: The main finding of the study is that optical density gradients across scaphoid fractures can be used to predict the risk of nonunion in the early weeks after a fracture.

Summary:
- Fracture-induced gradients are good predictors of nonunion.
- Fracture-induced gradients could provide a new and novel method to risk stratify scaphoid fractures.
- Fracture-induced gradients could have wider orthopedic implications for the clinical and scientific approach to all fractures.

PAPER 56

Clinical Paper Session 13: Wrist
Saturday, October 5, 2013 ● 10:05—10:11 AM
Category: Arthritis
Keyword: Wrist

Surgical Efficacy of Radial Shortening Osteotomy for Kienböck Disease: A 10-Year-Minimum Follow-Up Study
Level 4 Evidence

♦ Yuichiro Matsui, MD, PhD
♦ Tadanao Funakoshi, MD, PhD
♦ Makoto Motomiya, MD, PhD
♦ Michio Minami, MD, PhD
♦ Akio Minami, MD, PhD
♦ Norimasa Iwasaki, MD, PhD

Hypothesis: Although radial shortening osteotomy (radial shortening) is widely performed for patients with Kienböck disease, the long-term clinical results of this procedure are still unclear. We hypothesized that radial shortening could provide favorable long-term postoperative results for more than 10 years in the treatment of Kienböck disease.

Methods: Between 1991 and 2002, 11 wrists of 10 patients that had been classified as Lichtman stages IIIA (2 wrists), IIIB (8 wrists), and IV (1 wrist) underwent radial shortening for the treatment of Kienböck disease. These included 8 male and 2 female patients whose mean age at the time of surgery was 23.7 years (range, 11—44 y). The mean follow-up period was 14.3 years (range, 10—21 y). All patients were clinically examined for range of motion and grip strength. Postoperative clinical outcomes were measured using the Japanese version of the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire and the modified Mayo Wrist Score. Radiological and magnetic resonance imaging (MRI) studies were performed for all patients preoperatively and at follow-up, except for preoperative MRI from 1 patient. Statistical comparisons were performed using paired t-tests (P < .05).

Results: At follow-up, 6 wrists were asymptomatic and the remaining 5 had mild occasional pain. The mean range of extension significantly improved from 45° (range, 25° to 70°) preoperatively to 71° (range, 50° to 90°) postoperatively (P < .001). The mean percentage grip strength (affected side to contralateral side) significantly increased from 62% (range, 17% to 154%) preoperatively to 90% (range, 64% to 100%) postoperatively (P < .05). Whereas the mean modified Mayo Wrist Score was 92 points (range, 80—100), the mean Disabilities of the Arm, Shoulder, and Hand score was 5 points (range, 0—18). All patients achieved bony union at the osteotomy site within 12 weeks postoperatively. At follow-up, no progression of the Lichtman stages was found in any patients. There was no significant progressive lunate collapse in any patient. On the other hand, we found no MRI findings indicating revascularization of the lunate in 3 wrists.

Summary: Our study showed satisfactory clinical long-term results after 10 or more years in patients who underwent radial shortening. Although no revascularization of the lunate was found in 3 wrists, unloading of the lunate after radial shortening for Kienböck disease gives long-lasting symptom relief and prevents progressive lunate collapse.

REFERENCES


PAPER 57

Clinical Paper Session 13: Wrist
Saturday, October 5, 2013 ● 10:15—10:21 AM
Category: Basic Science—Clinical Research
Keyword: Wrist

Scaphocapitate Arthrodesis in the Treatment of Kienböck Disease
Level 4 Evidence

♦ Peter C. Rhee, DO, MS
♦ Ines C. Lin, MD
♦ Steven L. Moran, MD
♦ Allen Bishop, PhD
♦ Alexander Y. Shin, MD

Hypothesis: Scaphocapitate arthrodesis can result in improved functional outcomes in patients with Kienböck disease.

Methods: Patients with Kienböck disease who had undergone scaphocapitate arthrodesis at our institution between 1991 and 2010 were identified with a minimum of 1-year clinical follow-up. Hospital records were reviewed for operative details, preoperative and postoperative pain, range of motion, grip
strength, functional status, and complications. Modified Mayo Wrist Score and Lichtman outcome scores were calculated.

**Results:** A total of 27 patients (10 females and 17 males) with a mean age of 41 years (range, 15–66 y) at the time of scaphocapitate arthrodesis and average follow-up period of 60 months (range, 12–195 mo) were included in the study. Union was achieved in all patients. Significant loss of mean wrist motion was noted from preoperatively to postoperatively in flexion (−14.2°, P = .0006), extension (−10.5°, P = .0001), and ulnar deviation (−9.1°, P = .010). However, significant improvement in grip strength was noted (+6.6 kg, P = .009). Outcome scores were calculated in 22 patients and were good in 3, fair in 10, and poor in 9 patients based on the modified Mayo Wrist Score. SATISFACTORY outcomes were achieved in 7 of 22 patients (32%) based on the Lichtman outcome score. Conversion to total wrist arthrodesis occurred in 2 patients. Complications included delayed union (n = 3) and complex regional pain syndrome (n = 2).

**Summary:**
- Scaphocapitate arthrodesis can result in improved grip strength for patients with advanced stages of Kienböck disease who have failed revascularization attempts, or in the presence of an unsalvageable lunate.
- Coupling the distal and proximal carpal rows results in significant loss of mean wrist range of motion in flexion, extension, and ulnar deviation after scaphocapitate arthrodesis.
- Nonetheless, functional outcomes in medium-term follow-up are discouraging after scaphocapitate arthrodesis for advanced stages of Kienböck disease.

- Contracted Research with: Integra Orthopedics (A.Y.S.)
- Royalties/Honoraria received from: Integra (S.L.M.); Trimed Orthopedics (A.Y.S.)
- Ownership Interest: Conventus, Axogen (S.L.M.)
- Consulting Fees (eg, advisory boards) received from: Integra (S.L.M.); Acumed Orthopedics, LMT Surgical, Biotech Orthopedics (A.Y.S.)
- Receipt of Intellectual Property Rights/Patent Holder with: Integra (S.L.M.)

**PAPER 58**

Clinical Paper Session 13: Wrist
Saturday, October 5, 2013 • 10:25–10:31 AM
Category: Arthroplasty
Keyword: Wrist

**Functional Outcome of the Distal Radioulnar Joint Replacement in Patients Under 40 Years of Age**

**Level 4 Evidence**

- Antonio Rampazzo, MD
- Bahar Bassiri Gharib, MD, FEBOPRAS
- Rebecca Jones, MS
- Luis R. Scheker, MD

**Hypothesis:** The proposed method of distal radioulnar joint (DRUJ) replacement can be effectively used to treat joint osteoarthritis or instability in young patients without an increase in complication rates.

**Methods:** A retrospective study was performed in patients under 40 years of age who underwent total DRUJ replacement. Patients’ charts were reviewed and age at surgery, profession, hobbies, comorbidities, diagnosis, previous procedures, and complications were recorded. Preoperative and postoperative Disabilities of the Arm, Shoulder, and Hand and Patient-Rated Wrist Evaluation scores, visual analog scores, grip strength, lifting capacity, wrist pronation, supination, flexion, extension, and radial and ulnar deviation were registered. The differences between the pre- and postprocedure values were studied with a paired t-test.

**Results:** A total of 53 joints were replaced in 48 patients. Five patients had replacement of bilateral joints. The average age at the time of surgery was 31 years (range, 18–39 y). Twelve patients presented with comorbidities: Ehlers-Danlos syndrome (2), Madelung deformity (5), connective tissue disease (2), postburn scarring (1), stroke (1), and cervical radiculopathy (1). Forty-eight patients underwent surgery for osteoarthritis, and 5 for instability. The average follow-up was 54 months (range, 13–97 mo). The procedures performed before joint replacement were: distal radius open reduction and internal fixation (20), ulna shortening (15), DRUJ ligament reconstruction (8), triangular fibrocartilage complex repair (4), Sauve-Kapandji procedure (4), Darrach procedure (3), DRUJ replacement (2), and other wrist procedure (8). Sixteen patients underwent further procedures after implantation of the prosthesis: extensor carpi ulnaris release and implant coverage with dermal-fat graft (9), removal of osteophytes from the distal ulnar stump (3), replacement of the ultra-high-molecular-weight polyethylene ball (2), adjustment of the radial plate (1), and loosening of the implant at one-third distal of ulna (1). The average increase in grip strength and lifting capacity was 27.90 kg (P < .001) and 7.45 kg (P = .030), respectively. Supination improved 12.89° (P < .001) on average. Disabilities of the Arm, Shoulder, and Hand and Patient-Rated Wrist Evaluation scores decreased on average 30.25 (P < .001) and 38.43 (P < .001) points, respectively. The average decrease in visual analog score score was 6 of 10 (P < .001). A total of 29 patients would recommend the procedure, whereas 3 would not.

**Summary:**
- In this group of high-demand patients, the implant improved the functional status of the extremity.
- The most frequent complication was extensor carpi ulnaris tendonitis, which was addressed by incorporating into the main procedure the interposition of an adipofascial flap to cover the prosthesis.
- The major complication rate (infection, implant loosening, and mechanical failure) was extremely low (2%).

- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Aptis Co.
- Receipt of Intellectual Property Rights/Patent Holder with: Patent holder
- Other Financial Relationships: Part owner of APTIS Medical

**PAPER 59**

Clinical Paper Session 13: Wrist
Saturday, October 5, 2013 • 10:35–10:41 AM
Category: Arthritis
Keyword: Wrist

**Palmar-Shelf Arthroplasty, Long-Term Follow-Up**

**Level 4 Evidence**

- Hillel D. Skoff, MD

**Hypothesis:** Palmar-shelf arthroplasty (PSA) is an excellent surgical treatment alternative for rheumatoid arthritis of the wrist.

