2009 Combined Annual Meeting Abstracts

This booklet contains the abstracts for the Scientific Session papers as submitted by the authors. Abstracts are in presentation order by day and time.

These abstracts are also available in the Annual Meeting CD-ROM and on the ASSH website at www.assh.org.

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HYPOTHESIS:
Thumb carpometacarpal arthroplasty with flexor carpi radialis (FCR) interference screw fixation through a single incision is a fast and effective procedure with minimal postoperative radiographic settling or clinical loss of function.

METHODS:
Over twelve months, twenty-nine consecutive carpometacarpal arthroplasties were performed using FCR transfer tenotomized at the level of the scaphoid with an absorbable biotenodesis screw through the metacarpal base for interference fixation rather than direct tendon-to-tendon suture. All patients were evaluated with serial x-ray's and at a minimum of one year with the DASH, VAS, a functional survey, and measurements of range of motion, and strength in grip, lateral key, tip, and tripod pinch. The scaphoid to first metacarpal distance was measured immediately post-operatively, at 3 months, and at greater than 1 year to assess settling. Comparisons between groups were performed using the Mann-Whitney U test. Side-to-side comparisons within each group were performed using the Wilcoxon signed-rank test.

RESULTS:
Twenty-eight patients (97%) were available for follow-up at a mean of 19 months. No arthroplasties had required revision. The average length of procedure was 33 minutes. Post-operative scaphoid to first metacarpal distance was 5.8mm, which decreased by a mean of 0.9mm over the first 3 months, and an additional 0.6mm at final follow-up. There was no side-to-side difference in strength. The mean DASH score was 15, and mean VAS score was 1. All patients were able to return to their pre-operative level of employment and 50% participate in vigorous recreational activity. When comparing outcomes based on gender, Eaton staging, and workman’s compensation cases, the VAS pain score was higher in males and in workman’s compensation cases, than in females and non-workman’s compensation cases (p < 0.05).

SUMMARY POINTS:
- Thumb carpometacarpal arthroplasty using interference screw fixation through a single incision demonstrates excellent clinical outcomes with no revisions in this series.
- Operative times and radiographic settling rates compare favorably to the existing literature utilizing other techniques.
- There was no detectable difference in grip or pinch strength compared to the contralateral side.
- Males and workman’s compensation patients had increased pain despite no differences in range of motion, strength, or radiographic settling.

REFERENCES:
**The Reliability of One versus Three Trials of Pain-free Grip Strength in Subjects with Rheumatoid Arthritis**

**HYPOTHESIS:**
The evaluation of one trial of pain-free grip strength (6,9 in subjects with rheumatoid arthritis (RA) will demonstrate a clinically acceptable level of test-retest reliability, as measured by an Intraclass Correlation Coefficient (ICC) (2,1) \( \geq 0.90 \) (1).

**METHODS:**
A repeated measures, crossover design was used to evaluate the test-retest reliability of one versus the mean of three trials (2) of pain-free grip strength in 25 subjects with RA. Grip testing was performed utilising the Biometrics E-Link Evaluation System (Gwent UK), using a supported dynamometer. Pain levels were recorded before and after grip tests with a visual analogue scale (VAS). Grip was tested twice with a single trial and twice with three trials in a systematically varied order.

Data were analyzed using version 16.0 of the Statistical Package for the Social Sciences (SPSS Inc, Chicago, IL). ICC (2,1), 95% confidence intervals and the standard error of measurement were calculated (3). The non-parametric Wilcoxon signed rank test was used to investigate the differences in grip strength and VAS over grip tests (1).

**RESULTS:**
High levels of test-retest reliability (ICC \( \geq 0.91 \)) were found for both one trial and the mean of three trials of pain-free grip. The median values for the mean of three grip trials were higher than the median values for one grip trial, but this difference was not statistically significant \((p = 0.545)\). Clinically small, but statistically significant, increases in pain were reported following grip tests with the left hand and tests with one grip trial with the right hand \((p = 0.01)\). There was no evidence of a fatigue or learning effect in tests of three grip trials (8).

**SUMMARY POINTS:**
- There is a high level of reliability for the evaluation of one trial of pain-free grip strength with a supported dynamometer in subjects with RA.
- The evaluation of one trial of pain-free grip may save valuable clinical time while reducing the assessment burden placed on subjects with a chronic, painful condition.
- A one kilogram change in pain-free grip may be indicative of meaningful clinical change (10) in RA subjects, therefore, grip should be evaluated with an instrument with adequate sensitivity to detect this magnitude of change.
- There was no evidence of a fatigue effect during grip testing utilizing a one-minute recovery between grip trials. A one-minute recovery may control for fatigue when implemented in grip strength evaluation in symptomatic populations, thereby improving reliability.

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### Test-Retest Reliability

<table>
<thead>
<tr>
<th></th>
<th>ICC 2,1</th>
<th>95% CI</th>
<th>SEM (Kg)</th>
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<td>One trial left</td>
<td>0.96</td>
<td>0.911 - 0.982</td>
<td>0.8</td>
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<tr>
<td>One trial right</td>
<td>0.92</td>
<td>0.828 - 0.964</td>
<td>1.2</td>
</tr>
<tr>
<td>Three trials left</td>
<td>0.91</td>
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<tr>
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<td>0.97</td>
<td>0.922 - 0.985</td>
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*ICC = Intraclass correlation coefficient; CI = confidence interval; SEM = standard error of measurement*

### Pain Scales

<table>
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<tr>
<th></th>
<th>Median score (interquartile range) prior to grip test</th>
<th>Median score (interquartile range) after grip test</th>
<th>Wilcoxon signed rank test ( (p ) value), difference in pain rating</th>
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<td>Left single</td>
<td>9.5 (2.5-24.5)</td>
<td>11.0 (3.0-35.5)</td>
<td>((0.001)) 3.38</td>
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<tr>
<td>Left three</td>
<td>7.5 (2.0-27.0)</td>
<td>8.5 (2.7-40.5)</td>
<td>((0.004)) 2.88</td>
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<tr>
<td>Right single</td>
<td>11.0 (2.2-28.7)</td>
<td>13.0 (2.0-33.5)</td>
<td>((0.01)) 2.58</td>
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<td>Right three</td>
<td>7.0 (1.8-31.3)</td>
<td>10.5 (2.5-35.7)</td>
<td>((0.067)) 1.83</td>
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<td>Post single trials left and three trials left</td>
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<td>v 8.5 (2.7-40.5)</td>
<td>((0.881)) 0.15</td>
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<tr>
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<td>13.0 (2.0-33.5)</td>
<td>v 10.5 (2.5-35.7)</td>
<td>((0.432)) 0.78</td>
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</table>
REFERENCES:

HYPOTHESIS:
Several surgical techniques have been developed to treat arthritis of the basal thumb joint that fails to respond to conservative treatment. These techniques commonly use part or the entire flexor carpi radialis (FCR) tendon to reconstruct the carpometacarpal (CMC) joint. The purpose of this study was to determine if patients undergo changes in strength, range of motion (ROM), and function of the wrist following ligament reconstruction interposition (LRTI) using the entire FCR.

METHODS:
This is a prospective study in which fifty three patients with CMC arthritis had an LRTI performed using the entire FCR. Assessments were performed pre-operatively, at 3 months, 9 months, and 18 months post-operatively. Data collected included thumb and wrist AROM, grip, pinch and wrist strength; and functional outcomes using the Disability of Arm Shoulder Hand (DASH) questionnaire and SF-12. Statistical analysis was performed using paired t-tests.

RESULTS:
Wrist flexion and extension active ranges of motion (AROM) were regained by 18 months post-op. Radial deviation decreased while ulnar deviation increased, resulting in no net change in total active motion. Patients’ grip strength was equal to pre-op measurements by 9 months post-op and increased over pre-operative measurements at 18 months. DASH scores were significantly improved (p<.001) at all post-op intervals. Radial deviation strength was regained by 9 months and significantly higher at 18 months post-operatively. Wrist flexion, extension, and ulnar deviation strength measurements were either unchanged or greater than pre-op scores by 9 months.

SUMMARY POINTS:
• Patients demonstrated decreased active radial deviation and increased active ulnar deviation following surgery while total active motion was unchanged.
• Wrist strength in all planes remained either improved or unchanged following surgery.
• All patients reported significant functional improvement following surgery.

CLINICAL SIGNIFICANCE:
Further study will be needed to determine whether increased ulnar deviation leads to ulnar sided wrist sequelae.

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Best Paper 3
Thursday, September 3, 2009 * 3:14-3:21 PM
Combined Paper Session
Entire Flexor Carpi Radialis Tendon Harvest for LRTI Alters Wrist Motion
Level 2 Evidence
Edward H. Coale Jr., MD, Vancouver, WA
Valerie K. Bennett, OTR/L, CHT, Portland, OR
Amy Charlton, MOT, CHT, Portland, OR
Sandra B. Ruff, OTR, CHT, Portland, OR
Julie E. Teal, OTR/L, CHT, Portland, OR
Ken Ward, MD, Portland, OR

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Best Paper 4
Thursday, September 3, 2009 * 3:21 – 3:28 PM
Combined Paper Session
Are Hand Therapists Implementing Evidence-based Medicine into Daily Practice?
Level 4 Evidence
Kristin Valdes, OTD, OTR, CHT, Sarasota, FL
Tambra Marik, OTD, OTR/L, CHT, Gig Harbor, WA
Gretchen Kaiser Bodell, OTD, OTR/L, MBA, CHT, Phoenix, AZ
HYPOTHESIS:
Hand therapists who take the initiative to learn about evidence-based medicine are implementing evidence-based practice in their daily clinical decision making.

METHODS:
One hundred and nine hand therapists who attended an evidence-based medicine course at the 2008 ASHT conference participated in this convenience sample survey. Therapists were asked to report the clinical interventions they utilized for the treatment of lateral epicondylitis and the percent of daily treatment time each intervention was utilized to equal 100%. The survey questions were placed on a PowerPoint® slide. The surveys were collected at the conclusion of the course. Data analysis procedures included descriptive statistics and frequencies and chi-squared tests. The data were analyzed using SPSS 16.0 software.

RESULTS:
Of the 109 questionnaires returned, 68 were used for data interpretation. Forty one of the questionnaires were not interpreted due to percentage of interventions not equaling 100% of total treatment time. Exercises, mobilizations, orthotics and patient education are supported in the current literature. Therapeutic exercises were the most frequent utilized intervention (n = 56, 82.3%). Therapists reported they utilized mobilization (n = 23, 33.8%), orthotics (n = 7, 10.3%) and patient education (n = 30, 44.1%).

The efficacy of ultrasound, laser, electrical stimulation, deep friction massage and iontophoresis has minimal support in the current literature. Ultrasound was the intervention that was the second most frequently utilized intervention (n = 56, 82.3%). Therapists reported they utilized laser (n = 2, 2.9%), electric stimulation (n = 17, 25%), massage (n = 34, 50%) and iontophoresis (n = 25, 36.8%).

There is no literature that supports the efficacy of heat modalities or taping for sustained pain relief with patients with lateral epicondylitis. Heat was utilized (n = 23, 33.8%) and taping (n = 5, 7.4%).

SUMMARY POINTS:
- The mean percentage of treatment time being spent on the interventions that have strong support in the literature is: therapeutic exercises 37.9%, mobilization 15.9%, orthotics 14.4% and patient education 21.3%.
- The mean percentage of treatment time being spent on the interventions with minimal evidence present in the literature for the effect of pain relief is: US 15.2%, electric stimulation 15.9%, massage 26.1% and iontophoresis 18.4%.
- There is no current literature to support the use of heat or taping for the treatment of lateral epicondylitis. The therapists who reported they are using heat are spending 29.4% and taping 21% of the patient’s treatment time utilizing the interventions.
- To improve quality of care and clinical practice, therapists must be aware of the level of evidence present in the literature that support the interventions they are using in clinical practice.

<table>
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<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
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<td>Massage/Astym</td>
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<td>50.00</td>
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<td>Therapeutic Exercise</td>
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<td>Patient education</td>
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<td>5.00</td>
<td>49.00</td>
<td>21.3000</td>
<td>10.32289</td>
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<td>Valid N (listwise)</td>
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</table>

REFERENCES:
Augmentation of Zone II Flexor Tendon Repair using GDF5 in a Rabbit Model

Level 1 Evidence

† Ralph Frank Henn, MD, New York, NY
Christina E. Kuo, MD, Oak Brook, IL
Michael W. Kessler, MD, Manhasset, NY
Kamal D. Dagly, MD, Manhasset, NY
Daniel P. Grande, PhD, Manhasset, NY
Scott W. Wolfe, MD, New York, NY

HYPOTHESIS:
Despite improvements in mechanics and technique, Zone II flexor tendon repairs are still plagued by complications, including rupture and fibrosis. We hypothesized that sutures coated with Growth Differentiation Factor 5 (GDF5) would accelerate the healing of Zone II flexor tendon repairs.

METHODS:
Zone II flexor tendon lacerations were created and immediately repaired in the 2nd and 4th toe of the right forepaw of 44 New Zealand White Rabbits. One tendon underwent repair with 5-0 vicryl suture coated with GDF5, while the other tendon underwent repair with 5-0 vicryl suture without the GDF5 (Control). The allocation of GDF5 and control suture to either the 2nd or 4th toe was randomized. A proximal tenotomy of the flexor digitorum profundus (FDP) at the level of the common tendon in the wrist was performed to relieve tension on the more distal repairs. Twenty-one rabbits were sacrificed 21 days after repair (3 weeks) and twenty-three rabbits were sacrificed 42 days (6 weeks) after repair. The tendons were harvested and underwent either histological or biomechanical testing in a blinded fashion. The sample sizes were determined using a power analysis for maximum load and the groups were compared using paired t-tests.

RESULTS:
Four rabbits (8 tendons) were sacrificed for histological analysis at each time point. Control tendons demonstrated distinct borders at the transaction site and evidence of minimal endogenous repair at 3 weeks. In contrast, tendons repaired using GDF-5 coated sutures exhibited a more exuberant repair response. The Soslowsky histological score for collagen was higher in the GDF5 group at both time points.

The remaining tendon repairs were tested in tension until failure. All tendons failed at the repair site. The maximum load was significantly greater (p=0.04) in the GDF5 group (11.6 ± 3.5 N) compared to control tendons (8.6 ± 3.0 N) at 3 weeks. The maximum load was also greater in GDF5 group at six weeks but the difference was not statistically significant (p=0.12). Stiffness was greater in the GDF5 group at each time point, but the differences were not statistically significant (P>0.11).

SUMMARY:
The results support our hypothesis that GDF5 accelerates tendon healing in Zone II flexor tendon repairs. Coating growth factors onto existing sutures may prove to be an effective way to translate the use of growth factors into routine clinical practice. This may be particularly true in anatomic regions like the hand, where space is limited and precise targeting of growth factor is necessary.

REFERENCES:
Diagnostic Value of Grind Test for Thumb Carpometacarpal Osteoarthritis

HYPOTHESIS:
The purpose of this study is to determine the criterion validity of the grind test for CMC osteoarthritis by using Eaton classification system of radiological evaluation of the CMC joint as the “criterion.” The second purpose is to examine the inter-rater reliability of the grind test for CMC osteoarthritis.

METHODS:
A convenience sample of 22 patients with thumb or wrist pain were recruited from three private orthopedic clinics and one occupational medicine clinic located in College Station and Bryan, Texas. Each of the participants was evaluated with a grind test performed by two physical therapists who were blinded to the subjects’ diagnoses. A certified hand surgeon, who routinely uses the Eaton classification system, read all radiographs and determined whether they had any evidence of CMC osteoarthritis, and if present the Eaton stage of progression.