**Methods:** The PSA procedure consists of a resection of the distal radius preserving the volar cortex (palmar-shelf), distal ulna excision to achieve euvariance, scapholunate repair, and collagen—bone wax interposition. An external fixator is applied in distraction for 6 weeks, with cast immobilization until 3 months postoperatively.

There were 9 female and 4 male patients. Age at the time of surgery was 32 to 54 years (average, 43 y). Age at the time of follow-up was 46–65 years (average, 56 y). Patients were interviewed, examined, and x-rayed for the study. A questionnaire using a pain analog scale as well as the Quick—Disabilities of the Arm, Shoulder, and Hand and MASS scoring systems were compared to preoperative and postoperative subjective reports and wrist function. Standard error was calculated at a confidence level of 95%. Preoperative to postoperative comparison used the 2-sample t-test to derive the P value.

**Results:** One patient required wrist fusion at 1 year postoperatively for wrist instability. Those data were excluded from the analysis of the series. Of the remaining 12 patients, none have requested or required a revision procedure. All remaining patients experienced improvement with both pain and function. Patient satisfaction was very high. No wrist fused spontaneously. Scoring results demonstrated a consistent decrease in the pain analog scale at rest ranging from 5 to 8 preoperatively to 0 to 2 postoperatively, and with usage from 6 to 9 preoperatively to 1 to 3 postoperatively. The MASS score decreased 40% to 100%, with an average of 75.5% ± 9.8% improvement.

- Speaker has nothing of financial value to disclose

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The Quick—Disabilities of the Arm, Shoulder, and Hand score decreased from a score of 50 to 82 (average 63.4 ± 5.7) to 0 to 36 (average 15.5 ± 6.1) for a series composite of 76.0% <\(\text{fi}\)cant (was statistically signi\(\text{fi}\)cant. Wrist range of motion averaged 35° ± 6.5° extension and 32° ± 3.6° flexion, for a motion arc of 67° ± 8.2°. Radiographic results demonstrated maintenance of radiocarpal pseudoarthrosis and sagittal plane alignment with ulnar translocation of the carpus, creating an equally weighted 2-bone forearm.

**Summary:** In 1970, PSA was introduced by Chase as a resectional wrist arthroplasty. In 1999, this author reported results of 14 patients treated with PSA and observed for 4.2 years. In the current series, the author reports the long-term results of 12 patients treated with PSA, observed for 10 to 20 years (average, 13.2 y). In the short, intermediate, and now long term, follow-up palmar shelf arthroplasty consistently yields satisfactory results. Palmar-shelf arthroplasty compares favorably with reported results of both wrist arthrodesis and implant arthroplasty.

**REFERENCES**


**PAPER 60**

Clinical Paper Session 14: Basic Science/Microsurgery
Saturday, October 5, 2013 • 10:05—10:11 AM
Category: Basic Science—Lab Research
Keyword: Other

**The Influence of Age on Chemotactic and Inflammatory Marker Expression in Rats Following Peripheral Nerve Injury**

Not a clinical study

÷ F. Johannes Plate, MD
÷ Jiaozhong Cai, MLT
÷ Thomas L. Smith, PhD
÷ Zhongyu Li, MD, PhD

**Hypothesis:** The rate of Wallerian degeneration after peripheral nerve injury is limited by the clearance of myelin debris by macrophages. Increasing age lowers the rates of nerve recovery. This study hypothesized that inflammatory and monocyte chemotactic factor-1 (MCP-1) expression from Schwann cells in response to nerve injury decreases with age, resulting in decreased macrophage recruitment and activation.

**Methods:** In 15 young (mean weight, 146 g) and 15 old (mean weight, 471 g) Lewis rats, unilateral sciatic nerve crush injury was induced. Both sciatic nerves from 5 animals in each group were harvested at 1, 3, and 471 g) Lewis rats, unilateral sciatic nerve crush injury was induced. Both sciatic nerves from 5 animals in each group were harvested at 1, 3, and 10 days after injury. Ribonucleic acid was extracted using TRI reagent (Ambion) and assessed for quantity and purity (NanoDrop Technologies). The RNA was transcribed to cDNA using random hexamers and Superscript II (Invitrogen). Real-time polymerase and viability (electrophoresis). The RNA was transcribed to cDNA using random hexamers and Superscript II (Invitrogen). Real-time polymerase chain reaction was performed using Taqman (Applied Biosystems) for tumor necrosis factor-\(\alpha\), interleukin-6, and MCP-1 as target genes and glyceraldehyde 3-phosphate dehydrogenase as endogenous control. Histological analysis revealed differences in axon diameter and nerve fascicle area relative to total cross-sectional area between age groups at different time points. The total number of axons was similar in both groups at each time point (\(P > .05\)).

**Summary:**

÷ The significant reduction of MCP-1 expression in old animals revealed that aging affects the ability for sustained upregulation of the MCP-1 gene in response to injury, whereas the inflammatory response remained similar.
÷ Macrophage recruitment and activation may be decreased compared with young animals, limiting the rate of myelin clearance during Wallerian degeneration.
÷ Contracted Research with: Wright Medical

**PAPER 61**

Clinical Paper Session 14: Basic Science/Microsurgery
Saturday, October 5, 2013 • 10:15—10:21 AM
Category: Nerve/Neuromuscular
Keyword: Hand

**Comparison of Magnification in Primary Digital Nerve Repair: Literature Review, Survey of Practice Trends, and Assessment of 90 Cadaveric Repairs**

Not a clinical study

÷ Derek T. Bernstein, MD
÷ Kristy L. Hamilton, BA
÷ Christian Foy, MD
÷ Nancy Petersen, PhD
÷ David T. Netscher, MD

**Hypothesis:** There is no consensus on the optimal magnification level for digital nerve repair despite the importance of adequate visualization. We hypothesized that microscopic magnification is associated with superior digital nerve repairs, and that despite this, hand surgeons do not uniformly prefer 1 form of optical assistance over another.

**Methods:**

1. Published clinical outcomes of digital nerve repair accounting for magnification level were reviewed.
2. Members of the American Society for Surgery of the Hand were surveyed regarding their surgical practices.
3. A total of 90 cadaveric digital nerve repairs required to achieve 80% power were performed by 9 hand surgeons using loupes (\(\times 4.0\) to \(\times 4.0\)) or microscopic (\(\times 12.5\)) magnification. To ensure concordance, each repair was evaluated by 2 attending hand surgeons, who were blinded to the study protocol, using a visual grading scale (Fig. 1). Univariate and multivariate analyses were used to evaluate repairs.

**Results:**

1. Six relevant publications were identified, involving 130 repairs with loupes (\(\times 4 \times 6\)) and 255 by microscope. Univariate analysis revealed no statistically superior clinical outcomes using high-powered loupes (\(\times 4 \times 6\)) versus microscopic magnification, with no data on lower-magnification loupes more commonly used in practice.
2. Survey data indicated that 52% of hand surgeons use microscopes and 48% used loupes for digital nerve repair. Of those preferring loupes, 78.4% used \(\times 2.5\) to \(\times 3.5\) magnification. Furthermore, 75% of respondents worked in surgicenters, of which only 68.9% had access to a designated operative microscope.
3. Univariate and subsequent multivariate analysis of the cadaver repairs demonstrated excellent repairs in 60.0% of microscope repairs versus 28.9% of loupes repairs (odds ratio, 3.9; 95% confidence interval, 1.5–10.2), with excellent concordance between the evaluating surgeons (Fig. 2). The surgeon, level of training, repair time, and stitches per repair were not significantly related to an excellent repair.

÷ Speaker has nothing of financial value to disclose
There is no consensus on the optimal magnification level for digital neurorrhaphy in the literature despite the importance of adequate visualization for epineurial repair. More important, the loupe magnifications employed in these studies did not coincide with those currently used in practice, which limits their application.

Our survey of members of the American Society for Surgery of the Hand confirms the broad range of magnification levels used for digital nerve repairs. Furthermore, our survey highlights a significant number of hand surgeons without access to a designated operative microscope.

Our cadaveric study indicates the clear superiority of microscopic magnification in digital nerve repair. Our findings suggest that higher magnification levels might be associated with improved clinical outcomes.

Consulting Fees (eg, advisory boards) received from: Deputy Editor, Journal of Hand Surgery
Enhanced Ligament Differentiation for Adipocyte-Derived Mesenchymal Stem Cell Engineering

**Methods:** Polycaprolactone fumarate (PCLF), a novel polymer previously described in our laboratory, were synthesized into macroporous scaffolds (pore sizes, 500 – 750 μm) to allow cell–cell communication and nutrient flow. Porous scaffold molds were designed using SolidWorks CAD software and printed using a SolidScape 3-dimensional printer. Adipocyte-derived human mesenchymal stem cells were harvested and cultured in Dulbecco’s modified Eagle’s medium and 10% fetal bovine serum. The analysis compared this medium with a medium composed of Dulbecco’s modified Eagle’s medium with 5% platelet lysate (PL), a mixture of platelet release products. Seeds of scaffolds occurred in a dynamic bioreactor. Assays included cellular proliferation (MTS), viability (live/dead immunostaining), differentiation (aminoglycan, alkaline phosphatase, and total collagen), and immunostaining for collagen I, tenasin-C, and collagen III (ligament differentiation markers).