Interrater reliability: Interrater reliability of the grind test performed by the two trained physical therapists was compared utilizing intraclass correlation coefficients (Model 2,1).

Criterion validity: Criterion validity was determined by examining the specificity, sensitivity, predictive values and likelihood ratios between the radiographic evaluation and the grind test.

RESULTS:
The interrater reliability for the total sample (n = 20), was ICC (2,1) = 1.0, indicating complete agreement between the two examiners.

The sensitivity and specificity of the grind test were .39 and .94, respectively. Positive and negative predictive values were .92 and .53, respectively, with a prevalence of 65% in this sample. The positive likelihood ratio was 6.34 and the negative likelihood ratio was .65. Table 1 illustrates the 2 X 2 contingency table used to derive these results.

SUMMARY POINTS:
- The high specificity (94%), the lower sensitivity (39%), high predictive value (92%) and high positive likelihood ratio (6.4) would support that a positive grind test would indicate a high probability of carpometacarpal osteoarthritis but a negative grind test would not necessarily rule out the presence of carpometacarpal osteoarthritis.
- These are preliminary results and we plan to collect other data from another 50 participants in the next few months.
HS-Paper 1

Friday, September 4, 2009 * 8:45-8:52 AM
Clinical Paper Session 1: Carpal Instability

Interobserver Reliability and Intraobserver Reproducibility of Digital Photograph Documentation of Wrist Arthroscopy
Level of Evidence Not Applicable

Karl Josef Prommersberger, MD, PhD, Bad Neustadt, Germany
Steffen Löw, MD, Bad Neustadt, Germany
Karlheinz Kalb, MD, Bad Neustadt, Germany
Jörg van Schoonhoven, MD, Bad Neustadt, Germany

HYPOTHESIS:
By assessing interobserver reliability and intraobserver reproducibility of digital photograph documentation of wrist arthroscopy, we tested the hypothesis that the grading of cartilage lesions has a higher reliability than grading of scapholunate ligament or TFCC lesions.

METHODS:
The findings of 102 wrist arthroscopies performed by 13 surgeons were in standard fashion using images from a digital video camera. At least 6 photographs were taken: 1 radioscaphoidal joint with radiopalmar ligament, 2 scapholunate ligament from radiocarpal, 3 TFCC, 4 lunotriquetral joint with ulnar recessus, 5 scapholunate, and 6 lunotriquet joint from midcarpal. More photographs were taken if there was any additional pathology. Lesions of the scapholunate ligament were classified according to Geissler. In addition scapholunate ligament lesions were graded as partial or complete. Lesions of the TFCC were categorized according to Palmer. Lesions of the cartilage were classified according to Outerbridge. Arthroscopic findings were documented in the operation report. Three months later the 6 standard photographs and then – if more than 6 photographs had been taken – all photo documents were reclassified by the surgeon, who performed the arthroscopy, and by two experienced hand surgeons, who were not involved in the cases. Cohen’s Kappa was used as a measure of agreement between the observers three months postoperative and between findings noted in the operation report and the second reading of the photographs by the surgeon who performed the arthroscopy.

RESULTS:
In general intraobserver reproducibility (mean Kappa value .44) was better than interobserver reliability (.30). Assessing all available photographs (k = .47) did not improve intra-observer reliability compared to assessing only the six standard photographs (k = .44). Grading scapholunate ligament lesions as partial or complete the interobserver reliability was fair (k = .37). Using Geissler’s classification for scapholunate ligament lesions the interobserver reliability was k = .34. There was a substantial intraobserver reproducibility (k = .61) and interobserver reliability (k = .60) for cartilage lesions. While intraobserver reproducibility for TFCC lesions was substantial (k = .61), interobserver reliability was moderate (k = .40).

SUMMARY POINTS:
• Even with wrist arthroscopy, our best diagnostic modality for lesions of the scapholunate ligament, the TFCC and the carpal cartilage hand surgeons do not agree with diagnosis and pathology.
• Grading of cartilage lesions using digital photograph documentation of wrist arthroscopy has a higher reliability than grading of scapholunate ligament or TFCC lesions.
• Digital video documentation of wrist arthroscopy may illustrate wrist pathologies more sufficient.

HS-Paper 2

Friday, September 4, 2009 * 8:52-8:59 AM
Clinical Paper Session 1: Carpal Instability

Arthroscopic Evaluation of the Scapholunate Interval: A Correlation of Anatomic Lesions with the Geissler Classification
Level of Evidence Not Applicable

Gurpreet S. Dhaliwal, MD, New York, NY
Patricia A. Hsu, MD, New York, NY
Healthy Desai, MD, New York, NY
Nader Paksima, DO, MPH, New York, NY
Steve K. Lee, MD, New York, NY

HYPOTHESIS:
The Geissler classification is a commonly used arthroscopic classification to describe and grade the severity of injury to the scapholunate interval, however there are currently no studies which describe the exact ligamentous lesions associated with different stages of the classification. The purpose of this study is to determine if specific anatomic lesions of the scapholunate supporting structures correlate with the different stages of the Geissler classification.

METHODS:
Six fresh frozen cadaveric limbs underwent serial arthroscopic sectioning of the scapholunate supporting ligaments. In order to simulate a progressive scapholunate injury based on the current literature, sectioning occurred as follows: 1) volar scapholunate intersosseous ligament (SLIL), 2) membranous SLIL, 3) dorsal SLIL, 4) radioscaphocapitate (RSC), 5) long radiolunate (LRL), 6) dorsal radiocarpal (DRC), 7) dorsal intercarpal (DIC), and 8) scaphotrapeziotrapezoid (STT) ligaments. Arthroscopic
examination of both the radiocarpal and midcarpal joints was performed after each ligamentous sectioning and the appearance of the scapholunate interval was recorded. Descriptive statistics were used to analyze the data.

RESULTS:
There was a progressive increase in the Geissler grade with progressive sectioning of the scapholunate supporting ligaments. In all specimens, a Geissler stage 2 lesion correlated with varying degrees of sectioning to the intrinsic ligaments only, with all extrinsic ligaments being intact. In 4 of the 6 specimens, the dorsal SLIL was intact as well. Geissler stage 3 lesions first appeared with sectioning through the dorsal SLIL in 4 of 6 specimens and with sectioning through the RSC ligament in 2 of 6 specimens. Geissler stage 4 lesions did not occur until the DIC was sectioned in 5 of 6 specimens and occurred with sectioning of the DRC in 1 of the 6 specimens.

SUMMARY POINTS:
- Geissler stage 2 injuries typically involved lesions of the volar and membranous SLIL only.
- Geissler stage 3 injuries occurred with lesions of the dorsal SLIL and volar extrinsic ligaments.
- Geissler stage 4 injuries occurred with the addition of lesions of the dorsal extrinsic ligaments, most commonly the DIC.
- The Geissler stage of injury can be correlated to specific anatomic lesions, which may aid in the determination of appropriate treatment options.

### Table 1

<table>
<thead>
<tr>
<th>Specimen</th>
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Legend:
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- Geissler 2
- Geissler 3
- Geissler 4
- No Data

- Research or institutional support received from Smith & Nephew (Dhaliwal)
- Research or institutional support received from EBI; DePuy: A Johnson & Johnson Company, Small Bone Innovations, Stryker, Synthes (Paksima)
- Ownership interests (including stock options) received from Small Bone Innovations (Paksima)
- Full- or part-time employment or consulting arrangement with Stryker (Paksima)
- Research or institutional support received from Integra, Mitek, Arthrex, Hand Innovations, Medartis (Lee)

HS-Paper 3

**Friday, September 4, 2009 * 8:59-9:06 AM**
Clinical Paper Session 1: Carpal Instability

Long-Term Outcomes of Scapholunate Ligament Reconstruction with Bone-Retinaculum-Bone Autograft
Level 4 Evidence

- Maximilian C. Soong, MD, Peabody, MA
- Fred W. Ortmann, IV, MD, Greensboro, NC
- Gregory Merrell, MD, Indianapolis, IN
- Arnold-Peter C. Weiss, MD, Providence, RI

HYPOTHESIS:
Scapholunate interosseous ligament reconstruction with bone-retinaculum-bone (BRB) autograft is a viable long-term treatment for dynamic scapholunate instability.

METHODS:
Fourteen patients from a previously reported cohort who underwent BRB reconstruction for dynamic instability were evaluated by clinical and radiographic examination. Average age was 37 years (28-49). The surgical technique involves a graft harvested from the dorsal distal radius consisting of two bone plugs bridged by retinaculum (Figure 1). The plugs are secured into troughs created in the scaphoid and lunate with the retinaculum substituting for the disrupted scapholunate ligament (Figure 2). The interval reduction is secured with multiple Kirschner wires for eight weeks. Pins are then removed and therapy is initiated. Outcome measurements included scapholunate angle and gap, radiographic evidence of secondary arthritis, wrist extension and flexion, grip strength, and Mayo wrist score.

RESULTS:
Follow-up averaged 7.3 years (2.0-14.1). Clinical and radiographic outcomes deteriorated moderately from the prior report. Scapholunate angle averaged 65 degrees (range 45-80). Scapholunate gap averaged 3mm (range 2-10). Secondary radiographic arthritis was found in eight patients. Mayo wrist score averaged 80 (70-100). There were three failures resulting in one proximal row carpectomy and two total wrist fusion procedures. Findings at reoperation in the failed group included an intact graft without any apparent abnormalities, a partially ruptured graft (after a subsequent re-injury), and a completely resorbed graft.

SUMMARY POINTS:
- BRB autograft reconstruction has the potential to be a viable long-term treatment option for dynamic scapholunate instability.
- Results may deteriorate over time but are comparable with other soft-tissue techniques including capsulodesis and tenodesis in recent long-term studies.
- Failures related to graft strength, stiffness, or resorption may necessitate further surgery.
- Scapholunate instability remains a difficult problem to treat durably and predictably.
REFERENCES:

HS-Paper 4
Friday, September 4, 2009 * 9:06-9:13 AM
Clinical Paper Session I: Carpal Instability

Intracarpal Ligamentous Laxity in the Atraumatic Wrist: A Cadaveric Study of Eighty-Three Specimens
Level 1 Evidence

♦ Todd R. Rimington, MD, Washington, DC
T. Sean Lynch, MD, Chicago, IL
Marieta B. Pehlivanova, BS, Hyattsville, MD
Scott G. Edwards, MD, Washington, DC

HYPOTHESIS:
1. The normal physiologic range of scapholunate and lunotriquetral ligament laxity in the wrist is greater than previously described(1).
2. Despite being commonly used, the classification system described by Geissler et al.(1) is not applicable to atraumatic wrists as it cannot differentiate physiologic from pathologic laxity.
3. Wrist interosseous ligament laxity increases with:
   a. Age
   b. Type II lunate morphology, and
   c. Increased scapholunate gap and scapholunate angle.

METHODS:
Standard wrist arthroscopy was performed on 83 intact, atraumatic, fresh-frozen cadaveric wrist specimens. During arthroscopy scapholunate ligament (SLIL) grade and lunotriquetral ligament (LTIL) grade were determined using the Geissler classification system and a modified Geissler classification system designed by the authors. Lunate morphology was noted during arthroscopy. Prior to arthroscopy, scapholunate angle and scapholunate gap measurements were determined from radiographs of each wrist. Statistical analysis included: chi-square, various correlation coefficients, and both bivariate and multivariate models with p<0.05 as the level of significance.

RESULTS:
Evaluation of the SLIL in all specimens revealed 4 (5%) grade I specimens, 28 (34%) grade II, 40 (48%) grade III and 11 (13%) grade IV. Evaluation of the LTIL revealed 17 (20%) grade I specimens, 40 (48%) grade II, 28 (30%) grade III and 1 (1%) grade IV. On both bivariate and multivariate analyses SLIL grade increased with increasing age and LTIL grade increased with increasing age. In addition, LTIL grade decreased with female gender. SLIL or LTIL grade did not correlate with lunate morphology or radiographic measurements of SL gap or SL angle.

SUMMARY POINTS:
• The physiologic range of laxity within the SL and LT joints are wider than originally described by Geissler et al.(1) Grade II and a percentage of grade III interosseous ligaments, which previously have been described to be pathologic, are present in nearly half of all atraumatic wrists and suggest physiologic laxity.
• In isolation, the Geissler classification system cannot be used to determine pathologic instability in atraumatic wrists.
• In an attempt to refine the current intracarpal ligament classification described by Geissler et al.(1), the authors present a modification that attempts to assess the integrity of relevant secondary intracarpal joint constraints.
• Intracarpal ligaments demonstrate an age related progression of SL and LT joint laxity.
• There is no correlation between SLIL or LTIL laxity and lunate morphology, SL gap, or SL angle.

REFERENCE:
four-corner fusions performed with dorsal circular plates or with headless compression screws would yield similar outcomes.

**METHODS:**
A retrospective comparison of 39 consecutive patients with scapholunate or scaphoid nonunionadvanced collapse (SLAC or SNAC) was performed. These patients were treated with scaphoid excision and four-corner fusion utilizing either a circular plate (20 patients) or headless compression screws (19 patients). Mean followup was 33 months in the plate group and 29 months in the compression screw group. Functional outcomes evaluated were range of motion; pain; Disabilities of the Arm, Shoulder, and Hand (DASH) scores; grip strength; and time to union. Patients were also analyzed for return to work status and complications including delayed union and hardware failure. Statistical analysis of data was conducted with paired or unpaired t-tests or chi-squared tests as appropriate.

**RESULTS:**
Scaphoid excision and four-corner fusion resulted in significant function and symptom improvement in patients with SNAC and SLAC pathology regardless of type of fixation. Time to union was significantly shorter in the compression screw group when compared to the circular plate group (6.4 versus 9.1 weeks, p<.001). In the plate group, there were 2 revision surgeries, 3 delayed unions, and 4 hardware failures. None of these complications were seen in the compression screw group. No significant difference was seen between the two groups in postoperative range of motion, grip strength, pain, DASH scores, or return to work.

**SUMMARY POINTS:**
- Scaphoid excision and four-corner fusion are effective treatments for SLAC and SNAC patterns of wrist arthritis.
- Faster union and lower complication rates are associated with compression screw fixation for four-corner fusion when compared with dorsal circular plate fixation.

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**Effect** | **Reference category** | **Estimate** | **Standard Error** | **Z-Statistic** | **P-value** | **Odds Ratio** | **95% CI for OR**
--- | --- | --- | --- | --- | --- | --- | ---
Age | - | 0.0824 | 0.0236 | 3.48 | 0.0005 [sig.] | 1.0859 | 1.0367 1.1373
SL Angle | - | 0.0266 | 0.0206 | 1.29 | 0.1961 | 1.0269 | 0.9864 1.0692
SL Gap | - | 0.2628 | 0.3127 | 0.84 | 0.4007 | 1.3005 | 0.7046 2.4003
Gender | F | -0.2153 | 0.4640 | -0.46 | 0.6426 | 0.8063 | 0.3248 2.0019
Lunate Type | I | 0.4349 | 0.3977 | 1.09 | 0.2742 | 1.5448 | 0.7085 3.3682

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**HS-Paper 5**

Friday, September 4, 2009 * 9:13-9:20 AM
Clinical Paper Session 1: Carpal Instability

**Four-Corner Fusion: A Retrospective Comparative Study of Fixation with a Circular Plate versus Compression Screws**

Level 3 Evidence

† Harris S. Rose, MD, Seattle, WA
Jeffrey B. Friedrich, MD, Seattle, WA
Michael T. Mulligan, MD, Seattle, WA
Thanapong B. Waitayawinyu, MD, Seattle, WA
Thomas E. Trumble, MD, Seattle, WA

**HYPOTHESIS:**
Four-corner fusions performed with dorsal circular plates or with headless compression screws would yield similar outcomes.