**Results:** The PCLF scaffolds were created with pore sizes of 500 or 750 μm and porosities of 45% and 60%, respectively. After comparing multiple toxicity protocols to remove toxic byproducts, the preferred regimen led to pore shrinkage by 10%. After dynamic cell seeding of the progenitor cells on the PCLF, the cells remained viable for 2 weeks cultured in vitro culture plates (Fig. 1). The cell density throughout the pores and metabolic activity of the scaffolds increased as cell proliferation continued along the 3-dimensional PCLF scaffolds (P < 0.05). Adipocyte-derived human mesenchymal stem cell proliferation rates increased in PL compared with fetal bovine serum (P < 0.05). The cells had a low baseline expression of alkaline phosphatase and aminoglycan, but increased expression of total collagen when induced by the ligament and tenogenic growth factor fibroblast growth factor—2 (P < 0.05). This effect was significantly augmented when cultured in the presence of PL (P < 0.01). Immunostaining at 2 and 4 weeks for the expression of ligament markers tenasin-C and collagen I significantly increased with fibroblast growth factor and PL, comparable to human fibroblasts grown on the PCLF scaffolds (Fig. 2).

**Summary:** Our results demonstrate that adipocyte-derived human mesenchymal stem cells are able to attach, proliferate, and differentiate into ligamentous phenotypes along the porous PCLF scaffold. This novel scaffold has potential in stem cell engineering and ligament regeneration.

**REFERENCES**


**PAPER 63**

Clinical Paper Session 14: Basic Science/Microsurgery
Saturday, October 5, 2013 • 10:35–10:41 AM
Category: Basic Science—Lab Research
Keyword: Wrist

**Novel Porous Polycaprolactone Fumarate (PCLF) Scaffold for Adipocyte-Derived Mesenchymal Stem Cell Engineering and Platelet Lysate–Enhanced Ligament Differentiation**

**Not a clinical study**

*Eric R. Wagner, MD*
*Dalibel Bravo, BS*
*Steven Chase, BS*
*Michael J. Yaszenmski, MD, PhD*
*Mahroof Dadsetian, PhD*
*Sanjeev Kakar, MD, MBA*

**Hypothesis:** Intra-articular ligament injuries are difficult to treat because of their poor regeneration potential; current attempts at surgical reconstruction often do not relieve the patient’s symptoms. We hypothesized that a novel composite polymer “neoligament” would be able to be seeded with progenitor cells, and growth factors would be able to regenerate native ligamentous tissue.

**Methods:** Polycaprolactone fumarate (PCLF), a novel polymer previously described in our laboratory, were synthesized into macroporous scaffolds (pore sizes, 500 – 750 μm) to allow cell–cell communication and nutrient flow. Porous scaffold molds were designed using SolidWorks CAD software and printed using a SolidScape 3-dimensional printer. Adipocyte-derived human mesenchymal stem cells were harvested and cultured in Dulbecco’s modified Eagle’s medium and 10% fetal bovine serum. The analysis compared this medium with a medium composed of Dulbecco’s modified Eagle’s medium with 5% platelet lysate (PL), a mixture of platelet release products. Seeds of scaffolds occurred in a dynamic bioreactor. Assays included cellular proliferation (MTS), viability (live/dead immunostaining), differentiation (aminoglycan, alkaline phosphatase, and total collagen), and immunostaining for collagen I, tenasin-C, and collagen III (ligament differentiation markers).

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**REFERENCES**

Clinical Paper Session 15: Finger Joint Arthritis
Saturday, October 5, 2013 • 2:15–2:21 PM
Category: Arthroplasty
Keyword: Hand

Silicone Implant Arthroplasty for Nonrheumatic Metacarpophalangeal Osteoarthritis
Level 4 Evidence

♦ Mithun K. Neral, BS
♦ Douglas E. Pittner, MD
♦ Joseph E. Imbriglia, MD

Hypothesis: Silicone arthroplasty of the metacarpophalangeal joint (MCP) is a well-established treatment for rheumatoid arthritis.1,2 However, available literature on treatment of nonrheumatic arthritis is limited to case reports and retrospective reviews of small patient populations. The purpose of this study was to evaluate the clinical effectiveness of MCP arthroplasty for nonrheumatic arthritis in a larger group of patients with a longer follow-up period. We hypothesized that MCP arthroplasty for nonrheumatic arthritis would show significant improvement in hand function, pain relief, and overall patient satisfaction.

Methods: A search of all MCP arthroplasties performed by a single surgeon for nonrheumatic arthritis over a 12-year period found 136 arthroplasties. Of these, adequate prospective follow-up assessment could be completed for 30 patients with 38 MCP arthroplasties at 56 months average postoperative time. Objective measures included arc range of motion (ROM), grip and pinch strength, Disabilities of the Arm, Shoulder, and Hand (DASH) score, and visual analog pain score. Follow-up x-rays were reviewed. Patients also completed a subjective patient satisfaction questionnaire. Mean ROM, DASH, and pain were compared between the preoperative and follow-up groups by paired t-test and linear regression to identify significant differences and trends in long-term follow-up.

Results: There was significant improvement between mean preoperative and follow-up ROM, DASH, and pain, with P values of .0006, .0007, and < .0001, respectively. Mean follow-up ROM, DASH, and pain scores were 69.5° ± 3.0°, 15.0 ± 2.3, and 0.76 ± 0.2, respectively. Linear regression showed significant correlations between preoperative measurements and improvement at follow-up for ROM, DASH, and pain, with P values of .0003, .0310, and < .0001, respectively. There was no significant difference for grip (P = .593) or pinch (P = .296) strength when follow-up operative and nonoperative hand strengths were compared. Results of the questionnaire showed that 73% were “very satisfied,” 87% would “definitely do it again,” and 70% experience “rare or no pain.” Follow-up x-rays showed 5° mean angulation and 2 mm mean subsidence compared with immediate postoperative x-rays. Four arthroplasties required revision, for a revision rate of 11%.

Summary:
- Results from this study show improved ROM and DASH score, excellent pain relief, and excellent patient satisfaction in patients undergoing MCP arthroplasty for nonrheumatic arthritis.
- Patients with more severe ROM limitation, DASH score, and pain score experienced a greater improvement of these measures at follow-up.
- Strength improvement was limited although it remained comparable to the nonoperative hand.
- Angulation, subsidence, and complications in the study population were consistent with those reported in current literature.1,3,4

REFERENCES

Clinical Paper Session 15: Finger Joint Arthritis
Saturday, October 5, 2013 • 2:25–2:31 PM
Category: Arthritis
Keyword: Hand

Thumb Carpometacarpal Fusion With Distal Scaphoid Excision: A Novel Procedure for Pantrapezial Arthritis in the High-Demand Hand: A Clinical and Biomechanical Study
Level 4 Evidence

♦ Gary M. Lourie, MD
♦ Scott Tanaka, MD
♦ James Marino, MD

Hypothesis: Thumb carpometacarpal (CMC) fusion combined with distal scaphoid excision (DSE) improves range of motion (ROM) compared with fusion alone. This procedure may prove advantageous in the high-demand pantrapezial arthritis thumb.

Methods: Thirteen fresh-frozen cadaveric specimens underwent fluoroscopic evaluation in the posteroanterior (PA) plane with the thumb in radial abduction and adduction. In the lateral plane, thumb palmar abduction and adduction were measured. A CMC fusion was then simulated by passing 2 1.6-mm K-wires across the joint. The same 4 fluoroscopic images were taken after the fusion. The distal scaphoid was then excised and the
4 images were again obtained. The angle between the index finger metacarpal and thumb metacarpal was recorded.

Statistical analysis was performed using Wilcoxon signed-rank test. Eight patients, all deemed high demand with pantrapezial disease, underwent CMC fusion with DSE to prevent postoperative subsidence seen in conventional arthroplasty. Outcome measures included subjective assessment along with preoperative and postoperative ROM, pinch, and grip strength.

Results: The mean arcs of motion in the PA plane prefusion, postfusion, and postfusion with DSE were 48.5°, 25.1°, and 34.6°, respectively. An increase in arc of motion of 9.5° (P = .0002) was obtained after DSE compared with thumb CMC fusion alone. In the lateral plane, the mean arcs of motion prefusion, postfusion, and postfusion with DSE were 53.4°, 22.4° and 33.6°, respectively. A statistically significant increase in arc of motion of 11.2° (P = .0005) in the lateral plane was obtained after DSE compared with thumb CMC fusion alone. This was a 20% (P = .0002) and 21% (P = .0005) increase in prefusion range of motion in the PA and lateral planes, respectively, from fusion alone compared with fusion and DSE. All 8 patients healed uneventfully; showed no radiographic subsidence; achieved pain relief; and on objective evaluation demonstrated improved pinch and grip, and ROM, and were able to flatten the palm without difficulty.

Summary:
- An increase in ROM in both the PA and lateral planes was observed after DSE combined with fusion compared with CMC fusion alone, as shown in this cadaveric biomechanical study.
- Although thumb CMC fusion provides symptomatic relief, ROM is significantly limited. Patients are often unable to place the palm flat on a table postfusion.
- Distal scaphoid excision improves ROM and addresses the scaphotrapezoidal joint in patients with pantrapezial arthritis while maintaining the potential benefits of improved strength and decreased risk of subsidence in the younger, high-demand patient.

REFERENCES

PAPER 66
Clinical Paper Session 15: Finger Joint Arthritis
Saturday, October 5, 2013 • 2:35–2:41 PM
Category: Arthroplasty
Keyword: Hand

Suture Fixation Versus Reconstruction in CMC Arthroplasty: Double-Blind RCT
Level 2 Evidence

© Michael S. Shuler, MD
© Mellisa Roskosky, MSPH

Speaker has nothing of financial value to disclose
Hypothesis: Participants who receive the suture fixation technique will score significantly higher on functional outcome measures and will demonstrate greater strength and flexibility compared with patients who receive ligament reconstruction with tendon interposition.