**METHODS:**
A retrospective comparison of 39 consecutive patients with scapholunate or scaphoid nonunion advanced collapse (SLAC or SNAC) was performed. These patients were treated with scaphoid excision and four-corner fusion utilizing either a circular plate (20 patients) or headless compression screws (19 patients). Mean followup was 33 months in the plate group and 29 months in the compression screw group. Functional outcomes evaluated were range of motion; pain; Disabilities of the Arm, Shoulder, and Hand (DASH) scores; grip strength; and time to union. Patients were also analyzed for return to work status and complications including delayed union and hardware failure. Statistical analysis of data was conducted with paired or unpaired t-tests or chi-squared tests as appropriate.
Ischemic Nerves are more Susceptible to Mechanical Injury

Level of Evidence Not Applicable

HYPOTHESIS:
The median nerve in patients with Carpal Tunnel Syndrome experiences mechanical forces while undergoing ischemic conditions. In order to understand the pathophysiology of this neuropathy, we must define the role of ischemia and mechanical forces on the nerve to identify the responsible component for the cascade of events observed at the cellular level. In this study, we developed an in vitro system with a custom hydrostatic chamber to isolate the role that mechanical stimuli play in the pathogenesis of this injury type and to test the hypothesis that Schwann cells are mechanosensitive cells and that mechanical and ischemic stimuli promote distinct cellular and molecular responses.

METHODS:
An in vitro system was designed to apply mechanical stimulus, in the form of hydrostatic compression, to myelinated dorsal root ganglia (DRG) neuron/Schwann cell co-cultures. Pressure, dissolved oxygen, and pH were monitored and feedback control systems used to maintain homeostasis. The cultures were exposed to static compression (0.4PSI). For hypoxia studies, the cells were cultured at 5% atmospheric oxygen. Lactate dehydrogenase (LDH) production was assayed immediately and 24-hours post-compression as a measure of cytotoxicity. Twenty four hours post-compression, the co-cultures were immunolabeled with S-100, a pan-specific Schwann cell marker, NeuN, a neuron-specific marker, or myelin basic protein (MBP). The cultures were double-labeled with bromodeoxyuridine (BrdU) or TUNEL, markers for proliferation and apoptosis, respectively. Error bars are standard deviations from the mean and significance is based on a 1-tailed T-test.

RESULTS:
BrdU and S100 labeling demonstrated a dramatic 3-fold increase in Schwann cell proliferation following exposure to 0.4PSI of sustained pressure for 24 hours. Demyelination assay results suggest that compression (2.8-fold) and compression combined with hypoxia (3.8-fold) induce demyelination. Neuronal apoptosis and LDH release remained insignificant for compressed and hypoxic cultures, suggesting that demyelination is not a response to neuronal injury.

SUMMARY POINTS
- Using an in vitro model, we isolated the effects of mechanical stimuli and ischemic conditions on myelinated peripheral nerve cultures.
- Schwann cells are mechanosensitive as they respond to stimuli independent of axonal/neuronal injury.
- A low level of hydrostatic compression stimulates demyelination.
- Demyelination in the response to mechanical forces is even greater when combined with hypoxia.
- A low level of hydrostatic compression injury induces Schwann cell proliferation and apoptosis in vitro.
- This study provides the first concrete evidence that the preconditioning of neural tissue by ischemic parameters makes nerves much more susceptible to mechanical stimuli/injury.

Grant support received by NIH-NINDS
Vascularization of the Median Nerve in the Distal Forearm and its Clinical Significance

Sunil M. Thirkannad, MD, Louisville, KY
Robert Acland, MD, Louisville, KY
David Elliot, FRCS, Chelmsford, United Kingdom
Sunil M. Thirkannad, MD, Louisville, KY

HYPOTHESIS:
It is possible to dissect and mobilize an injured and retracted median nerve at the wrist while at the same time preserving its vascularity and achieving a tensionless repair.

METHODS:
Sixteen forearms from fresh frozen cadavers, were used in the study. In all specimens, red latex was injected intravascularly to delineate the vascular tree of the limb. The specimens were dissected to determine the gross vascular anatomy of the median nerve over a 12 cm length proximal to the carpal tunnel. Specimens were also chemically processed to enable a detailed look at the intraneural vascular network.

Following this, we analyzed the gap formed between the ends of a divided median nerve due to spontaneous retraction of the cut ends. We determined the average tension needed to reapproximate the cut ends. We then developed a dissection technique that would enable adequate mobilization of the median nerve while preserving its vascularity and at the same time achieve a tensionless repair.

RESULTS:
The entire vascular supply of the median nerve in the distal forearm was delineated. A suitable constant vessel was identified that would enable adequate mobilization of the nerve without compromising its vascularity.

The median nerve was found to retract by an average of 10.4 mm immediately after division. The tension required to coapt these ends was on an average 2.31 Newton. This constituted the baseline physiological tension of acute nerve retraction. However, using our dissection technique, it was possible to achieve the same degree of mobilization at a much reduced tension of only 0.89 Newton. Further we established that using our technique, it was possible to achieve a total of 15 mm mobilization while still remaining within physiological limits of tension and at the same time not compromising vascularity to the cut end. This ability to achieve additional mobilization becomes extremely important in cases of delayed repairs where the nerve is found to be retracted and fixed in scar.

SUMMARY POINTS:
- Our study has established the presence of an constant identifiable vascular pedicle to the median nerve in the distal forearm.
- We have developed a dissection technique that enables adequate mobilization of the median nerve while preserving its vascularity and at the same time achieving a tensionless repair.

Thermopolymerization of the Median Nerve in the Distal Forearm and its Clinical Significance

David Elliot, FRCS, Chelmsford, United Kingdom
Sunil M. Thirkannad, MD, Louisville, KY

HYPOTHESIS:
It is possible to dissect and mobilize an injured and retracted median nerve at the wrist while at the same time preserving its vascularity and achieving a tensionless repair.

METHODS:
Sixteen forearms from fresh frozen cadavers, were used in the study. In all specimens, red latex was injected intravascularly to delineate the vascular tree of the limb. The specimens were dissected to determine the gross vascular anatomy of the median nerve over a 12 cm length proximal to the carpal tunnel. Specimens were also chemically processed to enable a detailed look at the intraneural vascular network.

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SUMMARY POINTS:
- Our study has established the presence of an constant identifiable vascular pedicle to the median nerve in the distal forearm.
- We have developed a dissection technique that enables adequate mobilization of the median nerve while preserving its vascularity and at the same time achieving a tensionless repair.
so-called all ulnar hand. Only 10 patients in 8 reports have been
electrophysiologically proven to have all ulnar hands. Although the
rate of Type4 patients may be far smaller than 0.8% determined in
this study, the severity of CTS for this type can not be evaluated,
even by electrophysiological studies. Knowledge of the variations
in thenar muscle innervation is essential for the diagnosis of CTS.

HS-Paper 9
Friday, September 4, 2009 * 9:06-9:13 AM
Clinical Paper Session 2: Carpal Tunnel Syndrome

Determinants of Pain in Patients with Idiopathic
Median Nerve Dysfunction at the Carpal Tunnel
Level 2 Evidence

♦ Fiesky Nunez, MD, Burlington, MA
David C. Ring, MD, PhD, Boston, MA
Ana-Maria Vranceanu, PhD, Boston, MA

HYPOTHESIS:
Pain is determined by nociception and illness behavior and varies
substantially in patients with idiopathic median nerve dysfunction
at the carpal tunnel (commonly know as carpal tunnel syndrome; CTS). We tested the null hypothesis that pain in CTS correlates
with measures of illness behavior rather than demographic factors
or disease characteristics including electrodiagnostic findings.

METHODS:
One hundred fifty-two patients with electrodiagnostically confirmed
idiopathic median nerve dysfunction at the carpal tunnel completed
measures of illness behavior. All of the patients completed a 5-point
Likert measure of pain intensity and a measure of misinterpretation
or over-interpretation of nociception (the Pain Catastrophizing Scale).
Fifty-four patients (Group 1) completed a measure of depression (the
Patient Health Questionnaire Depression Subscale), anxiety about
pain (the Pain Anxiety Sensitivity Index), self-efficacy about pain (the
Pain Self-Efficacy Questionnaire) and a measure of dispositional
optimism (the Life Orientation Test). Ninety-eight patients (Group
2) completed another measure of depression (the Center for
Epidemiologic Studies of Depression), a measure of hypochondriacal
attitudes and beliefs (the Whitely Index) and a measure of fear of
experiencing anxiety symptoms (the Anxiety Sensitivity Index).
Bivariate and multivariable predictors of pain were sought from among
demographic, electrophysiological, and psychological factors.

RESULTS:
Gender, age, and electrophysiological measures did not correlate
with pain intensity. In Group 1, pain catastrophizing and depression
predicted 16% and 20.3% of the variation in pain intensity (p = .021
and .007, respectively). Pain catastrophizing was the only predictor
of pain in Group 2, accounting for 11.6% of the variation in pain
intensity (p = .008).

SUMMARY:
Illness behavior (specifically depression and misinterpretation or
overinterpretation of nociception) is the best predictor of pain intensity in
patients with idiopathic median nerve dysfunction at the carpal tunnel.

HS-Paper 10
Friday, September 4, 2009 * 9:13-9:20 AM
Clinical Paper Session 2: Carpal Tunnel Syndrome

Cost Analysis between Inpatient and
Outpatient Orthopaedic Procedures
Level 4 Evidence

♦ Charles S. Day, MD, Boston, MA
Eric C. Makhni, BS, Boston, MA
Christine Ahn, BS, Boston, MA
Shervin Tabrizi, BS, Boston, MA

HYPOTHESIS:
In an era of decreasing health care reimbursement, cost-
consciousness becomes imperative, especially in orthopaedic
surgery. Little has been reported regarding comparative
costs of different orthopaedic procedures, both inpatient and
outpatient. We hypothesized that costs of inpatient procedures
would be related to length-of-stay. We also hypothesized that,
among outpatient cases, both sports and hand cases would be
equally costly.

METHODS:
All orthopaedics procedures of an academic, tertiary-care medical
institution between July 2004 and June 2005 were included and
classified according to DRG. Procedures were classified as either
“inpatient” or “outpatient” and were segregated according to
orthopaedic subspecialty: foot/ankle, hand/wrist, “other” (i.e.
amputation, I&D), spine/back, sports, trauma, and joints. Average
length-of-stay was noted for inpatient cases, and average total
cost (direct + indirect) was noted for all types of procedures – both
inpatient and outpatient.

RESULTS:
A total of 4117 cases were included; 1933 (47%) were inpatient,
and 2184 (57%) were outpatient. Within inpatient, the majority of
the cases were trauma, back/spine, and joints, while outpatient
cases consisted mostly of hand/wrist and sports.

For inpatient procedures, spine, “other,” and joints had the
highest costs (at $22,531, $18,197, and $17,364, respectively).
Length-of-stay was highest for “other” and spine at 8.22 and 5.28
days, respectively. For outpatient cases, sports had the highest
cost (at $2,335) while foot/ankle had the lowest ($883). Among
arthroscopic cases, those that were therapeutic were more costly
than those that were diagnostic.
SUMMARY:
• Length-of-stay may help to explain part, but not all, of cost discrepancies among inpatient orthopaedics procedures.
• Sports cases are among the most costly within outpatient orthopaedics.
• Care must be taken to minimize costs associated with therapeutic arthroscopic procedures.

HYPOTHESIS:
The use of joint leveling procedures for the treatment of Kienböck's disease has been limited by the degree of disease advancement based on Litchman/Goldfarb criteria. The purpose of this multicenter trial was to compare the clinical and radiographic outcomes of wrists with more advanced Kienböck's disease (stage IIIB) to wrists with less advanced disease (stage I/IIIA) following radius shortening osteotomy. Our hypothesis was that there would be a statistically significant difference in outcomes between groups.

METHODS:
The study enrolled 31 wrists (30 patients, mean age 39 years), treated by radius shortening osteotomy for either stage IIIB (n=14) or stage I/IIIA (n=17) Kienböck's disease. Evaluation was carried out at a mean of 74 months (IIIB, 77 months; I/IIIA, 69 months). Radioscaphoid angle and carpal height ratio determined progression of disease and carpal collapse. Clinical outcome measures included the QuickDASH, Modified Mayo Wrist Score (MMWS), Visual Analogue Scale (VAS) ratings of wrist pain/function, wrist motion, and grip strength. Results were analyzed statistically using unpaired Student t-tests to evaluate outcomes between the two groups.

RESULTS:
Clinical outcomes using validated, patient-based measures of wrists treated for stage IIIB disease were similar to those with stage I/IIIA disease [QuickDASH (16 vs 12: p=.56), MMWS (84 vs 87: p=.59), VAS wrist pain (1.2 vs 1.7: p=.41), VAS wrist function (2.8 vs 2.1: p=.44)]. The average wrist flexion/extension arc was 102° for wrists with stage IIIB and 106° for wrists with stage I/IIIA Kienböck's (p=.70). Grip strength was 77% of the opposite side for stage IIIB wrists versus 84% for stage I/IIIA wrists (p=.36). Postoperative carpal height ratio and radioscaphoid angle were worse (p<.05) for wrists with stage IIIB (0.46: 65°) than stage I/IIIA (0.53: 53°) disease. Radiographic disease progression occurred in 7 wrists (6 stage I/IIIA and 1 stage IIIB). The one stage IIIB wrist that progressed underwent wrist arthrodesis.

SUMMARY POINTS:
• Radiographic outcomes for stage IIIB wrists were distinguished by reduced carpal height ratios and increased radioscaphoid angles.
• At a mean of 6 years, radiographic disease progression occurred in only one wrist with stage IIIB disease.
• Long term clinical outcomes of radius shortening using validated, patient-based assessment tools and objective measures are similar for stage I/IIIA and IIIB Kienböck's.
• Based upon the high likelihood of successful clinical outcome, we recommend radius shortening for symptomatic stage II, I/IIIA, and IIIB disease.
REFERENCES:

HS-Paper 12
Friday, September 4, 2009 * 10:12-10:19 AM
Clinical Paper Session 3: Kienböck’s /DRAJ

Capitate Shortening Osteotomy and Vascularized Bone Grafting for Treatment of Kienböck’s Disease
Level 4 Evidence

Julie E. Adams, MD, Minneapolis, MN
Terri M. Skirven, OTR/L, CHT, Philadelphia, PA
A. Lee Osterman, MD, King of Prussia, PA
Randall W. Culp, MD, King of Prussia, PA

HYPOTHESIS:
Capitate shortening osteotomy with vascularized bone grafting is a treatment option for Kienböck’s disease with a low incidence of complications and a high rate of satisfactory results.

METHODS:
Controversy exists regarding the optimum treatment for Kienböck’s disease. Capitate shortening osteotomy (CSO) and/or vascularized bone grafting is a treatment option, particularly in the setting of ulnar neutral or positive variance. However, limited information exists in the literature regarding outcomes following this procedure.

The medical records of all patients at our hand center who underwent CSO and vascularized bone grafting for Kienböck’s disease were retrospectively reviewed for demographic information, pre- and post-op pain, ROM, and radiographic stage. Operative reports were reviewed and post operative complications, return to work, and satisfaction were recorded. Statistical analysis by students t-test was performed (Excel) with p<0.05 considered significant.

RESULTS:
32 patients underwent 34 procedures (vascularized bone grafting and CSO with either K wire fixation (13), screw fixation (19), or both(1)) for Kienböck’s disease. Followup averaged 27.4 months. There were 18 female and 14 male patients. Average age was 37 yrs. There were 4 stage I, 10 stage II, 17 stage IIIa, and 3 stage IIIB patients. There was no statistically significant change in pre- vs post-op pain (48.2 vs 47.8, p=0.07), extension (47.8 vs 47.7, p=0.98), or grip strength (46.2 vs 53.0 #, p=0.11). 29 of 34 wrists were pain free at follow-up. Grip strength improved to 133% of preoperative values. Worker’s compensation patients had poorer results with lower grip strength (p=0.02) and more discomfort.

Minor complications included 2 superficial infections which resolved with oral antibiotics, pin or screw migration (n=2). Major complications included 1 deep pin site infection which required operative debridement and IV antibiotics. Ultimately this patient was revised to a proximal row carpectomy. Six patients had progression, but 3 of these patients had no pain postop. All but 4 patients returned to their preoperative avocations and occupations.

SUMMARY POINTS:
• Capitate shortening osteotomy with lunate revascularization is a viable treatment for Kienböck’s disease.
• Range of motion does not change significantly from pre- to post-op.
• Grip strength improves 133% from preoperative values.
• Workers compensation patients are less likely to do well.

HS-Paper 13
Friday, September 4, 2009 * 10:19-10:26 AM
Clinical Paper Session 3: Kienböck’s /DRAJ

Salvage of Failed Resection Arthroplasties of the Distal Radioulnar Joint using an Ulnar Head Prosthesis – Long Term Results
Level 4 Evidence

Joerg C. van Schoonhoven, MD, PhD, Bad Neustadt, Germany
Diego L. Fernandez, MD, Bern, Switzerland
Timothy J. Herbert, MD, Sydney, Australia

HYPOTHESIS:
Reconstruction of the distal radioulnar joint (DRUJ) with an ulnar head prosthesis and soft tissue repair will restore forearm rotation and reduce pain in patients with painful radioulnar impingement following resection of the ulnar head.
METHODS:
In a clinical prospective international multi center study 23 patients with painful instability of the forearm following ulnar head resection were treated between 1995 and 1998 using a new ulnar head prosthesis in three international hand centers. The short term results of these patients have been published. These original patients have been followed up to achieve the long term results in this longitudinal study. According to the study protocol clinical assessment consisted of the measurement of DRUJ stability, forearm rotation and grip strength, evaluation of the pain level using the verbal analog scale (1–4) and patients satisfaction using a visual analog scale (1–10). The preoperative, published short term and assessed long term data of the patients available at the latest follow up were statistically analyzed. Standardized radiographs of the wrist were evaluated for displacement of the ulnar head and loosening or bony reactions at the sigmoid notch or the ulna shaft.

RESULTS:
One patient was initially excluded from the study as the prosthesis had to be removed after 3 months due an infection. After a mean of 133 (97 to 154) months 16 of the original 22 patients were available for the long term follow up. All patients demonstrated a clinically stable DRUJ at the latest examination and no patient required further surgery since the short term evaluation in 1999. Average pain measured 3.9 preoperatively, 1.7 at the short term and 1.7 at the long term follow up, patients satisfaction 2.2, 8.2 and 8.9, pronation 73°, 86° and 83°, supination 52°, 77° and 81°, grip strength 42%, 72% and 77% of the unaffected side. All clinical parameter improved statistically significant (p < .001) from preoperatively to the short term follow up with no further statistically significant change between the short and long term follow up. Radiographs demonstrated no signs of stem loosening with congruity of the sigmoid notch towards the ulnar head.

SUMMARY POINTS:
- These are the first long term results on an ulnar head prosthesis.
- Previously reported clinical and radiological short term results did not deteriorate over time.
- Reconstruction of the DRUJ with this prosthesis appears to be a reliable, reproducible and lasting procedure for painful radioulnar impingement following ulnar head resection.

REFERENCE:

- Royalties, non-cash support, honoraria, or other funding received from Martin Medizin Technik Tuttlingen Germany (van Schoonhoven; Fernandez; Herbert)

HS-Paper 14
Friday, September 4, 2009 * 10:26-10:33 AM
Clinical Paper Session 3: Kienböck’s /DRUJ

The Effect of Ulnar Styloid Fractures on Patient-rated Outcomes after Volar Locking Plating of Distal Radius Fractures
Level 2 Evidence

♦ Douglas M. Sammer, MD, St. Louis, MO
Hriday Shah, BS, Ann Arbor, MI
Melissa J. Shauver, MPH, Ann Arbor, MI
Kevin C. Chung, MD, MS, Ann Arbor, MI

HYPOTHESIS:
Ulnar styloid fractures commonly occur in association with distal radius fractures. Ulnar styloid fractures that involve the insertion of the radioulnar ligaments can result in distal radioulnar joint (DRUJ) instability, and the literature suggests that these fractures should be treated with open reduction internal fixation (ORIF). However, in the absence of DRUJ instability, the implications of ulnar styloid fractures are not known. The hypothesis of this study is that the effect of ulnar styloid fractures without DRUJ instability on patient-rated outcomes after distal radius fracture ORIF will be minimal.

METHODS:
Between 2003 and 2008, a prospective cohort of distal radius fracture subjects treated with volar plating were enrolled. Patients with DRUJ instability treated at the time of distal radius ORIF were excluded. Only patients with a stable DRUJ were included in the study. Radiographs were evaluated to identify ulnar styloid fractures and to measure their size and amount of displacement when present. Patient-rated outcomes were measured at 6 weeks, 3 months, 6 months, and 12 months after surgery using the Michigan Hand Outcomes Questionnaire (MHQ). Physical examination, including a specific evaluation of the DRUJ, was performed at each postoperative visit. Regression analysis was performed to determine if the presence of an ulnar styloid fracture, or the fracture size or amount of displacement was predictive of MHQ scores.

RESULTS:
One hundred forty-four patients were enrolled; 88 patients had associated ulnar styloid fractures, and 56 did not. During the collection period, three patients with ulnar styloid fractures had DRUJ instability found intraoperatively and underwent ulnar styloid ORIF. These patients were excluded. The remaining patients with a stable DRUJ after distal radius ORIF were included in the study, and maintained DRUJ stability postoperatively. The presence of an ulnar styloid fracture was not an independent predictor of MHQ scores. Furthermore, neither the degree of displacement nor the size of an ulnar styloid fracture, when present, was predictive of MHQ scores.
SUMMARY POINTS:
- In the absence of DRUJ instability after distal radius ORIF, the presence of an ulnar styloid fracture did not affect subjective outcomes.
- In addition, when an ulnar styloid fracture was present, neither the degree of displacement nor the size of the fracture was an independent predictor of subjective outcomes.

In the absence of DRUJ instability after distal radius ORIF, the presence of an ulnar styloid fracture did not affect subjective outcomes. In addition, when an ulnar styloid fracture was present, neither the degree of displacement nor the size of the fracture was an independent predictor of subjective outcomes.

<table>
<thead>
<tr>
<th>Fracture Displacement</th>
<th>No. Patients</th>
<th>MHQ Scores**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6 weeks</td>
<td>3 months</td>
</tr>
<tr>
<td>0-0.9 mm</td>
<td>22 (28%)</td>
<td>56 ± 27</td>
</tr>
<tr>
<td>1-1.9 mm</td>
<td>29 (37%)</td>
<td>66 ± 16</td>
</tr>
<tr>
<td>≥ 2 mm</td>
<td>28 (35%)</td>
<td>72 ± 18</td>
</tr>
</tbody>
</table>

* Degree of displacement was not a significant predictor of MHQ scores (p=0.41)  
** MHQ scores given as mean ± standard deviation

METHODS:
A retrospective review of prospectively collected data was performed of one-hundred-nineteen patients with highly comminuted articular distal radius fractures treated by external fixation or volar plating. Sixty-one patients were treated with bridging external fixation and fifty-eight patients were treated with volar plate fixation. Immediate post-operative radiographs were compared to final follow-up x-rays for evaluation of radiographic parameters including radial length and palmar tilt. Visual Analog Scale for pain (VAS), range of motion and DASH scores were also compared. Complaints of ulnar-sided wrist pain or tenderness were documented. Two-tailed unpaired t-tests were completed to compare outcomes between patient groups. Incidence of binomial data such as the presence of a specific complication was compared between groups using Fisher's Exact Probability Test.

RESULTS:
Patients treated with volar plating had an average change in measured radial length of (-) 0.09mm between the first post-operative and final follow-up radiographs. The external fixator group demonstrated significant shortening with an average change in radial length of (-) 0.82mm (p < 0.02). The volar plating group had a significantly (p < 0.001) greater arc of rotation at final follow-up (169° versus 142°). Finally, patients treated with volar plating had significantly (p < 0.04) less ulnar-sided wrist pain (4/58 patients in the volar plating group versus 13/61 patients in the external fixation group).

SUMMARY POINTS:
- In patients with highly-comminuted distal radius fractures, volar plating is an effective method of treatment. While ulnar-sided wrist pain is known to occur after distal radius fracture, it is more common following external fixation than after volar plating.
- Increased incidence of ulnar-sided wrist pain may be related to changes in radial height observed with external fixation. The use of volar plating in patients with highly comminuted articular fractures of the distal radius affords better maintenance of radial length and preservation of rotation.

HS-Paper 15
Friday, September 4, 2009 * 10:33-10:40 AM
Clinical Paper Session 3: Kienböck's /DRUJ

Incidence of Ulnar-Sided Wrist Pain following Treatment of Intra-articular Distal Radius Fractures with Volar Plate versus External Fixation  
Level 2 Evidence

♦ Marc J. Richard, MD, Durham, NC  
Michael Miller, BS, Durham, NC  
Richard D. Goldner, MD, Durham, NC  
David S. Ruch, MD, Durham, NC

HYPOTHESIS:
Volar plate fixation provides an improved means of maintaining radial length without detriment to overall function in patients with high-impact fractures of the distal radius. Improved radial length is correlated with increased arc of rotation and decreased incidence of ulnar-sided wrist pain.

HS-Paper 16
Friday, September 4, 2009 * 10:05-10:12 AM
Clinical Paper Session 4: Dupuytren's

Collagenase Injection as Nonsurgical Treatment of Dupuytren's Disease: 8-Year Follow-up  
Level 4 Evidence

▲ Andrew J. Watt, MD, Palo Alto, CA  
Catherine Curtin, MD, Palo Alto, CA  
♦ Vincent R. Hentz, MD, Palo Alto, CA

HYPOTHESIS:
Collagenase injection is a safe and efficacious modality for the treatment of Dupuytren's disease with long-term results comparable to surgical intervention.
INTRODUCTION:
Collagenase has been investigated in phase II and ongoing phase III clinical trials for the treatment of Dupuytren’s disease. The purpose of this study is to establish long-term results in a subset of patients who underwent collagenase injection for the treatment of Dupuytren’s contracture.

METHODS:
The 23 patients who had participated in the Phase II clinical trial of injectable collagenase at Stanford University Medical Center in 1999-2000, were contacted by letter and phone. 9 subjects were available for follow-up examination. One patient had received placebo injection and was excluded. The remaining 8 patients completed a Dupuytren’s Disease questionnaire and underwent independent examination of joint motion by a single examiner.

RESULTS:
Eight patients participated in the 8-year follow-up study: 6 had been treated for isolated MCP joint contracture, 2 patients had been treated for isolated PIP joint contracture.

Average pre-injection contracture was 57.2° in the MCP group. Average contracture was 8.8° at 1 week, 10.8° at 1 year and 22.5° at 8 year follow-up. 67% (4/6) patients experienced recurrence while 33% (2/6) had no evidence of disease recurrence at 8-year follow-up. No patients had undergone further intervention on the treated finger.

Average pre-injection contracture was 45° in the PIP group. Average contracture was 7.5° at 1 week, 15° at 1 year and 60° at 8 year follow-up. 100% (2/2) patients experienced recurrence. No patients had undergone further intervention on the treated finger.

Patients subjectively rated the overall clinical success at 60% (range 0 to 100%) and 87.5% of patients stated that they would pursue further injection for treatment of recurrent or progressive disease.

SUMMARY POINTS:
- Enzymatic fasciectomy is safe and efficacious with initial response to injection resulting in reduction of joint contracture to within 0 to 5° of normal in 90% of patients.
- Long-term recurrence rates suggest recurrence in 67% or MCP joint contractures and 100% of PIP joint contractures; however, recurrence was generally less severe than the initial contracture.
- Patient satisfaction is high with 87.5% of patients stating that they would pursue further injection for the treatment of recurrent or progressive disease.
- These data support a role for collagenase injection in the treatment of Dupuytren’s contracture, particularly in patients with isolated MCP joint contractures and those who are reluctant to proceed with surgical intervention or minimize recovery time.

REFERENCES:

HS-Paper 17
Friday, September 4, 2009 * 10:12-10:19 AM
Clinical Paper Session 4: Dupuytren’s Disease and Fibroblast Contractility
Level I Evidence

* Issei Komatsu, MD, Durham, NC
L. Scott Levin, MD, FACS, Durham, NC
Angelica Selim, MD, Durham, ND
Howard Levinson, MD, Durham, NC

HYPOTHESIS:
Myofibroblasts (which express f¿-smooth muscle actin (f¿-SMA)) within Dupuytren nodules are putatively responsible for disease progression; however, previous study showed these cells are often only focally present and in certain instances may be absent. In contrast, fibroblasts are diffusely present in Dupuytren nodules and in vitro work demonstrates that fibroblasts remodel their extracellular matrix through actomyosin contractility. It is hypothesized that both fibroblasts and myofibroblasts cause Dupuytren contractures and the contractile proteins non muscle myosin IIA and IIB (NMMIIA and NMMIIB) are robustly expressed in both these cells. The important question is not which cell causes Dupuytren contractures, because fibroblasts and myofibroblasts are similar, but rather what are the intracellular proteins that mediate cell contractility to cause contractures.

METHODS:
Tissues from Dupuytren fascia (n=10) and normal palmar fascia (n=10) were immunostained for f¿-SMA, NMMIIA, and NMMIIB, and sections were analyzed with the assistance of a Dermatopathologist.

RESULTS:
The cellular areas arranged in nodules had plump nuclei and robustly expressed NMMIIA and NMMIIB, in comparison to normal palmar fascia. NMMIIA and NMMIIB were ubiquitously expressed throughout nodules whereas f¿-SMA was focally absent.

SUMMARY POINTS:
The notion that myofibroblasts cause Dupuytren’s disease may be incomplete. Immunohistochemical analysis demonstrates that NMMII isoforms are expressed throughout nodules but myofibroblasts are not. The relative expression pattern of f¿-SMA, in conjunction with the ubiquitous expression of NMMII in nodule fibroblasts but not normal palmar fascia or Dupuytren cords, would suggest both fibroblasts and myofibroblasts play a role in Dupuytren contractures. Prevention of myofibroblast...
formation may be insufficient to prevent Dupuytren's disease; rather, inhibition of the common contractile proteins NMMIIA and NMMIIB in both fibroblasts and myofibroblasts may be necessary to prevent Dupuytren's disease progression.


HS-Paper 18

Friday, September 4, 2009 * 10:19-10:26 AM
Clinical Paper Session 4: Dupuytren's

An Anatomic and Biomechanical Study of Landsmeer's Oblique Retinacular Ligament and its Role in Finger Extension
Level 1 Evidence

Hiroake Ueba, MD, New York, NY
Thomas Gardner, MCE, New York, NY
Natan Moradi, New York, NY
Holger C. Erne, MD, Bad-Neustadt-Saale, Germany
Robert J. Strauch, MD, New York, NY

HYPOTHESIS:
The oblique retinacular ligament (ORL) is a constant anatomic structure and assists in distal interphalangeal (DIP) joint extension when the proximal interphalangeal (PIP) joint is extended.