Methods: Study participants were randomly assigned to 1 of 2 groups of 30 patients (60 total participants). Subjects in both groups underwent a trapeziectomy. In the investigational group, the trapeziectomy was followed by a ligament reconstruction using a suture fixation system to restore thumb metacarpal alignment, without tendon interposition. In the control group, it was followed by the use of harvested flexor carpi radialis to reconstruct the palmar oblique ligament. Both groups went through identical immobilization procedures and therapy regimens. Overall functionality was measured using the Disabilities of the Arm, Shoulder, and Hand questionnaire score, assessed at baseline and at each follow-up visit. Participants were also asked to rate their pain from 0 to 10 at each follow-up visit. Measurements were taken at baseline and each follow-up visit from 6 weeks onward to assess strength (grip strength and key and tip pinch strength) and range of motion (radial and palmar abduction). Data collected at baseline and 2 weeks, 6 weeks, 3 months, and 6 months postoperatively were analyzed using t-tests and linear regression modeling.

Results: There was no significant difference detected in Disabilities of the Arm, Shoulder, and Hand score or analog pain scale between the investigational and control groups at baseline or any follow-up visits. Strength and range of motion measurements at each follow-up visit were standardized by each patient’s baseline measurements. Similar to the functionality results, the groups did not differ significantly on any of these measures during the follow-up period. Operative time was significantly shorter in the investigational group, by 9.6 minutes.

Summary: Despite finding no significant difference in functionality, strength, and range of motion, we believe these results indicate that the 2 techniques are at least equivalent procedures. Using a suture fixation system to reconstruct the ligament eliminates the need to harvest a tendon from the wrist, making it both a shorter and potentially less invasive alternative.

▲ This presentation will discuss Mini Tight-Rope by Arthrex

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**PAPER 67**

Clinical Paper Session 15: Finger Joint Arthritis
Saturday, October 5, 2013 • 2:45—2:51 PM
Category: Arthritis
Keyword: Hand

**Sixteen-Year Experience of the ARPE Prosthesis for Symptomatic Trapezial-Metacarpal Osteoarthritis**

Level 4 Evidence

- Nicholas J. Goddard, FRCS

Hypothesis: Sixteen years of experience are presented of trapezial-metacarpal joint replacement for Eaton stage 2 and 3 disease using an ARPE implant (Biomet). This is a ball and socket design with hydroxyapatite-coated metacarpal stems, a hydroxyapatite-coated high-density polyethylene/CoCr hemispherical socket, and a modular 4-mm head/neck component with variable offsets.

Methods: This study reviews experience with 202 patients over a 16-year period, with a predominantly female population and mean age of 58.3 years. All patients were reviewed clinically (using the Disabilities of the Arm, Shoulder, and Hand questionnaire) and radiologically.

Results: Of the 227 prostheses with a mean 7.8-year follow up (range, 1—16 y), 93% of implants were still in situ and functioning well. Complications can be divided into early and late. Four patients had early dislocations that were
either simply reduced or revised using a different head and neck component. The late dislocations were revised to simple excision arthroplasty. There were 6 cases of loosening, 1 of trapezial fracture, and 5 of documented wear. Overall, 7% were revised; a further 4% had radiological evidence of loosening and were asymptomatic.

Summary: Green stated in 2003 that “total joint arthroplasty appears not to offer any compelling functional advantage or durability of trapezial excision and ligament reconstruction, and is clearly fraught with a high complication rate,” but our data suggest that this is in fact a pessimistic view. Trapezial-metacarpal joint replacement using an ARPE implant provides excellent pain relief (which in a limited patient cohort is preferable to ligament reconstruction with tendon interposition), good function, and in the event of failure, uncomplicated potential for salvage.

- Consulting Fees (eg, advisory boards) received from: Acumed

### PAPER 68

Clinical Paper Session 16: Evidence/Clinical Guidelines  
Saturday, October 5, 2013 • 2:15—2:21 PM  
Category: Other  
Keyword: Other  

The Quality of Randomized Controlled Trials in Hand, Wrist, and Elbow Surgery: A Critical Analysis of Current Literature  
Not a clinical study  

- Jaeohon M. Kim, MD  
- Ryan Michael Zimmerman, MD  
- Christopher M. Jones, MD  
- Norman H. Dubin, PhD  
- James P. Higgins, MD  
- Kenneth R. Means, Jr, MD  

Hypothesis: We hypothesized that randomized controlled trials (RCTs) in hand, wrist, and elbow surgery are of varying quality based on standardized metrics.

Methods: We selected the 6 most frequently cited journals that regularly publish hand, wrist, and elbow surgery manuscripts, based on 5-year average impact factors from the 2011 Journal Citation Reports. Using PubMed and journal-specific search query, we identified and screened 2,114 articles. A total of 63 RCTs met the inclusion criteria for analysis. Two authors were blinded to the study protocol and randomly assigned to each paper. The reviewers used the Modified Coleman Methodology Score (MCMS) and Jadad scale (5-point validated quality measure) to assess manuscript quality and the Consolidated Standards for Reporting of Trials statement to assess the completeness of reporting. We compared study characteristics and methodology variables with the manuscript quality using Fisher’s exact test and 2-tailed Student’s t-tests in univariate analysis. Pearson coefficient (R) determined the strength of correlation between the number of citations and the quality of the studies.

Results: There was a strong correlation between Jadad scale and MCMS (R = 0.73; P < .001) and between Consolidated Standards for Reporting of Trials statement completeness and MCMS (R = 0.74; P < .001). Based on MCMS, 9 studies were good, 25 were fair, and 29 were poor. None were graded excellent. Randomized controlled trial quality had significantly improved between 2001 and 2005 and 2006 and 2012 (P = .006), and the top journal based on impact factor had a higher number of good quality RCTs (P = .025). Important methodological deficiencies in poorly scoring RCTs include lack of power analysis (P = .002), lack of withdrawal and dropout description (P = .007), and failure to use validated outcomes assessments with an independent investigator (P < .001). Individual study quality was not associated with geography, funding, conflict of interest, or multicenter trials. Among studies published more than 3 years ago (N = 41), the quality of RCTs did not correlate with how often the study was cited (r = 0.138; P = .390), although this may be underpowered.

Summary:  
- Despite an overall improvement in RCTs over the past decade, a large number of studies were of poor quality based on MCMS and Jadad scale.  
- Even with a high level of evidence, the study design and execution of RCTs should be critically assessed.  
- Common methodological deficiencies include lack of power analysis, lack of withdrawal and dropout description, and failure to use validated outcomes assessments. These deficiencies may introduce bias and lead to statistically underpowered studies.

### REFERENCES


- Royalties/Honoraria received from: Integra LifeSciences, Inc  
- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Stryker and Zimmer stock owner

### PAPER 69

Clinical Paper Session 16: Evidence/Clinical Guidelines  
Saturday, October 5, 2013 • 2:25—2:31 PM  
Category: Other  
Keyword: Other  

Citation Accuracy for Scientific Articles Published in Journal of Hand Surgery (American) in 2011  
Not a clinical study  

- Suhail K. Mithani, MD  
- Daniel Blizzard, MD  
- Marc J. Richard, MD  
- David S. Ruch, MD  
- Fraser J. Leversedge, MD  

Hypothesis: Previously, reference listings in the Journal of Hand Surgery—American (J Hand Surg Am) were reviewed for accuracy and improvement was associated with a more stringent reporting process at the time of manuscript submission.1 The accuracy of citations in supporting a statement of fact, however, has not been evaluated. The purpose of this study was to evaluate the accuracy of citation listing and the ability of the reference to support a statement in scientific articles published in J Hand Surg Am in 2011.

Methods: All scientific articles for 3 months of J Hand Surg Am in 2011 were identified. Statements of fact were identified by the authors in 40 articles and citation support for each statement was assessed by criteria described by Eichorn and Yankauer.2 Major errors were defined by the followee: (1) the cited reference did not substantiate the assertions of the
Table 1: Return to Play Recommendations According to Hand or Wrist Injury

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>Immediate Return</th>
<th>Immediate Excision (If Healed in 4 wk)</th>
<th>Immediate Excision (If Healed After 4 wk)</th>
<th>Immediate Excision (If Healed After 8 wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nondisplaced Metacarpal Shaft Fracture Return to Play</td>
<td>14</td>
<td>27</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Scaphoid Fracture Return to Play</td>
<td>0</td>
<td>27</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Pisiform Fracture Treatment and Return to Play</td>
<td>12</td>
<td>18</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Hook of Hamate Fracture Return to Play</td>
<td>11</td>
<td>12</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Thumb UCL Tear Treatment No Surgery</td>
<td>1</td>
<td>14</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Return to Play</td>
<td>2</td>
<td>12</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Stable PIP Dislocation Return to Play</td>
<td>4</td>
<td>12</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

PP, protected play; UP, unprotected play; PIP, proximal interphalangeal.
PAPER 71

Clinical Paper Session 16: Evidence/Clinical Guidelines
Saturday, October 5, 2013  •  2:45–2:51 PM
Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Hand

The Impact of Depression and Pain Catastrophization on Patient-Rated Outcomes Before and After Treatment for Atraumatic Hand Conditions

Level 1 Evidence

Daniel London, BA
Jeffrey Stepan, BS
Martin L. Boyer, MD, FRCS(C)
Ryan Patrick Caffee, MD

Hypothesis: Evidence suggests that patient-rated hand function is affected by depression and pain catastrophization; however, the impact of these comorbidities on response to treatment is unknown. We hypothesized that patients affected by depression and/or pain catastrophization would have worse patient-rated hand function at baseline and 3 months after treatment compared with unaffected patients, but they would demonstrate a response to treatment comparable to unaffected patients.

Methods: Sample size estimates indicated 50 depressed and/or pain catastrophizing patients and 200 unaffected patients provided 94% power to detect a 10-point difference in Michigan Hand Questionnaire (MHQ) scores. A total of 256 patients presenting to an orthopedic hand clinic were prospectively enrolled in this cohort investigation. Patients prescribed treatment for atraumatic conditions were eligible for inclusion. At enrollment, all patients completed the Center for Epidemiologic Studies–Depression Scale (CES-D), the Pain Catastrophizing Scale (PCS), and the MHQ (0–100 scale, where 100 = perfect function). One and 3 months after treatment, patients recompleted the MHQ. Participants’ psychological comorbidity status was categorized as either affected (depressed: CES-D ≥16, or pain catastrophizing: PCS ≥30) or unaffected (CES-D <16 and PCS <30). Diagnoses and treatments between affected and unaffected patients were examined. The effects of time, patients’ status, and their interaction on MHQ scores were evaluated by mixed modeling.

Results: Of the 256 patients enrolled, 50 were affected and 206 were unaffected. Diagnoses and treatments were similar between groups (Table 1). At the time of enrollment, unaffected patients’ mean MHQ score (64.9, 95% confidence interval [CI]: 62.5–67.3) was significantly higher than affected patients’ mean MHQ score (48.1, 95% CI: 43.3–53.0). Affected and unaffected patients demonstrated similar significant absolute improvement over baseline at 3 months after treatment (affected: 12.4, 95% CI: 7.5–17.4; unaffected: 12.9, 95% CI: 10.4–15.3). Thus, affected patients still rated their hand function as worse compared with unaffected patients (unaffected: 77.7, 95% CI: 75.0–80.5; affected: 60.58, 95% CI: 54.96–66.18) at final follow up (Fig. 1).

Summary:
- Patients who are depressed and/or pain catastrophizers report worse self-rated hand function at baseline and after treatment compared with unaffected patients.
- At 3 months after treatment, both depressed and/or pain catastrophizing patients and unaffected patients rate their hand function as significantly improved compared with pretreatment.
- Although depressed and/or pain catastrophizing patients report worse self-related hand function at both baseline and at follow-up, these patients show similar absolute improvement in self-rated hand function after treatment compared with unaffected patients.

Table 1: Participant Diagnoses and Treatments According to Patient Status

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>%</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthritis</td>
<td>51</td>
<td>24.8</td>
<td>14</td>
<td>28.0</td>
</tr>
<tr>
<td>Cyst/mass</td>
<td>14</td>
<td>6.8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dupuytren disease</td>
<td>10</td>
<td>4.9</td>
<td>2</td>
<td>4.0</td>
</tr>
<tr>
<td>Nerve compression</td>
<td>35</td>
<td>17.0</td>
<td>14</td>
<td>28.0</td>
</tr>
<tr>
<td>Tendonitis</td>
<td>74</td>
<td>35.9</td>
<td>9</td>
<td>18.0</td>
</tr>
<tr>
<td>Ulnar-sided wrist pain</td>
<td>5</td>
<td>2.4</td>
<td>2</td>
<td>4.0</td>
</tr>
<tr>
<td>Arthritis and tendonitis</td>
<td>5</td>
<td>2.4</td>
<td>2</td>
<td>4.0</td>
</tr>
<tr>
<td>Nerve compression and tendonitis</td>
<td>8</td>
<td>3.9</td>
<td>4</td>
<td>8.0</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>1.9</td>
<td>2</td>
<td>4.0</td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aponeurotomy</td>
<td>9</td>
<td>4.4</td>
<td>2</td>
<td>4.0</td>
</tr>
<tr>
<td>Brace/medication/therapy</td>
<td>52</td>
<td>25.2</td>
<td>19</td>
<td>38.0</td>
</tr>
<tr>
<td>Injection</td>
<td>97</td>
<td>47.1</td>
<td>16</td>
<td>32.0</td>
</tr>
<tr>
<td>Surgery</td>
<td>47</td>
<td>22.8</td>
<td>13</td>
<td>26.0</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>0.5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 1: Mean MHQ scores over time based on patients’ status as being either unaffected or affected. Both groups demonstrated significant improvement from baseline to 3 months after treatment. The affected group’s mean MHQ score was always significantly less than the unaffected group’s mean MHQ score. Error bars represent 95% confidence intervals.

REFERENCES


- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: OrthoHelix, LLC; MiMedX, LLC
- Consulting Fees (eg, advisory boards) received from: OrthoHelix, LLC; MiMedX, LLC

**PAPER 72**

Keyword: Wrist

**Functional Outcomes Following Treatment of Scaphoid Fractures in Children and Adolescents**

**Level 4 Evidence**

- J. Joseph Gholson, BS
- Peter M. Waters, MD
- David Zurakowski, PhD
- Donald S. Bae, MD

**Hypothesis:** Pediatric scaphoid fractures predominantly involve the waist, and almost one third of patients present late with established nonunions, most which require surgical treatment. Little is known about the long-term functional outcomes of children treated for scaphoid fractures. We hypothesized that with appropriate treatment, functional outcomes as measured by the Disabilities of the Arm, Shoulder, and Hand (DASH) inventory and the Modified Mayo Wrist Score (MMWS) would not vary significantly between patients with acute fractures and nonunions.

**Methods:** A previously established cohort of 312 patients was contacted to complete the DASH inventory, DASH work and sports modules, and MMWS. A total of 63 patients, age 8 to 18 years at the time of treatment, completed the surveys. Twenty-four patients presented with a chronic scaphoid nonunion and 39 presented with an acute fracture. Twenty of the 24 nonunions and 6 of the 39 acute patients were treated surgically. The mean follow-up was 7.3 years (range: 2.6–17.7 y). Univariate analysis and multivariable linear regression were used to identify predictors of MMWS and DASH scores.

**Results:** All patients went on to successful bony healing. The median DASH score for the overall cohort was 1, with a significantly higher DASH of 4 for patients with nonunions compared with 0 for patients with acute fractures (P < .001). Multivariate analysis determined that chronic nonunions (P = .020) and proximal pole fractures (P = .030) are independent predictors of a higher DASH score, whereas surgery (P = .520), age (P = .890), and gender (P = .810) did not influence the DASH. The median work module score was 0 for both acute fractures and nonunions (P = .110). The median sports and arts module score was 6 in nonunions and 0 in acute patients (P = .010). The median MMWS for patients with both acute fractures and chronic nonunions was 100 (P = .110).

**Summary:** Children and adolescents who present with nonunions can be successfully managed surgically with minimal midterm functional compromise. Whereas patients treated for nonunions have significantly decreased wrist function compared with acute fractures, the level of function for nonunion patients was in accordance with the general population (mean DASH of 10.1 ± 14.68). No differences were seen in MMWS between patients treated for acute fractures versus nonunions.

**REFERENCE**

- Contracted Research with: ASSH, POSNA (D.S.B.)
- Royalties/Honoraria received from: Textbooks LWW (P.M.W.); Lippincott Williams and Wilkins (D.S.B.)
- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Optimer, Cubist, Osiris (D.S.B.)

**PAPER 73**

Keyword: Wrist

**Radiological and Arthroscopic Assessment of Scaphoid Nonunion and Scapholunate Instability**

**Level 4 Evidence**

- Masahiro Tatebe, MD
- Takaaki Shinozaka, MD
- Michiro Yamamoto, MD
- Shigeru Kurimoto, MD
- Hitoshi Hirata, MD

- Speaker has nothing of financial value to disclose
Hypothesis: Some authors have reported acute scaphoid fracture with carpal instability; these cases are not rare. However there are only a few reports about established scaphoid nonunion assessed by x-ray, computed tomography, and arthroscopy. Our null hypotheses were as follows: (1) Scaphoid nonunion with scapholunate (SL) dissociation (SLD) is not rare, (2) scaphoid nonunion with SLD have severe dorsal intercalated segment instability deformity, (3) fracture patterns and/or lunate types are associated with SLD.

Methods: We reviewed 70 (average, 28 y) scaphoid nonunions. Patients demographic and injury characteristics were recorded. Fracture pattern and displacement of nonunion fragment (fragment gap > 1 mm) were confirmed by computed tomography. Carpals alignments (radiolunate, radioscaphoid, and SL angle) were determined by plain radiograph. Scapholunate/ lunotriquetral (SL/LT) instability and lunate morphology were confirmed by arthroscopy. The patient was determined to have SL/LT instability when the arthroscopy showed Geissler grade 3 or 4.

Results: Scapholunate instability was detected in 16 cases, and LT instability in 12 cases; both SL and LT instability occurred in 7 cases. No significant association was found between instability and carpal alignment. Fracture pattern showed 3 patterns: waist volar in 44, waist dorsal in 19, and proximal pole in 7. Type 1 lunate was present in 34 patients and type 2 lunates were in 36. Fracture patterns show no significant differences between SL/LT instabilities and lunate type. Type 1 lunate and displaced nonunion are associated with the radiolunate/SL angle (dorsal intercalated segment instability pattern). Patients’ demographic and injury characteristics also had no association with any parameters.

Summary:
- Combined scaphoid nonunion and SL/LT instability is not rare.
- The fracture pattern had no correlation with SL/LT instability.
- Lunate type and displaced nonunion are associated with a DISI pattern.