METHODS:
40 fresh frozen fingers were used for this study and the presence and consistency of the ORL was noted. The fingers were mounted in a custom designed jig that allowed full motion at the MP and IP joints. The distal phalanx was connected to an Instron 5848 which allowed precisely calibrated DIP flexion with the ability to measure the force required to flex the joint in varying PIP and MP positions. The force required to flex the DIP joint was then assessed with the PIP joint in 0, 30, 60 and 90 degrees of flexion, as well as varying the MP joint positions of 0 and 45 degrees. The ‘normal’ force was measured and then all measurements were repeated following serial sectioning of the ORL, and subsequently the central slip.

RESULTS:
The ORL was present on the radial and ulnar sides of each finger in 38 specimens. The ORL tended to be more robust in the ring finger followed by the index, middle and small fingers, respectively.

In the intact finger DIP flexion force was greatest at 30 degrees of PIP flexion and least at 90 degrees of PIP flexion. There was statistical significance between the 90 degree and all other positions of PIP flexion with respect to flexion force in the intact specimen.

Serial sectioning of the ORL revealed that it contributed 25% to the total force required to flex the DIP joint with the PIP at 0 degrees, 31% at 30 degrees (p<.001), 18% at 60 degrees, and 3% at 90 degrees. MP joint position of 0 or 45 degrees did not affect the force required to flex the DIP joint.

Sectioning the central slip revealed a statistically significant effect at 90 degrees of PIP flexion where the force required to flex the DIP joint increased by 77%.

SUMMARY POINTS:
• The ORL is a relatively constant anatomic structure most robust in the ring and index fingers, and least robust in the small finger.
• The ORL contributes approximately 25 to 30% of the resistance to DIP flexion with the PIP at 0 to 30 degrees of flexion and a minimal amount at 90 degrees of flexion.
• The intact central slip accounts for the decrease DIP flexion force at 90 degrees PIP flexion.

HS-Paper 19

Friday, September 4, 2009 * 10:26-10:33 AM
Clinical Paper Session 4: Dupuytren's

Anatomy of Irreducible Metacarpophalangeal Joint Dislocation in a Cadaver Model
Level of Evidence Not Applicable

Ahmed M. Afifi, MD, Cleveland, OH
Tahseen A. Cheema, MD, Albuquerque, NM
Amanda Medoro, MS, Albuquerque, NM
Christina Salas, MSc, Albuquerque, NM
Mahmoud Taha, PhD, Albuquerque, NM

HYPOTHESIS:
Considerable controversy exists over the anatomy of irreducible dorsal metacarpophalangeal dislocation. The aim of this work is to a: develop a cadaveric model of MP dislocation that closely simulates the clinical situation, and b: study the anatomy of the structures around the MP joint and their contribution to irreducibility of the dislocation. We hypothesize that 1) the flexor tendons, lumbricals and the superficial transverse and natatory ligaments (Kaplan's original "noose" theory) do not cause the irreducibility, and 2) division of the volar plate is necessary to reduce the dislocation.

METHODS:
Nine fresh cadaveric hands were used in this study. The hands were amputated just proximal to the carpus and stabilized in a specially formulated fixture. An index finger MP joint dislocation was created by an impact load delivered by a servohydraulic testing machine (MTS Systems), at a displacement rate of 100 mm/s and with a maximum displacement of 60 mm. Closed reduction of the dislocation was attempted, followed in irreducible cases by an open dissection of the joint to identify the anatomy of the structures around the MP joint and the cause of the irreducibility.
RESULTS:
Three specimens were excluded because of a proximal phalanx fracture or a technical error in the MTS machine. An irreducible dislocation was produced in six index MP joints. The flexor tendons were found ulnar to the joint in all cases, the radial digital nerve was superficial (50%) or radial (50%) to the metacarpal head, and the lumbrical was usually radial (83%) to the joint. Division of the volar plate was necessary to reduce the dislocation in all the cases, whereas division of the deep transverse metacarpal ligament is less efficacious. The natatory and superficial transverse metacarpal ligaments, flexor tendons and the lumbricals do not contribute to irreducibility.

SUMMARY POINTS:
• We present a novel model for creating an irreducible MP dislocation using an impact load simulating the clinical situation. Models for joint dislocation through an impact load are scarce in the literature.
• The volar plate is the primary structure preventing reduction of the dislocation.
• The noose theory is inaccurate.
• The anatomy of the structures surrounding the MP is variable, and careful dissection to prevent iatrogenic injuries is mandatory.

REFERENCES:
SUMMARY POINTS:
- Prosthetics adaptation was favored over hand transplantation after both unilateral and bilateral amputations.
- The cost for hand transplantation far exceeds that of prosthesis adaptation, both unilaterally and bilaterally.
- This study indicates that after both unilateral and bilateral hand amputation, prosthetic adaptation is the dominant strategy at this time.

Utilities and costs show prosthesis adaptation as the dominant strategy

METHODS:
352 patients with distal radius fractures were treated with (154) and without surgery (198) and followed prospectively in our trauma registry. Baseline demographics and functional scores were obtained at presentation. All patients were followed at regular intervals and received a standardized therapy regimen. Outcome parameters included a visual analog pain scale and Disability of the Arm Shoulder and Hand (DASH) scores. Stiffness was defined as tip to palm distance greater than 1 cm for all fingers. Differences in baseline patient characteristics between stiff and non-stiff patients were assessed using Student’s t-tests for continuous data and Fisher’s exact tests for categorical data. Mixed models with random coefficients were used to examine the association between finger stiffness and outcomes over time.

RESULTS:
Although there were no significant differences in pain (p=0.10) or DASH (p=0.32) between stiff and non-stiff patients at 1 year, there were significant differences in change trajectories of pain and DASH scores relative to finger stiffness across 3, 6 and 12 months of follow-up. Those who were stiff had a rate of change that differed by a pain score of 1.2 on average (p<0.001). Similarly, stiff patients demonstrated a rate of change in function that differed by a DASH score of 17.8 (p<0.001). The stiff patients have a much steeper improvement curve. Of the patient characteristics examined, only advanced age was a positive predictor for later hand stiffness (p=0.009).

SUMMARY POINTS:
- Finger stiffness had an effect on pain and DASH scores early during treatment, though this differential decreased over time.
- By 1 year, there were no significant differences between stiff and non stiff patients.
- Advanced patient age was the only positive predictor for late hand stiffness.
- Early in the course of treatment, finger stiffness has a large effect on recovery; this dissipates over time until 1 year, where outcomes are similar. In the aged patient population, a heightened awareness and vigilance is required to proactively treat against hand stiffness.

HS-Paper 21
Friday, September 4, 2009 * 1:00-1:07 PM
Clinical Paper Session 5: Distal Radius Fracture

Finger Stiffness following Distal Radius Fractures: Is it a Functional Problem?
Level 2 Evidence

♦ Steve K. Lee, MD, New York, NY
● Nader Paksima, DO, New York, NY
Nikola Lekic, BS, New York, NY
Alissa Zingman, BA, New York, NY
● Michael G. Walsh, PhD, New York, NY
Kenneth Egol, MD, New York, NY

HYPOTHESIS:
Decreases in range of motion after distal radius fractures are seen in the wrist, forearm, and hand. It is common to report only wrist and forearm range of motion after distal radius fractures. However, recovery of hand range of motion probably contributes additionally to an overall good clinical outcome. The purpose of this study was 1) to identify the association between hand stiffness and pain and functional outcomes, and 2) to identify predictors for hand stiffness after distal radius fracture.

- Research or institutional support received from EBI, DePuy: A Johnson & Johnson Company, Small Bone Innovations, Stryker, Synthes (Paksima)
- Research or institutional support received from Stryker, Synthes, Biomet (Walsh)
- Ownership interests (including stock options) received from Small Bone Innovations (Paksima)
- Ownership interests (including stock options) received from Johnson & Johnson (Walsh)
- Full- or part-time employment or consulting arrangement with Stryker (Paksima)
- Full- or part-time employment or consulting arrangement with Exactech (Walsh)
Arthroscopic Guided Osteotomy for Distal Radius Malunions
Level 4 Evidence

¬ Francisco del Piñal, MD, PhD, Santander, Spain
Francisco J. Garcia-Bernal, MD, PhD, Santander, Spain
Alexis Studer, MD, Santander, Spain
Leopoldo Cagigal, MD, Santander, Spain
Higinio Ayala, MD, Santander, Spain
Javier Regalado, MD, Santander, Spain

BACKGROUND:
It has been shown that step-offs of 1mm or more are associated in the midterm to pain and osteoarthritis after a distal radius fractures. On the other hand impaction fractures are healed after 3 weeks. Corrective osteotomies of the intra-articular fragments guided by arthroscopy may be performed months after the injury preserving the nourishment of the fragments and being associated to excellent outcomes. Our aim is to present our experience in the management of intra-articular distal radius malunions guided by the dry arthroscopy technique.

METHODS:
11 patients were operated for malunion of the distal radius 1 to 5 months after the traumatic event under arthroscopic guidance. In all cases the dry arthroscopic technique was used. Original fracture patterns were: 1 radial styloid fracture, 1 radiocarpal dislocation, and 9 C31 fractures. Seven patients have had surgery prior to the referral, while the rest had cast treatment. In 5 cases an antero-ulnar or radial styloid fragment was repositioned. In the rest more than one fragment (up to 3) was osteotomized. In one patient the articular osteotomy was combined with an ulnar shortening.

RESULTS:
The average improvement in ROM was: 44º of flexo-extension and 59º of pronosupination. The grip strength average was 85% of the contralateral side. The results in the Gartland and Werley system were quite common as the fragments did not fit as in an acute fracture (< 2 mm). Step-offs however were reduced in most cases to zero. One patient was considered a radiological failure, because the fragment displaced due to poor fixation, although so far no additional surgery has been required and the patient has no complaints. Another patient required hardware removal.

CONCLUSIONS:
Arthroscopic guided osteotomy permit precise definition of the malunited fragments with minimal interference with the vascularization. This technique can be used for patients with irregularly defined fragments that are not amenable to classic techniques.

REFERENCES:
plating at two Level-I trauma centers. All patients were treated with internal distraction plating across the radiocarpal joint and followed for a mean of 48 weeks. At the time of final follow-up, radiographs were evaluated for radial length and palmar tilt. Range of motion, complications, and DASH scores were also obtained.

RESULTS:
Thirty-three patients with a mean age of 69.7 years were treated with distraction plating for highly comminuted distal radius fractures not amenable to volar plate fixation. At the time of final follow-up, all fractures had healed and radiographs demonstrated a mean palmar tilt of 5.4° and a mean radial length of -0.7 mm. The mean values for wrist flexion and extension were 44° and 50° respectively. The average pronation and supination were 82° and 80° respectively. At final follow-up, the mean score on the DASH questionnaire was 35. Digital stiffness was noted in 10 patients during the post-operative course but only one patient required a subsequent surgery for tenolysis. Three patients developed complications: one patient complained of transient superficial radial neuritis, one patient developed complex regional pain syndrome, and one patient developed an infection with poor wound healing subsequently requiring a skin graft.

SUMMARY POINTS:
- In the elderly, distraction plating is an effective method of treatment for highly-comminuted, osteoporotic distal radius fractures not amenable to volar plate fixation. Total arc of motion measurements for patients treated with distraction plating are functional with a mean of 94° of flexion/extension and 162° of pronation/supination.
- The use of distraction plating in elderly patients with highly comminuted fractures of the distal radius results in maintenance of radial length and palmar tilt at the time of fracture union. It yields acceptable results and provides a reasonable means for the management of these difficult fractures.

REFERENCES:
HYPOTHESIS:
We hypothesize that using the receiver operating characteristic curves can estimate the minimum recovery in grip strength, key pinch strength, and wrist arc of motion needed for patient satisfaction after treatment of distal radius fractures (DRFs).

METHODS:
A prospective cohort of 125 DRF patients was evaluated at 3 months after surgery for grip strength, key pinch strength and wrist arc of motion. They also completed the Michigan Hand Outcomes Questionnaire, which has specific questions asking patients about their satisfaction with hand strength and wrist arc of motion. Receiver operating characteristic (ROC) curves were constructed using these patient satisfaction items as the “gold standard”. Each cut-point of each objective measurement was tested for discriminatory ability between those who were satisfied and dissatisfied. The strength of the relationship between patient satisfaction and each of the objective measures is measured to estimate the amount of grip strength, key pinch strength and wrist arc of motion that need to be regained for a patient to go from being dissatisfied to being satisfied with these outcomes.

RESULTS:
We found that the area under the curve (AUC) for grip strength was 0.77 (95%CI=0.68, 0.85), 0.71 for key pinch strength (95%CI=0.61, 0.80), and 0.81 for wrist arc of motion (95%CI=0.72, 0.90). We further found that the optimal cut-points for satisfaction occurred when patients had recovered 65% of their grip strength, 87% of their key pinch strength, and 95% of the wrist arc of motion, as measured as percents of their uninjured wrists.

SUMMARY POINTS:
- A much greater wrist arc of motion must be recovered for patients to be satisfied and this motion is much greater than what is needed to perform activities of daily living.
- Constructing ROC curves can be used in estimating the amount of recovery needed for to achieve patient satisfaction after hand surgery.
A Prospective Randomized Study Comparing Woven Polyglycolic Acid and Autogenous Vein Conduits for Reconstruction of Digital Nerve Gaps
Level 1 Evidence

HYPOTHESIS:
The purpose of this study is to compare sensory recovery, cost, and complications following digital nerve repair using autogenous vein and synthetic conduits.

METHODS:
The study enrolled patients presenting for repair of digital nerve injuries with gaps precluding primary repair. Each nerve repair was randomized to repair with either a commercially-available woven polyglycolic acid mesh tube or an autologous vein harvested from the dorsal hand or forearm. The time required to perform each nerve repair, including vein harvest in the vein group, was recorded. Sensory testing, consisting of moving and static two-point discrimination testing, was performed by a blinded observer at 3 months, 6 months, and 12 months following nerve repair. Patient factors were compared between the two groups using Chi-squared and Student’s t-test to determine homogeneity. Results of sensory testing were compared between the two groups at each time point using Student’s t-test. Time and cost of repair were compared.

RESULTS:
The study group consisted of 42 patients, with 76 nerve repairs. Patients ranged in age from 19 to 76 years (median 35). 41 nerves were repaired with a synthetic conduit, 35 with autologous vein. Nerve gaps ranged from 4 to 25mm (mean 9.7mm). The study groups were not significantly different regarding age, time between injury and repair, length of nerve gap, medical history, smoking history, or presence of a worker’s compensation claim. Mean repair time in the vein group (33.9 minutes) was significantly longer than the synthetic conduit group (17.6 minutes), corresponding to an average increased cost of $582.11. Average cost per synthetic conduit was $748.54. Mean static and moving 2-point discrimination at 6 months for the synthetic conduit group were 8.33±2.0 and 6.58±2.3, respectively, compared to 8.50±1.8 and 7.06±2.2 for the vein group. Values at 12 months for the synthetic conduit group were 7.53±1.9 and 5.62±2.2, compared to 7.63±2.6 and 6.58±.9 for the vein group. These differences were not statistically significant. Patients with a worker’s compensation claim had a significantly worse sensory recovery at 12 months post-repair than those without. Smokers had a significantly worse sensory recovery at 6 and 12 months post-repair than non-smokers. There were two implant extrusions in the synthetic conduit group requiring reoperation.