REFERENCES

**PAPER 74**

Clinical Paper Session 17: Wrist: Scaphoid/Scapholunate Saturday, October 5, 2013 • 4:00–4:06 PM
Category: Basic Science - Lab Research
Keyword: Wrist

Radiographic Evaluation of the Modified Brunelli Technique Versus a Novel Scapholunate-triquetral Tenodesis Technique for Scapholunate Dissociation in a Cadaver Model

Not a clinical study

Jennifer W. Hsu, MD
Katie K. Jegapragasan, MD
Mithulun K. Jegapragasan, MD
Jerry I. Huang, MD

Hypothesis: The modified Brunelli technique (MBT) is a popular ligament tenodesis technique that reconstructs the volar scaphotrapezium-trapezoid and dorsal scapholunate (SL) ligaments (SLL), and tightens the dorsal radiocarpal ligament. However, recurrent diastasis is common, as with other reconstructions. A new reconstructive method, described by Ross et al., involves transossesous tunnels across the scaphoid, lunate, and triquetrum (scapholuno-triquetrum [SLT] tenodesis), for a biologic tether along the central axis of the SL joint. The tendon is then passed dorsally to tighten the dorsal radiocarpal and reconstruct the dorsal SLL. We hypothesized that this novel method would provide better anatomic reduction of the SL articulation and stronger reconstruction in a cadaver model, as measured by SL angle and diastasis on radiographs.

Methods: Ten fresh-frozen cadaveric wrists were radiographically examined in neutral, ulnar deviation, and clenched fist positions. Scapholunate angle and diastasis were recorded in each position with the SLL intact, after sectioning of the ligament and secondary restraints, and after reconstruction by either the MBT (5 arms) or the SLT technique (5 arms). Wrists were cycled through their maximum flexion and extension arc 100 times to simulate wrist motion, after ligament sectioning as well as after reconstruction. Statistical analysis was performed with JMP Pro 10.0.0 (SAS Institute). Means were compared with Student’s t-test and matched-pair t-test where appropriate.

Results: After ligament sectioning and cycling, all wrists demonstrated significantly increased SL diastasis on the clenched fist view, with average distance of 5.1 mm, compared with 2.2 mm in intact specimens (P = .001). After cycling, there was larger diastasis in the MBT reconstructions compared with the SLT reconstructions, although this was not statistically significant (3.1 vs 2.5 mm; P = .470).

After ligament sectioning and cycling, SL angle increased from an average of 50.1° to 64.9° in the clenched fist position (P < .0001). In the cycled MBT reconstructions, SL angle remained increased compared with intact wrists (56.8° vs 47.4°; P = .030). In the cycled SLT reconstructions, SL angle was not significantly different from intact wrists (55.8° vs 52.8°; P = .150).

Summary:
- In this cadaveric model, both MBT and SLT techniques restored anatomic parameters after sectioning of the SLL.
- With cycling, normal diastasis was better maintained with the SLT reconstructions compared with the MBT, although this was not statistically significant. There was also greater variation in diastasis with MBT reconstructions.
- Restoration of the SL angle was better in wrists undergoing SLT reconstruction compared with MBT reconstruction.

REFERENCES

Speaker has nothing of financial value to disclose.
A New Technique for Scapholunate Ligament Reconstruction Utilizing FCR and Interference Screw Fixation

Level 4 Evidence

• Mark Ross, FRACS
• Greg Couzens, FRACS

Hypothesis: Our technique for transosseous scapholunate (SL) ligament (SLL) reconstruction yields reliable and satisfactory results compared with published surgical techniques.

Methods: We present a consecutive prospective cohort of patients who had an SLL reconstruction using a technique developed by the authors. This technique builds on the concepts of the Brunelli reconstruction and the 3-ligament tenodesis reconstruction of Garcia-Elias et al. A strip of flexor carpi radialis is left attached distally and passed volar to the STT joint to control scaphoid flexion. The same graft is used to reconstruct the SLL. However, security and tensioning of the graft and reduction of the SL interval are improved by passing the graft centrally through the scaphoid, lunate, and triquetrum. The graft is secured by interference-screw fixation into the triquetrum. Further passage of the graft dorsally from triquetrum to scaphoid augments the dorsal-intercarpal ligament.

Results: Patients were between 23 and 54 years of age at surgery; 81.8% were male. The operative hand was dominant in 91%. There was an average of 11.5 months from the time of injury to surgery (range, 4–30 mo). A total of 72% had static deformity of the SL articulation.

Results of the Quick-Disabilities of the Arm, Shoulder, and Hand questionnaire improved from a preoperative mean average of 50 (SD, 15.22) to 21.2 (SD, 15.33). Patient-Rated Wrist Evaluation score improved from a mean of 43.1 (SD, 7.25) to 18.92 (SD, 11.87). Grip strength (Jamar dynamometer) improved from 37.4 (SD, 17.35 kgf) to 44.4 (SD, 5.04 kgf). Pain during normal activity (100 mm, visual analog scale) improved from 17.8 (SD, 6.54) to 13.56 (SD, 13.99). Flexion-extension total arc of movement reduced from 130.18° (SD, 6.85°) to 102.27° (SD, 26.65°). On x-ray, the SL interval improved from 4.18 mm (SD, 0.603 mm) to 1.627 mm (SD, 0.660 mm). The SL angle improved from 80.45° (SD, 5.13°) to 56.82° (SD, 5.13°).

We observed 1 complication in a patient who initially recovered well and returned to professional football. At 10 months postsurgery, he experienced a high-energy hyperextension injury and fractured the lunate (dorsal third). He was treated with a scaphocapitolunate arthrodesis.

Summary:
- This technique builds on the features of previous SLL reconstructions and offers greater ease of reduction and improved graft security.
- Graft placement close to the rotational axis of the SL articulation allows balanced reduction without favoring either dorsal or volar gap closure.
- This technique has demonstrated excellent results in treating patients with static deformity, a challenging group with previous techniques.

References:
PAPER 77

Clinical Paper Session 18: Dupuytren Disease
Saturday, October 5, 2013 • 3:40–3:46 PM
Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Hand

**Nonsurgical Treatment of Dupuytren Contracture: 3-Year Safety Results Using Collagenase Clostridium histolyticum**
Level 4 Evidence

- Clayton A. Peimer, MD
- Claudia A. McGoldrick, BA
- Greg Kaufman, MD

**Hypothesis:** Adverse events (AEs) observed after the approval of collagenase Clostridium histolyticum (CCH) (XIAFLEX and XIAPEX) are similar to those observed in the first year of postmarketing surveillance.

**Methods:** The current analysis is based on 3 years of postmarketing safety data reported to Auxilium Pharmaceuticals, Inc. Reports analyzed were received from February 2, 2010 (United States approval date) through February 2, 2013. This analysis also includes reports of tendon rupture, ligament injury/rupture, and nerve injury.

**Results:** The AEs reported during the first 3 years of global postmarketing surveillance were similar in type and incidence to those reported in the first year of postmarketing surveillance. From February 2, 2010 through February 2, 2013, approximately 49,078 injections of CCH were administered. An estimated 1,732 AEs were reported in 846 patients and were most commonly localized, nonserious reactions to CCH injections, including skin tears, contusion, peripheral edema, pain in extremity, and injection site reactions (Table 1). There were 19 reports of skin grafts among 228 patients who experienced skin tear postinjection; 11 of 19 were considered to be associated with the finger manipulation procedure and most commonly occurred in treatment of the little finger proximal interphalangeal joint. There were 26 reports of tendon rupture at a rate of 0.05% (26 of 49,078) and 1 report each of A2 pulley injury, stretch neuropraxia (numbness without pain away from the injection site after full extension), and ligament injury. Of the 17 tendon ruptures for which joint and finger could be identified, most occurred in the little finger (5 metacarpophalangeal and 8 proximal interphalangeal) (Table 2). There were also 2 reported cases of complex regional pain syndrome (reflex sympathetic dystrophy), 1 of which resolved within 3 months.

**REFERENCES**
3. Contracted Research with: Auxilium Pharmaceuticals, Inc (C.A.P.)

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**Table 1: Most Commonly Reported Adverse Events Associated With CCH Injection During 3 Years of Postmarketing Surveillance at ≥2% Incidence**

<table>
<thead>
<tr>
<th>Reported AE</th>
<th>Postmarketing AE, n (%)</th>
<th>Reporting Rate per 1,000 Doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin tear†</td>
<td>228 (13.2)</td>
<td>4.6</td>
</tr>
<tr>
<td>Contusion‡</td>
<td>168 (9.7)</td>
<td>3.4</td>
</tr>
<tr>
<td>Peripheral edema</td>
<td>164 (9.5)</td>
<td>3.4</td>
</tr>
<tr>
<td>Drug ineffective</td>
<td>106 (6.1)</td>
<td>2.2</td>
</tr>
<tr>
<td>Pain in extremity</td>
<td>80 (4.6)</td>
<td>1.6</td>
</tr>
<tr>
<td>Swelling, unspecified</td>
<td>67 (3.9)</td>
<td>1.4</td>
</tr>
<tr>
<td>Lymphadenopathy</td>
<td>53 (3.1)</td>
<td>1.1</td>
</tr>
<tr>
<td>Hematoma§</td>
<td>49 (2.8)</td>
<td>1.0</td>
</tr>
<tr>
<td>Injection site pain</td>
<td>47 (2.7)</td>
<td>1.0</td>
</tr>
<tr>
<td>Injection site hematoma</td>
<td>45 (2.6)</td>
<td>0.9</td>
</tr>
</tbody>
</table>

*†A total of 1,732 AEs were reported; ‡= number of reported AEs/total AEs reported.
§Includes laceration and skin lesions.
‡Includes the term “contusion” (any body system) and “ecchymosis” (skin/subcutaneous).
§Other than injection site (vascualr).