SUMMARY POINTS:
- Sensory recovery following digital nerve reconstruction with autologous vein conduit was equivalent to that using polyglycolic acid conduit.
- The cost profile of the two treatments was similar.
- There were fewer postoperative complications in the vein group.
SUMMARY POINTS:

- Outcomes are similar between the two groups for elbow flexion and supination strength.
- Patients appropriate for double nerve transfer tend to have less severe injury and lower pre-operative DASH scores than single nerve transfer patients.
- Double nerve transfer patients have greater grip strength, but this may be due to less severe injury in this group.
- Single nerve transfer patients had a greater improvement in DASH scores.
- Postoperative DASH scores are similar in single and double nerve transfer patients.
- The median nerve may be better used for another purpose in patients with upper trunk brachial plexus injuries.

REFERENCES:


HS-Paper 28
Friday, September 4, 2009 * 2:34-2:41 PM
Clinical Paper Session 6: Nerve

Level I Evidence

- Guilherme Giusti, MD, Rochester, MN
- Wouter F. Willems, MD, Rochester, MN
- Patricia F. Friedrich, RT, Rochester, MN
- Matthew R. Jensen, SA, Rochester, MN
- Allen T. Bishop, MD, Rochester, MN
- Alexander Y. Shin, MD, Rochester, MN

HYPOTHESIS:
An effective alternative to nerve autografting is needed to minimize morbidity and solve limited availability issues. We hypothesized that processed allografts and collagen conduits would allow recovery of motor function equivalent to autografts.

METHODS:
A unilateral 10 mm sciatic nerve defect model in Lewis rats was used. 64 rats were divided into three experimental groups: Group I was repaired with an ipsilateral reverse autologous nerve, Group II, a processed acellular nerve allograft harvested from Sprague-Dawley rats and processed by Axogen Laboratories was used and Group III, a 2.0 mm inner diameter collagen conduit (Stryker Orthopedics, Neuromatrix). The animals were studied at 12 and 16 weeks post-operatively. Evaluation included tibialis anterior(TA) isometric tetanic muscle force, TA muscle weight, compound muscle action potential(CMAP), passive ankle plantar flexion angle and nerve histomorphometry. All results except ankle flexion angle were normalized to the contralateral side. Isometric motor strength was measured using our previously described and validated method(1). Statistical investigation was performed with a significance set at á = 0.05.

RESULTS:
The normalized isometric tetanic force results at 12 weeks for group I was 45.2±14.9%, for group II 43.4±18.0% and for group III 7.0±9.2%. At 16 weeks, the results for group I was 65.5±14.1%, for group II 36.3±15.7 and for group III 12.1±16.0%. At 16 weeks, autograft was statistically superior compared to processed allograft. Both autograft and allograft demonstrated better results than collagen conduits. Although histomorphometric analysis did not demonstrate differences in myelinated nerve counts between autograft and allograft at either 12 or 16 weeks, isometric tetanic force, muscle weight and CMAP were statistically superior in the autograft group. There were improvements in isometric tetanic motor force in the autograft between 12 and 16 weeks that were significant, however, there was no improvement of motor force in the processed allograft group.
SUMMARY:
Autograft demonstrated statistically superior motor recovery compared to processed allograft or collagen conduits. Despite the similarities in histomorphometry of the autograft and processed allograft, there was a statistically superior improvement of motor function in the autograft group that occurred by 16 weeks whereas the processed allograft group failed to improve in motor function between 12 and 16 weeks. Based on this rat sciatic nerve model, autograft remains the gold standard in motor nerve reconstruction. Further investigation of processed allograft nerves with longer periods of recovery periods are needed to determine if there is a clinical role for processed allografts in motor nerve reconstruction.

REFERENCE:

Figure 1: The mean and standard deviation for autograft, processed allograft and collagen conduit in 12 and 16 weeks based on the TA maximal isometric tetanic force of the experimental side as a percentage of the contralateral side.

REFERENCE:

HS-Paper 30

Friday, September 4, 2009 * 2:48-2:55 PM
Clinical Paper Session 6: Nerve

Hemi-Contralateral C7 Transfer to the Median Nerve: Outcomes and Complications
Level 4 Evidence

† Douglas M. Sammer, MD, St. Louis, MO
Michelle F. Kircher, RN/BSN, Rochester, MN
Allen T. Bishop, MD, Rochester, MN
Robert J. Spinner, MD, Rochester, MN
Alexander Y. Shin, MD, Rochester, MN

HYPOTHESIS:
Radial nerve damage results in substantial functional limitations of the upper extremities. No detailed data exists regarding long-term results, the patient satisfaction and professional and social reintegration following tendon transfer for irreparable damage to the radial nerve. In this retrospective study, we investigated this hitherto missing data through the DASH questionnaire.
HYPOTHESIS:
In brachial plexus injuries with total root avulsions, the uninjured contralateral-C7 nerve root (hemi or whole) can be transferred to provide axons to the injured median nerve with the goal of obtaining grasp. The hypothesis of this study is that hemi-C7 transfer to the median nerve can be used to successfully restore functional grasp with an acceptable morbidity rate.

METHODS:
A retrospective review of all patients at a single institution from 2001 through 2008 who underwent hemi-C7 transfer for neurotization of the median nerve after traumatic brachial plexus injury was performed. Objective outcomes including electrodiagnostic study results and BMRC motor grading were reviewed in all patients with at least 18 months of postoperative followup. Complications including donor side morbidity were recorded in all patients.

RESULTS:
Twenty-one patients underwent hemi-C7 transfer to the median nerve using an ipsilateral vascularized ulnar nerve graft. The mean age at the time of surgery was 25 years, and the average time from injury to surgery was 153 days. EMG-proven reinnervation occurred in 24% of patients, with the first signs of reinnervation occurring at an average of 28 months postoperatively (Table I). Clinical evaluation of composite grasp showed 7% of patients with a motor grade of M2, 13% of patients with a motor grade of M1, and 80% of patients with a motor grade of M0 (Table I). No patients developed clinically useful function. All patients developed subjective C7-distribution sensory changes on the donor side that improved over time, with an average 2-point discrimination of 5 mm at 14 months postoperatively. Eight of 21 patients (38%) developed transient motor deficits. One patient developed profound motor and sensory deficits and required tendon transfers on the donor side.

SUMMARY POINTS:
- The hemi-C7 nerve transfer failed to restore clinically significant median nerve motor function.
- The hemi-C7 nerve transfer resulted in severe donor-side morbidity in one patient.
- It is difficult to justify its use for restoration of median nerve function in traumatic brachial plexus injuries.

Electrodiagnostic study results

<table>
<thead>
<tr>
<th>Electrodiagnostic study results</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. patients</td>
<td>17</td>
</tr>
<tr>
<td>No. patients with EMG evidence of motor reinnervation</td>
<td>4 (24%)</td>
</tr>
<tr>
<td>Mean time to first sign of motor reinnervation (months)</td>
<td>28 (range 12 to 57)</td>
</tr>
<tr>
<td>Mean length of follow-up (months)</td>
<td>33 (range 19 to 58)</td>
</tr>
</tbody>
</table>

* Patients with less than 18 months postoperative followup excluded (average followup 33 months, range 19 to 58).

Motor grade (composite grip)*

<table>
<thead>
<tr>
<th>Motor grade (composite grip)</th>
<th>12 (80%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. patients M0</td>
<td>12 (80%)</td>
</tr>
<tr>
<td>No. patients M1</td>
<td>2 (13%)</td>
</tr>
<tr>
<td>No. patients M2</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>No. patients M3</td>
<td>0</td>
</tr>
<tr>
<td>No. patients M4</td>
<td>0</td>
</tr>
<tr>
<td>No. patients M5</td>
<td>0</td>
</tr>
</tbody>
</table>

* N = 15 patients with > 18 months postoperative followup (mean f/u 40 months, range 22 to 66)

REFERENCES:

HS-Paper 31

Saturday, September 5, 2009 * 8:45-8:52 AM
Clinical Paper Session 7: Scaphoid/Lunate

Triage of Suspected Scaphoid Fractures: Computed Tomography versus Magnetic Resonance Imaging

Level I Evidence

**Wouter H. Mallee, MSc, Amsterdam, Netherlands**
Job N. Doornberg, MD, PhD, Amsterdam, Netherlands
Carel Goslings, MD, PhD, Amsterdam, Netherlands
David C. Ring, MD, PhD, Boston, MA
Niek Van Dijk, MD, PhD, Amsterdam, Netherlands
Mario Maas, MD, PhD, Amsterdam, Netherlands

OBJECTIVE:
The purpose of this prospective study was to compare the diagnostic performance characteristics of computed tomography (CT) versus magnetic resonance imaging (MRI) for patients with clinically suspected scaphoid fractures with negative plain radiographs.

HYPOTHESIS:
MRI is superior to CT for suspected scaphoid fractures.
METHODS:
Thirty-four consecutive patients with clinically suspected scaphoid fractures and negative plain radiographs underwent CT and MR-imaging within four days after trauma. This prospective study was approved by our institutional review board and all patients gave written informed consent. CT data were reformatted in standard axial, sagittal and coronal planes relative to the wrist. MRI examination was performed with a 1.0T open MRI to allow for central placement of the wrist in the magnetic field. A panel including surgeons and radiologists came to a consensus diagnosis for each study. Based on current literature, we used 6-week follow-up plain radiographs as a reference standard to calculate sensitivity, specificity and accuracy for both imaging modalities.

RESULTS:
According to the reference standard there were six true fractures of the scaphoid (prevalence 18%). CT imaging diagnosed a fracture of the scaphoid in four patients (12%), with three false positive, one true positive and five false negative results. MRI showed a scaphoid fracture in seven patients (21%), with three false positive, two false negative and four true positive results. Sensitivity, specificity and accuracy for CT were 17%, 89% and 76%; and for MRI 67%, 89% and 85% respectively. This resulted in a positive predictive value of 0.57 for MRI and 0.25 for CT. Negative predictive values were 0.93 for MRI and 0.83 for CT.

SUMMARY POINTS:
- MRI was superior to CT.
- Neither CT or MRI was entirely accurate, both were subject to false positives and false negatives scans.
- The best reference standard for a true fracture of the scaphoid is debatable.
- Not clear when bone edema on MRI and small unicortical line on CT represent a true fracture.

REFERENCES:

Marti-Keuning-Eckhardt Foundation Post Doc Fellowship

HS-Paper 32
Saturday, September 5, 2009 # 8:52-8:59 AM
Clinical Paper Session 7: Scaphoid/Lunate
Undisplaced Scaphoid Fractures: The Use of a Week 4 CT Scan to Predict the Outcome of Non-operative Treatment and Reduce the Length of Immobilisation
Level 2 Evidence

♦ Tim R.C. Davis, FRCS, Nottingham, United Kingdom
John Geoghegan, FRCS, Nottingham, United Kingdom
Michael J. Woodruff, FRCS, FRCS (Tr&Orth), Nottingham, United Kingdom
Raj Bhatia, FRCS (Tr&Orth), MD, Nottingham, United Kingdom
Nick Downing, FRCS, Nottingham, United Kingdom
John Oni, FRCS, Nottingham, United Kingdom

HYPOTHESIS:
This prospective cohort study investigated whether assessment of union on Week 4 CT scans can predict the outcome of undisplaced scaphoid waist fractures which are treated non-operatively in a below-elbow plaster cast for 4-8 weeks.

METHODS:
59 scaphoid waist fractures in 57 patients (median age = 26 years) were recruited and all were CT scanned at 4 weeks. These 4 week CT scans demonstrated that 43 (73%) of the fractures were undisplaced. Fracture union was assessed on these 43 CT scans by two independent observers and the reproducibility of this assessment was tested by determining Cohen’s kappa values. All the fractures were followed-up radiographically for a mean of 112 (range 53 to 795) days. The duration of non-operative treatment was determined by the treating surgeon and 26 fractures were mobilised at 4 weeks, 2 at 5 weeks, 4 at 6 weeks, 1 at 7 weeks and 11 at 8 weeks.

RESULTS:
Comparison of the two observers assessments of union revealed good reproducibility (kappa = 0.77). 37 of the 43 undisplaced fractures were classed as “united” on the 4 week CT scan and all 37 actually united, even though 25 of these were only immobilised for 4 weeks. Only one of the six undisplaced fractures which was classed as “not yet united” on the Week 4 CT scan failed to unite, such that the 4 week CT scan had 88% sensitivity, 100% specificity and 100% positive and 17% negative predictive values for predicting the outcome of the undisplaced fractures. The 4 week CT scan of the one undisplaced fracture which developed a nonunion clearly showed that the fracture had not yet united.

SUMMARY POINTS:
- The outcome of non-operative treatment of undisplaced scaphoid waist fractures can be predicted with reasonable accuracy by assessing fracture union on a week 4 CT scan.
If the week 4 CT scan shows union and the fracture is undisplaced, then further immobilisation of the fracture is may be unnecessary: all such fractures which were mobilised at week 4 actually united.

**HS-Paper 33**

Saturday, September 5, 2009 * 8:59-9:06 AM  
Clinical Paper Session 7: Scaphoid/Lunate

**Biomechanical Evaluation of Interfragmentary Compression of Scaphoid Screws**  
Level 3 Evidence

♦ Louise A. Crawford, MBChB, MRCS (Ed), Wigan, United Kingdom  
Eric Powel, BSc (Hons), Wigan, United Kingdom  
Ian A. Trail, MBChB, MD, FRCS, Wigan, United Kingdom

**HYPOTHESIS:**  
A variety of interfragmentary compression screws are available on the market with the recent introduction of ‘two-piece’ compression screws. We hypothesise that there is no difference in the compression that these screws can achieve.

**METHODS:**  
Scaphoid screws tested were: Acutrak, Asnis, Herbert, Herbert-Whipple, Little Grafter, TwinFix and Kompressor. Interfragmentary compression testing was performed on 10 screws of each type using the ‘Instron Compression Tester’. Blocks of standardised sawbone material were used to simulate cancellous bone. Each screw was passed through the sawbones materials, separated by a spacer, and continuous compression forces recorded. For each screw the compression of the ‘flush’ position was noted. For the screws offering ‘two-piece compression’ – TwinFix and Kompressor – recordings were made until maximum compression was achieved. We also tested the pull out force for each screw.

**RESULTS:**  
Mean compression and extension forces are shown below:

<table>
<thead>
<tr>
<th>Screw Type</th>
<th>Mean Compression Force (N)</th>
<th>Extension Force (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acutrak</td>
<td>11.4</td>
<td>16.9</td>
</tr>
<tr>
<td>Asnis</td>
<td>19.1</td>
<td>19.4</td>
</tr>
<tr>
<td>Herbert</td>
<td>4.5</td>
<td>6.65</td>
</tr>
<tr>
<td>Herbert-Whipple</td>
<td>20.8</td>
<td>32.5</td>
</tr>
<tr>
<td>Little Grafter</td>
<td>11.4</td>
<td>26.9</td>
</tr>
<tr>
<td>Kompressor</td>
<td>50.8</td>
<td>32.2</td>
</tr>
<tr>
<td>TwinFix</td>
<td>30.5</td>
<td>12.9</td>
</tr>
</tbody>
</table>

SPSS package was used for statistical analysis. There was a statistically significant difference between the different screws for both the compression force and the resistance to pull out (extension). P<0.001

For the dual component screws, the Kompressor screw produced significantly stronger compression than the TwinFix.

**SUMMARY POINT:**  
Dual component screws recorded the greatest interfragmentary compression with the Kompressor screw achieving maximum compression.

**REFERENCES:**  

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**HS-Paper 34**

Saturday, September 5, 2009 * 9:06-9:13 AM  
Clinical Paper Session 7: Scaphoid/Lunate

**Scaphoid Excision, Four Bone Fusion versus Proximal Row Carpectomy: A Comparison of Contact Biomechanics**  
Level of Evidence Not Applicable

♦ Peter Tang, MD, MPH, New York, NY  
David Wei, MS, New York, NY  
Hiroaki Ueba, MD, New York, NY  
Tom Gardner, MCE, New York, NY  
Robert J. Strauch, MD, New York, NY  
Melvin P. Rosenwasser, MD, New York, NY

**HYPOTHESIS:**  
PRC and FBF are common motion-preserving operations for the arthritic wrist. We hypothesize: (1) proximal row carpectomy (PRC) contact pressure is greater than scaphoid excision, four bone fusion (FBF) contact pressure; (2) PRC contact area is smaller than FBF contact area; and (3) the amount of contact translation is equal for both PRC and FBF wrists.

**METHODS:**  
Six fresh-frozen cadaveric forearms underwent scaphoid excision, four bone fusion with k-wires. Low Fuji contact film was placed in the radiocarpal joint of each specimen and a 200 N load was applied via the wrist tendons in three positions: neutral, 45 degrees of flexion, and 45 degrees of extension. The specimen then underwent PRC and the experiment was repeated. The film was scanned and analyzed with a customized MATLAB program. Multivariable ANOVA and Student’s t-test were performed for statistical analysis.

**RESULTS:**  
We found the PRC wrist demonstrated significantly higher pressure compared to FBF for all positions (p<0.05). The average pressure in the PRC wrist was 25% greater compared to the FBF wrist.
(4.4 MPa and 3.5 MPa, respectively). The PRC wrist also trended, but did not reach statistical significance, toward smaller contact area (36 mm²) compared to the FBF wrist (63 mm²). In terms of kinematics, lunate contact in the FBF wrist moved significantly dorsal with flexion and volar with extension (p=0.005). After PRC, capitate contact moved significantly dorsal and radial with flexion and volar and ulnar with extension (p<0.05). Lastly, in terms of translation of contact between flexion and extension, no significant difference was found in lunate (6.6 mm) translation compared to capitate (7.4 mm) translation (p=0.63).

SUMMARY POINTS:
- The PRC wrist has significantly higher contact pressure and trends toward smaller contact area compared to the FBF wrist. 
- Lunate contact in the FBF wrist moves significantly dorsal with flexion and volar with extension, while capitate contact in the PRC wrist moves significantly dorsal and radial with flexion and volar and ulnar with extension.
- Lastly, no significant distance was found in the amount of contact translation between the PRC and FBF wrists.

Figure 1: Composite illustration of FBF and PRC contact kinematics. Average contact positions are shown for three wrist positions: flexion, neutral, and extension.

HS-Paper 35

Saturday, September 5, 2009 * 9:13-9:20 AM
Clinical Paper Session 7: Scaphoid/Lunate

PRCA- Palmar Radiocarpal Artery Vascularized Bone Graft for the Unstable “Humpbacked” Scaphoid Nonunion with an Avascular Proximal Pole
Level 4 Evidence

♦ T. Greg Sommerkamp, MD, Edgewood, KY
Jeffrey A. Greenberg, MD, Indianapolis, IN
Hill Hastings II, MD, Indianapolis, IN

HYPOTHESIS:
The unstable scaphoid nonunion with humpbacked collapse and elevated ISA's (intrascaphoid angles) coupled with an ischemic or avascular proximal pole represents the most challenging combination for the scaphoid surgeon. Most currently described pedicled vascularized bone grafts (VBG’s) arise from the dorsum of the distal radius, and are technically difficult to insert from the radiodorsal aspect of the wrist while simultaneously attempting to correct the humpback deformity. Other free VBGs from the iliac crest, and medial femoral condyle / descending geniculate artery are certainly excellent options, but are fairly extensive microsurgical procedures with lengthy operative times. Kuhlman introduced the PRCA – VBG in 1987, and Mathoulin reported on his initial 17 nonunions treated with the PRCA in 1998.

METHODS:
We now present our results with eleven unstable, humpbacked nonunions with ischemic proximal poles, treated with the volar PRCA graft + ORIF. There were 9 males and 2 females, with an average age of 26. The average duration of the nonunions was 5.7 years. Preop ISA’s by dedicated scaphoid CT scanning were: coronal 52°, and sagittal 50°.

RESULTS:
All nonunions healed. The average STS (scaphoid trabeculation) scores as assessed by serial CT scanning at week 6 were 68%, and 80% by 3 months demonstrating increasing percentage union over time. No significant difference was observed in the trabeculation rates between the proximal pole / graft interface and the distal pole / graft interface. Sagittal ISA’s improved from 50° preop to 32° post op indicating a reasonable correction of the humpback collapse deformity. Patients were followed an average of 22 months with no sign of further AVN / late segmental collapse.

SUMMARY POINTS:
The pedicled PRCA – VBG successfully addresses the dual needs of the humpbacked scaphoid with the avascular proximal pole, while simultaneously limiting dissection to one incision on the volar aspect of the wrist, and avoiding the additional complexities of free vascularized bone grafts. The PRCA- VBG provides for:
- a VOLAR source of vascularized bone for proximal pole AVN
- direct mechanical correction of the humpback collapse through a VOLAR approach, with a stout corticocancellous wedge graft
- a consistently large, reliable pedicle (0.8 to 1.0mm)
- dissection limited to one incision on volar wrist
- avoidance of complexities of free microsurgical VBG’s

REFERENCE:
One Step Treatment of Grade II and IIIA Thumb Hypoplasia: A Combination of First Web Plasty, MP Joint Ligamentoplasty and Opponensplasty

HYPOTHESIS:
Clinical features of Blauth II and IIIA (Manske’s classification) hypoplastic thumb include a narrow first web space, hypoplastic or absent thenar muscles, and an instable MCP joint. We postulate that these three components can be treated at the same time in a procedure combining a first web enlarging plasty, a MCP joint ligamentoplasty and an opponensplasty.

METHODS:
14 patients were treated over a period of 8 years (1998-2006) including three bilateral cases. Age at operation ranged from 22 to 180 months with a mean of 64 months. There was 10 grade IIIA and 7 grade II. The right hand was affected in 10 patients and the left hand in 7. The first web space was enlarged with a four flaps Z plasty in 4 cases. In 13 cases an island flap (Foucher's kite flap), raised from the dorsal aspect of the second MCP joint was used to enlarge the first web space followed by closure of the donor site with a LLL plasty (no skin graft required). An opponensplasty was performed in the 17 cases, using a first sling of the flexor superficialis of the ring finger with a pulley created within the flexor retinaculum. MCP joint ligamentoplasty was then achieved using the second slip of the flexor superficialis. In 11 cases the ulnar collateral ligament alone was incompetent whereas a combined reconstruction of both the UCL and RCL was required in 6 cases.

RESULTS:
The mean follow-up period was 4 years. All the flaps full survived. The angle between the first and second metacarpal was increased (+15°). The mean opposition score was 6.5. 11 of the 14 patients were able to perform the first group of manual tasks of Manske’s protocol. Stability of the MP joint was increased with a mean residual angular passive deviation ranging from 10 to 40°.

SUMMARY POINTS:
- Overall thumb function can be improved in Grade II an IIIA thumb hypoplasia by a combination of web space enlargement, MCP joint stabilisation and opponensplasty.
- Combined Kite flap and LLL plasty is a safe way to enlarge the first web in hypoplastic thumbs.
- A single tendon transfer can be used to simultaneously improve stability of the MP joint and enhance opposition.

REFERENCES:
Correlation of Motor Function and Stereognosis Impairment in the Affected Hands of Children with Hemiplegic and Triplegic Cerebral Palsy

Level 4 Evidence

♦ Elspeth R.E. Kinnucan, MD, Minneapolis, MN
Ann E. VanHeest, MD, Minneapolis, MN
Wendy A. Tomhave, OTR, Minneapolis, MN
Julie Agel, MA, Minneapolis, MN

HYPOTHESIS:
Motor function impairment, as measured by the Jebsen-Taylor test, is correlated with stereognosis impairment, as measured by ability to correctly identify 12 objects, in the affected upper extremity of children with hemiplegic and triplegic cerebral palsy. Additionally, the stereognosis and motor function of the affected upper extremity is significantly more impaired than the stereognosis and motor function of the unaffected upper extremity.

METHODS:
A chart review identified children with hemiplegic and triplegic cerebral palsy with complete stereognosis testing and Jebsen-Taylor testing between 1997 and 2008. The initial Jebsen-Taylor and stereognosis test results were recorded for each subject, as well as age, diagnosis, affected side, and prior treatment with hand therapy, botulinum toxin injection, or surgery. Descriptive statistics, chi square analysis, paired T-tests, and correlation measurements were used for analysis of the data.

RESULTS:
Forty-six children were included in the study, including 25 girls and 21 boys with an average age of 8.8 years (range 6-16). The right side is affected in 25 children. Thirty-nine children have hemiplegic cerebral palsy and 7 have triplegic cerebral palsy.

Statistically significant inverse correlations exist between the cards, small objects, checkers, light objects and heavy objects on the Jebsen-Taylor subtests, as correlated with the stereognosis scores in the affected hand (p<=0.007); i.e. patients with longer times to complete motor tasks had significantly greater stereognosis impairment (Fig. 1). The stereognosis scores for the patients who were not able to complete the Jebsen-Taylor test with the affected hand were significantly lower than those who were able to complete the Jebsen-Taylor test with the affected hand (p=0.04).

The stereognosis scores were significantly lower for the affected side as compared with the unaffected side (p<0.001) (Fig. 2). The Jebsen-Taylor total test times were significantly longer for the affected as compared with the unaffected side (p<0.001).

SUMMARY POINTS:
• In children with hemiplegic and triplegic cerebral palsy, impairment of stereognosis is correlated with impairment in motor function.
• The inability to complete the Jebsen-Taylor test with the affected hand is associated with impaired stereognosis function in children with hemiplegic and triplegic cerebral palsy.
• The stereognosis and motor function is significantly more deficient in the affected hand as compared with the unaffected hand.
• Future studies need to examine whether associated motor and sensory impairment is due to a shared CNS injury, or whether stereognosis testing includes testing of the motor system peripherally.

REFERENCES:
**HS-Paper 38**

Saturday, September 5, 2009 * 8:59-9:06 AM  
Clinical Paper Session 8: Pediatrics

**Microsurgical Reconstruction of Congenital Missing Digits with Toe-to-Hand Transfers**  
Level 4 Evidence

† Neil F. Jones, MD, Orange, CA  
Ranjan Gupta, MD, Orange, CA  
Scott L. Hansen, MD, San Francisco, CA  
Neil G. Harness, MD, Orange, CA

**HYPOTHESIS:**  
To develop a more simple classification system for congenital absence and hypoplasia of the digits and to develop an algorithm for microsurgical reconstruction of these children by toe-to-hand transfers.

**METHODS:**  
A large series of 78 children with congenital differences of their hands who had undergone 90 toe-to-hand transfers was evaluated retrospectively by analyzing their preoperative X-rays and photographs to determine which digital rays were missing and their level of absence. Each hand can be described by three letters R(radial), C(central) and U(ulnar) and by two numbers. The first letter and number describe the absent rays and the second letter and number describe rays that are present. A normal hand would be designated R0U5 or U0R5 and complete aplasia would be designated R5 or U5. Symbrachydactyly with a thumb but no fingers would be designated U4R1. Level of absence proximal to the carpus is designated (c), from the carpus to the metacarpophalangeal joints (m) and distal to the metacarpophalangeal joints (p). An algorithm for microsurgical reconstruction by 4 different combinations of toe-to-hand transfers has evolved.

**RESULTS:**  
Based on this new classification system, there are 12 phenotypes of digital aplasia. However, only 6 phenotypes are suitable indications for reconstruction with microsurgical toe-to-hand transfers, namely R1U4, R2U3, R3U2, R4U1, U4R1 and US or R5. Optimal reconstruction of the severe radial deficiency phenotypes R2U3, R3U2 and R4U1 is a toe-to-thumb transfer, using either the second toe(23) or great toe(15). For severe transverse or ulnar longitudinal deficiencies U4R1, there are two options - either a second toe transfer into the ring or small finger position(27), or two second toes transferred either simultaneously or in separate procedures into the middle finger and small finger positions to provide three point pinch(12). Finally, the aplastic hand U5 or R5 phenotype is best reconstructed with two second toe transfers into the thumb and small finger positions(7).

**SUMMARY POINTS:**  
- Retrospective analysis of a large series of children with congenital digital aplasia and hypoplasia has resulted in the development of a simplified classification system.
- There are 12 phenotypes of digital aplasia and hypoplasia.
- Our treatment algorithm which has evolved over a series of 90 toe-to-hand transfers directly predicts which of four possible microsurgical toe-to-hand transfers will provide the most optimal reconstruction of each of the 6 digital aplasia phenotypes.

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**HS-Paper 39**

Saturday, September 5, 2009 * 9:06-9:13 AM  
Clinical Paper Session 8: Pediatrics

**A Minimally Invasive Stepwise Surgical Algorithm for Displaced Pediatric Phalangeal Neck Fractures: The Importance of Percutaneous Reduction**  
Level 4 Evidence

† Jonas L. Matzon, MD, Philadelphia, PA  
Roger Cornwall, MD, Cincinnati, OH

**HYPOTHESIS:**  
Displaced pediatric phalangeal neck fractures require reduction and pin fixation, but the method of reduction is debated, with closed reduction not possible in late-presenting fractures, late open reduction risking avascular necrosis (AVN), and the role of a recently-reported percutaneous reduction technique not yet clearly defined. We hypothesized that a prospectively-applied stepwise reduction algorithm including closed, percutaneous, and open reduction techniques would produce satisfactory outcomes even in late presenting factors while minimizing the need for open reduction and its risk of AVN.

**METHODS:**  
Sixty-one consecutive children (mean age 9.4 years, range 2-18) presenting with closed, displaced phalangeal neck fractures were treated using the following algorithm. Closed reduction (CR) was attempted first. If closed reduction failed to achieve satisfactory alignment, percutaneous reduction (PR) was performed using a temporary intrafocal “joystick” pin with percutaneous osteoclasis performed as needed. If percutaneous reduction failed, open reduction was performed. All fractures were secured following reduction with percutaneous interfragmentary pins regardless of reduction method used. Radiographic and clinical outcomes were retrospectively graded by the Al-Qattan system including union, deformity, range of motion, and function. Continuous variables were compared using two-tailed t-tests with 95% confidence intervals, and nominal variables were compared with Fisher’s exact test.
RESULTS:
Satisfactory alignment was achieved in all 61 fractures, by CR in 49 and PR in 12. No fracture required open reduction. Average time from injury to surgery was 7.6 days (range, 0-13) for CR and 16.6 days (range, 5-36) for PR (p<0.001). Fifty-three patients were followed for at least one year or until full functional recovery was achieved: results were excellent in 45, good in 4, fair in 1, and poor in 3. Four complications accounted for the fair and poor results, including two flexion contractures (CR, PR), one nonunion following pin tract infection (CR), and one case of AVN in a crush injury with multiple fractures (CR). There were no cases of AVN in the PR group.

SUMMARY POINTS:
- Our stepwise surgical algorithm for displaced pediatric phalangeal neck fractures produces 92% good-excellent results, even in late-presenting fractures.
- This series, the largest reported series of displaced phalangeal neck fractures in children, demonstrates percutaneous reduction to be reliably effective and safe in the 20% of fractures not amenable to closed reduction.
- Percutaneous reduction techniques should be learned and routinely utilized in the treatment of these fractures, in order to minimize the need for late open reduction and its associated risk of AVN.