**Summary:** Three-year postmarketing surveillance shows a safety profile with reporting rates consistent with the published 1-year postmarketing surveillance.

---

**Table 2: Specifies Regarding Tendon/Ligament Events**

<table>
<thead>
<tr>
<th>Finger and Joint Affected</th>
<th>Tendon Rupture</th>
<th>Tendon/Ligament Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index finger, MCP</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Index finger, PIP</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Middle finger, MCP</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Middle finger, PIP</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ring finger, MCP</td>
<td>4</td>
<td>1 □</td>
</tr>
<tr>
<td>Ring finger PIP</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Little finger, MCP</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Little finger, PIP</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

The joint and/or finger was unknown in remaining 9 reports. □ A2 pulley injury.

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**PAPER 78**

Clinical Paper Session 18: Dupuytren Disease
Saturday, October 5, 2013 • 3:50–3:56 PM
Category: Other
Keyword: Hand

**Delayed Manipulation Following Clostridial Collagenase Histolyticum Injection for Dupuytren Contracture**
Level 1 Evidence

- F. Thomas D. Kaplan, MD
- Marie Badalamente, PhD
- Lawrence Hurst, MD
- Gregory A. Merrell, MD
- Raymond Pahk, MD

**Hypothesis:** After treatment of Dupuytren contracture with clostridial collagenase histolyticum injection (CCH), manipulation for cord rupture can be performed in a delayed fashion, at 2 or 4 days after injection, without compromising efficacy or safety.

**Methods:** Patients with Dupuytren contracture involving the metacarpophalangeal joint caused by a palpable cord participated in a multicenter, prospective, randomized trial. Patients with a contracture of the metacarpophalangeal joint greater than 20° were randomized to undergo manipulation at 1 (group 1), 2 (group 2), or 4 (group 3) days after injection. All patients received 1 dose of CCH (0.58 mg) and were observed for 90 days. Primary end point was the percentage of patients obtaining a greater than 50% reduction in contracture 30 days after injection. The
secondary end point was the percentage of patients maintaining clinical success (defined in the CORD 1 study as a reduction of contracture to 50% reduction in contracture); results were 92% in group 1, 91% in group 2, and 85% in group 3, with the difference between groups not significant. At 90-day follow-up, the percentage of patients maintaining less than 5° contracture was 91% in group 1, 82% in group 2, and 83% in group 3; the difference was not significant (Table 1). The Michigan Hand Outcomes Questionnaire (MHQ) improved from an average of 72 to 93 in group 1, 78 to 94 in group 2, and 83 to 88 in group 3. There was no statistical difference in MHQ score between groups at any time point, although there was a trend toward higher scores in patients with clinical success at day 90. Adverse events are shown in Table 2, and are comparable to rates seen in prior studies.1–5 There were no serious adverse events.

**Summary:**
- There was no significant difference in efficacy after CCH injection when manipulation was delayed until day 2 or 4 after injection.
- Delaying manipulation after CCH injection can be done safely, without an increase in adverse events.
- Patients successfully treated with CCH for Dupuytren contracture showed improvement in MHQ scores, demonstrating improved hand function with reduction of contracture.

### Table 1: Percentage of Clinical Improvement in Contracture After 30 Days and Those Maintaining Clinical Success 90 Days After Injection, Stratified by Group

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Day 1</th>
<th>Group 2</th>
<th>Day 4</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent clinical improvement in</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>contracture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N missing = 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(&gt; 50% reduction 30 d after injection)</td>
<td>11/11</td>
<td>10/11</td>
<td>11/13</td>
<td>.8271</td>
</tr>
<tr>
<td>Maintained clinical success</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N missing = 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction of contracture to ≤ 5 maintained to 90 d after injection</td>
<td>10/11</td>
<td>9/11</td>
<td>10/12</td>
<td>.8109</td>
</tr>
</tbody>
</table>

*Patient L08 had missing data on day 30, but at day 90 had no residual contracture.

### Table 2: Adverse Events

<table>
<thead>
<tr>
<th>Adverse Event</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arm pit pain</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Blood blister</td>
<td>3</td>
<td>12 ± 4.36</td>
</tr>
<tr>
<td>Bruising</td>
<td>14</td>
<td>14.29 ± 5.28</td>
</tr>
<tr>
<td>Bruising–arm pit</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Bruising–hand</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Itching</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Lymphadenopathy</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Nummness</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Edema</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Itching</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Itching in arm pit</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Pain</td>
<td>5</td>
<td>12 ± 6.63</td>
</tr>
<tr>
<td>Pain in palm</td>
<td>1</td>
<td>49</td>
</tr>
<tr>
<td>Skin tear</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Swelling</td>
<td>18</td>
<td>13.28 ± 5.23</td>
</tr>
</tbody>
</table>

### References

4. This presentation discusses clostridial collagenase histolyticum (Xiaflex) by Auxilium Pharmaceuticals.

**PAPER 79**

Clinical Paper Session 18: Dupuytren Disease
Saturday, October 5, 2013 • 4:00–4:06 PM
Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Hand

**Recurrence of Dupuytren Contracture After Nonsurgical Treatment With Collagenase Clostridium Histolyticum:**

**Summary:**

- **Hypothesis:** Treating Dupuytren contracture with collagenase *Clostridium histolyticum* (CCH) shows a sustained durability of response in most subjects.

- **Methods:** The CORDLESS trial is an ongoing 5-year follow-up of patients treated in clinical trials (CORD I/II and JOINT I/II). Beginning 2 years after the first injection of CCH, each patient was reevaluated once each year, with 6 months or more between visits. A clinical success or successfully treated joint was defined as achieving a correction to 0° to 5° after the initial treatment. Recurrence was defined as increase 20° or more, with a palpable cord from the last injection, or when a treated joint underwent medical/surgical intervention. In addition, the number of joints that demonstrated an increase 30° or more was also analyzed to represent a measure often cited as clinically relevant.

- **Results:** Of 644 patients enrolled in the CORDLESS trial, 539 completed the year 4 follow-up. In the original trials, of a total 1,081 treated joints, 623 (57.6%) were treated successfully. At year 4 follow-up, nominal rate of recurrence in joints achieving clinical success was 42.1% and 27.9% for 20° or more and 30° or more worsening, respectively. The recurrence rate slowed from years 3 to 4 (7.1% increase) compared with years 2 to 3 (15.4% increase). Proximal interphalangeal joints showed a higher recurrence rate than metacarpophalangeal joints (Fig. 1). The recurrence rate for low-severity proximal interphalangeal joints (40°) was 70.6%. To date, a total of 543 successfully treated joints (87.2%) have not had additional medical/surgical interventions. From years 3 to 4, the rate of CCH use for the treatment of worsening contractions in joints with clinical success surpassed the rate of secondary fasciectomy (Table 1). Adverse events were reported by 311 of 644 patients (48.3%) but only 1 was related to treatment (decrease in ring finger circumference resulting from Dupuytren contracture resolution), and there were no treatment-related serious adverse events. No long-term safety issues were identified.

- **Summary:**
  - The nominal recurrence rates at 4 years for 20° or more and 30° or more contracture worsening were 42.1% and 27.9%, respectively, and the rate slowed from years 3 to 4 compared with years 2 to 3.
  - Proximal interphalangeal joints with less severe contraction at baseline had lower recurrence rates.
  - A total of 87.2% of successfully treated joints have not had further medical/surgical treatment; retreatment with CCH was more common than fasciectomy in these patients.
  - No long-term safety/risk issues were identified.

- **Robert N. Hotchkiss, MD**
  - Clayton A. Peimer, MD
  - Stephen Geoffrey Coleman, FRACS
  - Ted Smith, PhD
  - James P. Tursi, MD
  - Greg J. Kaufman, MD

**REFERENCES**

Clinical improvement, % of joints 55.0 60.0 59.3 69.8
Clinical success, % of joints 31.3 36.3 31.5 53.5

Table 2: Efficacy Results by Baseline Severity of Contracture After First and Last Injections

<table>
<thead>
<tr>
<th>First injection</th>
<th>Little</th>
<th>Ring</th>
<th>Middle</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical success, % of joints</td>
<td>55.8</td>
<td>46.0</td>
<td>46.2</td>
<td>56.3</td>
</tr>
<tr>
<td>Clinical improvement, % of joints</td>
<td>73.2</td>
<td>63.2</td>
<td>65.4</td>
<td>71.9</td>
</tr>
<tr>
<td>Range of motion, change in degrees</td>
<td>19.8</td>
<td>17.8</td>
<td>17.6</td>
<td>19.3</td>
</tr>
<tr>
<td>High baseline severity (&gt; 40 contracture)</td>
<td>9.6</td>
<td>15.1</td>
<td>17.9</td>
<td>27.3</td>
</tr>
<tr>
<td>Clinical improvement, % of joints</td>
<td>31.7</td>
<td>48.0</td>
<td>42.9</td>
<td>63.6</td>
</tr>
<tr>
<td>Range of motion, change in degrees</td>
<td>21.6</td>
<td>24.7</td>
<td>21.9</td>
<td>24.1</td>
</tr>
<tr>
<td>Last injection</td>
<td>50.7</td>
<td>37.9</td>
<td>42.3</td>
<td>53.1</td>
</tr>
<tr>
<td>Clinical success, % of joints</td>
<td>68.1</td>
<td>58.6</td>
<td>61.5</td>
<td>68.8</td>
</tr>
<tr>
<td>Clinical improvement, % of joints</td>
<td>17.9</td>
<td>17.7</td>
<td>16.6</td>
<td>18.2</td>
</tr>
<tr>
<td>Range of motion, change in degrees</td>
<td>31.7</td>
<td>48.0</td>
<td>42.9</td>
<td>63.6</td>
</tr>
<tr>
<td>High baseline severity (&gt; 40 contracture)</td>
<td>21.6</td>
<td>24.7</td>
<td>21.9</td>
<td>24.1</td>
</tr>
</tbody>
</table>

REFERENCES


• Contracted Research with: Auxilium Pharmaceuticals, Inc (R.N.H., C.A.P., S.G.C.)
• Consulting Fees (eg, advisory boards) received from: Auxilium Pharmaceuticals, Inc (C.A.P.)
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PAPER 80

Clinical Paper Session 18: Dupuytren Disease
Saturday, October 5, 2013 • 4:10–4:16 PM
Category: Basic Science—Clinical Research
Keyword: Hand

Efficacy and Safety of Collagenase Clostridium histolyticum in the Treatment of Proximal Interphalangeal Joints in Dupuytren Contracture: Combined Analysis of 4 Phase 3 Clinical Trials

Level 4 Evidence

• Marie A. Badalamente, PhD
• Lawrence C. Hurst, MD
• Prosper Benhaim, MD
• Brian Cohen, PhD

Hypothesis: An analysis was undertaken to determine the efficacy and safety of collagenase Clostridium histolyticum (CCH) in the treatment of Dupuytren contracture (DC) of the proximal interphalangeal (PIP) joint.

Methods: This retrospective analysis examined DC of 644 PIP joints in 506 subjects enrolled in CORD I/II and JOINT I/II clinical trials 1–3 to determine the percentage of subjects who achieved clinical success (0° to 5° extension), clinical improvement (< 50% of baseline contracture), and improvement in range of motion (ROM) at 30 days after the first injection and the last injection of CCH. Per protocol, a maximum of 3 injections/cord was allowed.

Results: A total of 1,165 CCH injections were administered to cords affecting 644 PIP joints. Clinical success and clinical improvement were shown in 27.0% (174 of 644) and 49.0% (316 of 644) of PIP joints after 1 injection, and in 33.8% (218 of 644) and 58.0% (374 of 644) after the last injection, respectively; 60% of PIP joints received 1 injection, 24% received 2 injections, 15% received 3 injections, and 1% received 4 injections. Mean change in ROM increased from 51.0° at baseline to 71.2° after the first injection, and to 75.4° after the last injection. Clinical success and clinical improvement were highest in the index finger compared with the other fingers (Table 1). Improvement in ROM was generally comparable among the fingers and slightly higher after the last injection. Clinical success and clinical improvement were markedly better in the subgroup with low (≤ 40°) baseline severity than high baseline severity after the first and last injection (Table 2). The most common adverse events included edema (58.3%), contusion (38.0%), injection site hemorrhage (23.0%), pain in extremity (22.4%), injection site pain (20.9%), and swelling (16.2%). Three flexor tendon ruptures of the little finger were reported. No further tendon ruptures occurred after changing the injection method.

Summary:

• Collagenase Clostridium histolyticum was effective for DC of PIP joints of both low and high baseline severity and by finger.
• Outcomes after CCH injection were better in the low baseline severity subgroup, which suggests that earlier intervention achieves better outcomes.
• Clinical success and clinical improvement were most improved in the index finger and least improved in the little finger after the first and last injections in subjects with high baseline severity.

Table 1: Efficacy Results by Finger After First and Last Injections

<table>
<thead>
<tr>
<th>First injection</th>
<th>Little</th>
<th>Ring</th>
<th>Middle</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical success, % of joints</td>
<td>24.3</td>
<td>27.5</td>
<td>29.6</td>
<td>46.5</td>
</tr>
<tr>
<td>Clinical improvement, % of joints</td>
<td>44.7</td>
<td>53.8</td>
<td>51.9</td>
<td>67.4</td>
</tr>
<tr>
<td>Range of motion, change in degrees</td>
<td>20.3</td>
<td>20.9</td>
<td>19.4</td>
<td>19.7</td>
</tr>
<tr>
<td>Last injection</td>
<td>31.3</td>
<td>36.3</td>
<td>31.5</td>
<td>53.5</td>
</tr>
<tr>
<td>Clinical success, % of joints</td>
<td>55.0</td>
<td>60.0</td>
<td>59.3</td>
<td>69.8</td>
</tr>
<tr>
<td>Clinical improvement, % of joints</td>
<td>25.2</td>
<td>23.8</td>
<td>23.7</td>
<td>21.8</td>
</tr>
<tr>
<td>Range of motion, change in degrees</td>
<td>19.8</td>
<td>17.7</td>
<td>16.6</td>
<td>18.2</td>
</tr>
</tbody>
</table>

Figure 1: Nominal recurrence rates overall and by type of Dupuytren contracture joint.

Table 1: Intervention Types Chosen for Treatment of Worsening Contracture in Joints Originally Treated to Clinical Success (Reduction in Dupuytren Contracture to 0 by 5), by Year

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Year 2, n (%)</th>
<th>Year 3, n (%)</th>
<th>Year 4, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>15 (100)</td>
<td>32 (100)</td>
<td>38 (100)</td>
</tr>
<tr>
<td>CCH</td>
<td>0 (0)</td>
<td>6 (18.8)</td>
<td>18 (47.4)</td>
</tr>
<tr>
<td>Fascectomy</td>
<td>9 (60)</td>
<td>20 (62.5)</td>
<td>12 (31.6)</td>
</tr>
<tr>
<td>Needle aponeurotomy</td>
<td>3 (20)</td>
<td>4 (12.5)</td>
<td>5 (13.2)</td>
</tr>
<tr>
<td>Fasciotomy</td>
<td>0 (0)</td>
<td>1 (3.1)</td>
<td>1 (2.6)</td>
</tr>
<tr>
<td>Dermo-fasciotomy</td>
<td>0 (0)</td>
<td>1 (3.1)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Other</td>
<td>3 (20)</td>
<td>0 (0)</td>
<td>2 (5.3)</td>
</tr>
</tbody>
</table>

This retrospective analysis examined DC of the proximal interphalangeal (PIP) joint. The hypothesis was undertaken to determine the efficacy and safety of collagenase Clostridium histolyticum (CCH) in the treatment of Dupuytren contracture (DC) of the proximal interphalangeal (PIP) joint.

Methods: This retrospective analysis examined DC of 644 PIP joints in 506 subjects enrolled in CORD I/II and JOINT I/II clinical trials 1–3 to determine the percentage of subjects who achieved clinical success (0° to 5° extension), clinical improvement (< 50% of baseline contracture), and improvement in range of motion (ROM) at 30 days after the first injection and the last injection of CCH. Per protocol, a maximum of 3 injections/cord was allowed.

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• Outcomes after CCH injection were better in the low baseline severity subgroup, which suggests that earlier intervention achieves better outcomes.
• Clinical success and clinical improvement were most improved in the index finger and least improved in the little finger after the first and last injections in subjects with high baseline severity.
• Adverse events in PIP joints were similar to those observed in metacarpophalangeal joints, and there was no evidence to support that the little finger PIP joints are more difficult to treat.

REFERENCES


PAPER 81

Clinical Paper Session 18: Dupuytren Disease
Saturday, October 5, 2013 • 4:20–4:26 PM
Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Hand

Open Fasciotomy: Still a Major Weapon in the Surgical Armamentarium Against Dupuytren Disease?
Level 4 Evidence

Camilla J. Stewart, MBChB
Issaq Ahmed
Dominique Davidson
Geoffrey Hooper, FRCS

Hypothesis: There is current interest in minimally invasive treatment of Dupuytren disease but little in effectiveness of treatment by open fasciotomy. We reviewed a series of 1,077 open fasciotomies performed by a single consultant to ascertain the reoperation rate and results of secondary surgery.

Methods: Theater coding data were used to identify a consecutive series of patients who underwent open fasciotomy as a primary procedure for Dupuytren disease over a 5-year study period. The initial fasciotomy was done using the same technique for all patients: under intravenous regional anesthesia with small transverse incisions made over the cords at 1 to 3 levels. These were allowed to heal by secondary intention for 2 to 3 weeks with free digital mobilization (Figs. 1, 2). Outcome measurements recorded for the initial open fasciotomy included the completeness of intraoperative correction, occurrence of perioperative or postoperative complications, time to reoperation, and degree of digital contracture at reoperation. The details of the revision operations were noted, together with the degree of intraoperative correction. Follow-up ranged between 5 and 10 years, and statistical analysis was performed using SPSS software.

Results: A total of 1,077 consecutive patients were treated by open fasciotomies for Dupuytren disease between January 2000 and January 2005. Of these patients, 143 (13.5%) required operations for recurrent disease of the same hand. Data were obtainable for 97 cases, in which a total of 144 digits were reoperated. Complete intraoperative release was achieved in most digits (134 of 144; 93%), irrespective of the number of incisions required, with 1 documented postoperative complication. The mean time to reoperation was 46 months (SD, 22 mo; range, 8–180 mo). The mean pre-revision total extension deficit (TED) for the 144 reoperated rays was 81° (SD, 39°; range, 30° to 180°), which was similar to the mean TED before the first procedure: 82° (SD, 38°; range, 30° to 180°). The severity of the recurrent TED was greatest in rays that had undergone 3-level fasciotomy (103°) and least in those that had undergone a single-level fasciotomy (78°). Complete intraoperative release was obtained in most cases for all types of revision procedure (140 of 144; 97%).

Summary:
• A low reoperation rate was identified, with good intraoperative correction achieved by initial open fasciotomy and secondary surgery.
• We believe that this refinement of the earlier method of percutaneous fasciotomy is a useful and safe technique in the surgical armamentarium for the treatment of Dupuytren disease.

REFERENCES