REFERENCES:
Radiographic evidence of skeletal immaturity and an acceptable coronal deformity meets criteria for treating DCP malunions non-operatively. While achieving anatomic alignment in acute DCP fractures remains the goal of treatment, treating late presenting pediatric DCP malunions non-operatively is advocated based on these findings thus avoiding devastating complications of difficult surgical procedures.

Figure 1: A 14 year old had a 30º volar apex deformity at injury; and, 50% translational deformity of the distal fragment in relation to the proximal shaft.

Figure 2: At 82 months post-injury, the fracture had remodeled to 0.0º angular deformity; and, 0.0% translational deformity in the sagittal plane. The patient regained full range of motion equal to the contralateral joint.

REFERENCES:
HS-Paper 42
Saturday, September 5, 2009 * 10:12-10:19 AM
Clinical Paper Session 9: Elbow

**Total Elbow Allografts with Collateral Ligament Reconstruction for Posttraumatic Elbow Injuries**
Level 4 Evidence

♦ Amirhesam Ehsan, MD, Los Angeles, CA
John M. Itamura, MD, Los Angeles, CA

**HYPOTHESIS:**
The use of total osteoarticular elbow allografts as a salvage procedure for reconstruction of posttraumatic elbow periarticular defects and bone loss has been associated with multiple complications including infection, nonunion and instability. We hypothesize that the use of allograft collateral ligament reconstruction in conjunction with bone morphogenetic protein-II (BMP II) at the host graft junction could address the problems of instability and nonunion respectively.

**METHODS:**
We report a consecutive series of 8 patients with posttraumatic elbow injuries and extensive bone loss treated with massive osteoarticular elbow allografts augmented by collateral ligament reconstruction using hamstring allograft. The native radial head was replaced in 6 of the eight patients. To improve union rates, (BMP II) was applied to the host-graft junctions of the reconstructed elbow. Patients were evaluated clinically and radiographically.

**RESULTS:**
The average age of patients was 43 years (range, 30-69). At a mean follow up of 30 months (range, 12 to 44 months), the average Mayo Elbow Performance score was 81, with three patients demonstrating an excellent score, four patients with a good score, and one patient with a fair score. All patients reported no or only minimal pain in the elbow. The average arc of motion was 102°, with a mean of 18° (range, 10° to 40°) of extension to 120° (range, 110° to 130°) of flexion. The mean rotational arc of motion was 100°, with a mean of 49° of pronation and 51° of supination.

Four of the eight elbows developed a complication. Two patients demonstrated extensive resorption of the graft necessitating allograft removal and subsequent revision osteoarticular allograft reconstruction. One patient developed a nonunion at the humeral host-graft junction. The last patient developed a radio-ulnar synostosis at the ulnar host-graft junction. No infections were encountered in this series.

**SUMMARY POINTS:**
- The results of this study suggest that total elbow allografts with reconstruction of collateral ligaments when used in conjunction with radial head replacements may improve elbow stability.
- Furthermore the use of BMP-2 may accelerate host-graft union rates.
- This procedure can serve as a viable salvage option in selected patients; however continued long-term observation is indicated to ensure durability of the elbow reconstruction.

<table>
<thead>
<tr>
<th>Case</th>
<th>Postoperative Pain</th>
<th>Gain of Flex/Ext Arc of Motion</th>
<th>Gain of Pron/Sup Arc of Motion</th>
<th>Elbow Stability</th>
<th>Postoperative Mayo Elbow Perf Score</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mild</td>
<td>20 deg</td>
<td>40 deg</td>
<td>Unstable</td>
<td>75</td>
<td>Elbow Allograft Revision Secondary to Resorption and Instability</td>
</tr>
<tr>
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<td>40 deg</td>
<td>20 deg</td>
<td>Unstable</td>
<td>80</td>
<td>Nonunion Treated with iliac crest bone graft and revision ORIF MCL rupture after postop fall</td>
</tr>
<tr>
<td>3</td>
<td>Mild</td>
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<td>10 deg</td>
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<td>75</td>
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</tr>
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</tr>
<tr>
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<td>None</td>
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<td>Stable</td>
<td>95</td>
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</tr>
<tr>
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Figure 1 A-B: (A) Preoperative anteroposterior and (B) lateral radiograph of a posttraumatic elbow injury after a distal humerus fracture. Note joint incongruity and extensive bone loss.

Figure 2 C-D: (C) Postoperative anteroposterior and (D) lateral radiograph demonstrating incorporation of allograft with bridging callus, and maintenance of joint articulation at 12 months.

Postoperative Clinical Data
REFERENCES:

HS-Paper 43

Saturday, September 5, 2009 * 10:19-10:26 AM
Clinical Paper Session 9: Elbow

Reconstruction by the Costal Osteochondral Autograft for a Large Articular Defect in Patients of Osteochondritis Dissecans of the Elbow

Level 4 Evidence

Kozo Shimada, MD, Osaka, Japan
Eiji Sogo, MD, Osaka, Japan
Jun-ichi Miyake, MD, Osaka, Japan
Tai-ichi Matsumoto, MD, Okayama, Japan

HYPOTHESIS:
Costal osteochondral autograft is a useful surgical option for treatment of a severely damaged elbow in young athletes such as progressive osteochondritis dissecans lesion.

METHODS:
Patients: Fifteen severely damaged elbows due to osteochondritis dissecans were treated by osteochondral autograft with use of a costal rib and followed more than 9 months (9-30, average 18months). All of them were male aged 13 to 43 (average 17years) and showed a large stage III or IV (ICRS) osteochondral lesions (the lesion diameter larger than 15mm) of humeral capitellum.

Procedure: We debrided the involved osteochondral lesion completely and deepened cylindrically up to 15mm depth. An osteochondral transitional zone of the 5th or 6th costal rib was harvested and press-fitted to the defect (Figure 1). In nine cases with a large defect, the residual costal rib was shaved, and impacted between the host wall and osteochondral graft as a wedge. In most cases, internal fixation was not necessary because the graft was stable. After two weeks immobilization, motion exercise was started.

Assessment: We assessed the functional results (JOA Score: Japanese Orthopaedic Association Elbow Performance Score), sports activity and radiography every three months. MRI was assessed at postoperative six or twelve months.

RESULTS:
All patients showed bony union of the graft in postoperative three months. We allowed them to return to their daily activity in one month and previous sports activity at six months, which was achieved by all of them. The JOA score was 77.9 before operation. It improved to 95.7 at postoperative 6months, 96.0 at postoperative 12months and maintained until follow-up in most cases (92.7). A case showed recurrence of a chondral lesion at 18 months, which was treated by arthroscopic debridement. Radiographic follow-up showed some remodeling of the graft and MRI follow-up showed congruent articular surface of the graft, however subchondral revascularization of the graft was not achieved in six months and it needed twelve months period (Figure 2). One patient showed postoperative pneumothorax and it was treated properly without any functional problem. Donor site problem was not observed in any case at follow-up.

SUMMARY POINTS:
- Costal osteochondral autograft was a reliable procedure for the treatment of severe osteochondritis dissecans lesions of the elbow.
- Functional recovery was good and quick enough to return to the former sports activity.
- Complication rate was low and donor site problem was minimum.
- Remodelling of the graft was observed radiographically time-by-time, and MRI confirmed revascularization at twelve months.

REFERENCES:

Figure 1: Costal osteochondral autograft for the elbow OCD.

Figure 2: Radiograms before operation / after operation / 2 yrs. postop. / MRI 1 yr. postop.
Mechanical Failure of Coonrad-Morrey Total Elbow Arthroplasty in Patients who have Osteo and Post-Traumatic Arthritis

Level 4 Evidence

HYPOTHESIS:
Active patients with osteoarthritic or post-traumatic arthritic elbows experience greater levels of stress at the coupling mechanism with a semi-constrained total elbow arthroplasty than do rheumatoid patients, for whom the implant was originally designed.

METHODS:
During a seven year period, the authors have identified seven failures of the central axis mechanism in patients in whom a Coonrad-Morrey total elbow arthroplasty had been placed for severe osteoarthritic or post-traumatic conditions. Patients range between the age of 45-75 with the mean age of 58 and in all patients the elbow was the only joint involved with arthritic degeneration. In all cases the central axis failed with fracture or deformity. All required revision with a new custom solid central axis. In all cases the polyethylene bushings were extremely deformed and/or fractured. During the same period the authors noted failure in six rheumatoid patients, due to implant loosening, peri-prosthetic fracture or infection, but none demonstrated failure of the central axis/bushing mechanism.

RESULTS:
All osteoarthritic/post-traumatic patients reported sudden instability of their elbow with a sense of pain and presented with an unstable, uncoupled implant. This occurred at 1.5-4 years post implantation. In contrast, in none of the rheumatoid patients was any degree of central axis failure noted.

SUMMARY:
The Coonrad-Morrey total elbow arthroplasty has become the “gold standard” for management of rheumatoid arthritis of the elbow. However, its use has evolved to application in patients with osteoarthritic and post traumatic conditions of the elbow due to fracture. These patients tend to be younger and otherwise more healthy and active. The result is significant potential for failure at the central axis through application of stresses for which the implant was not originally designed. These findings warrant re-evaluation of the implant design and fabrication of a more robust central axis and polyethylene bushing if the implant is to be used in non-rheumatoid patients.

The surgeon faced with patients with isolated elbow arthritis, elbow trauma, or post traumatic conditions, who are otherwise healthy and active should consider alternative designs and carefully counsel patients setting strict limitations of activity to prevent transmission of excessive forces to the prosthetic elbow joint.

Driving with an Immobilized Upper Extremity: A Randomized Prospective Crossover Trial

Level 2 Evidence

HYPOTHESIS:
This study aims to determine whether upper extremity immobilization has detrimental effects on driving performance, in the setting of a standardized driving performance course.

METHODS:
Thirty-six healthy police officers-in-training were assigned a sequence of fiberglass splints (long arm thumb spica and short arm splints, left and right-sided) using a randomized balanced cross-over design. Driving skills were tested on a standardized cone-marked course familiar to participants, which included sections testing real-world driving maneuvers. The course is used to certify driving skills of regional emergency personnel, and has an established scoring system. Time and number of cones hit per section, cone-penalized total time (five second penalty per hit cone), and pass/fail designation were recorded. Passing grade was assigned to runs with total cone-penalized time under 230 seconds and less than 4 total cones hit. Participants were asked to rate their perceived driving difficulty and safety for each splint. Effects of upper extremity immobilization on total and cone-penalized driving times, adjusted for learning and environmental effects with an imputation technique, were tested in a linear mixed effects model. Effects of immobilization on the number of cones hit, similarly adjusted, were tested in a Poisson model fit with generalized estimating equations.

RESULTS:
Thirty participants completed a set of runs. Left long arm thumb spica splints increased cone-penalized time by 22.2 seconds (CI 10.0-34.4 seconds; p<0.001), and left short arm splints by 16.2 seconds (CI 4.6-27.7 seconds; p=0.007). A similar trend was seen in the number of cones knocked down. Although not significant, when analysis was limited to the sections of the course that did not involve backing up, the left arm splints increased cone-penalized total time the most. The left long arm thumb spica splint had the highest perceived difficulty (median, 8.0; CI 7.0-8.0) and lowest perceived safety (median, 3.0; CI 2.0-5.0).
SUMMARY POINTS:
- Immobilization of the left upper extremity may adversely affect the ability to drive an automobile in a safe, efficient manner.
- Driving performance measured with this particular standardized track and scoring system was significantly worsened with left-sided arm immobilization.
- The challenge may be due to the visual and spatial constraints in a left side driver’s seat.

HS-Paper 46

Saturday, September 5, 2009 * 10:05-10:12 AM
Clinical Paper Session 10: Arthroscopy/Arthroplasty

Arthroscopic Foveal Reattachment of the Triangular Fibrocartilage Complex for Distal Radioulnar Joint Instability
Level 4 Evidence

◆ Kevin R. Kuzma, MD, Erie, PA
John D. Lubahn, MD, Erie, PA
Gary R. Kuzma, MD, Greensboro, NC

HYPOTHESIS:
Instability of the distal radioulnar joint can occur following detachment of the triangular fibrocartilage complex from the ulna. This instability can lead to pain, lost range of motion, and decreased grip strength. Arthroscopy is being increasingly used to treat disorders of the wrist. Arthroscopic repair of the TFCC is a viable alternative to open repair or reconstruction.

METHODS:
Ten patients with ulnar sided TFCC detachments of ligamentum subcruetum from the fovea of the ulna were treated using arthroscopic repair of the TFCC between 2004 and 2008. Preoperative and postoperative range of motion and grip strength were measured. Pain and DRUJ stability were also assessed.

RESULTS:
Mean follow-up was 12.8 months (3 - 53 months). Seven of ten patients sustained TFCC injury as the result of a fracture at the wrist. Dorsiflexion decreased from 63.3° preoperatively to 61.0° postoperatively. Palmar flexion improved from 52.8° to 64.4°. Radioulnar deviation improved from 19.8° and 27.1°, respectively, to 26.1° and 31.9°. Pronation and supination improved from 80.2° and 77.8°, respectively, to 87.3° and 85.1°. Grip strength improved from an average of 44.2 lbs preoperatively to 56.5 lbs postoperatively. This is an improvement of 132% compared to preoperative levels and is 82% of the grip strength of the opposite hand. No patient had instability of the DRUJ postoperatively and only three of ten reported any level of pain (pain with heavy grip in one, nagging pain in one, and continued pain in one).

SUMMARY POINTS:
- Detachment of the TFCC from the ulna can lead to pain, instability, and loss of motion and grip strength at the wrist.

HS-Paper 47

Saturday, September 5, 2009 * 10:12-10:19 AM
Clinical Paper Session 10: Arthroscopy/Arthroplasty

The Long-term Outcome of Anatomical Reattachment of the TFCC to the Ulnar Fovea using ECU Half-Slip and Interference Screw
Level 4 Evidence

◆ Toshiyasu Nakamura, MD, PhD, Tokyo, Japan
Masao Nishiwaki, MD, PhD, Tokyo, Japan
Masato Okazaki, MD, Tokyo, Japan
Kazuki Sato, MD, PhD, Tokyo, Japan
Yoshiaki Toyama, MD, PhD, Tokyo, Japan
Hiroyasu Ikegami, MD, PhD, Tokyo, Japan

HYPOTHESIS:
Since 1998, we treated 39 wrists of ulnar detachment of the TFCC (Fig. 1A) by reattachment technique using half-slip of the extensor carpi ulnaris (ECU) tendon with a very small interference screw. We examine the long-term outcome of this procedure with a minimum of 5 years follow-up.

METHODS:
The technique indicates that the ECU half-slip induced inside the TFCC (Fig. 1B), was tightly sutured to the remnant TFCC, and pulled out through the bone tunnel that was made at the center of the fovea by 2.5 mm diameter drill (Fig. 1C). The ECU half-slip was subsequently anchored to the ulnar fovea with a small titanium interference screw (Fig. 1D). There were 17 wrists of 16 cases (12 right, 3 left, 1 bilateral, mean age, 40 years) with an average follow-up of 6.4 years (range, 5-12 years). The neutral ulnar variance was indicated in 13 wrists and positive in 4. In the positive variance wrists, the ulnar shortening equalized the abutment before the reattachment. Diagnosis was done by arthrogram, MRI and DRUJ arthroscopy findings. Clinical and radiographic results were evaluated.

RESULTS:
At final follow-up, 13 wrists indicated no pain, 3 wrists demonstrated mild pain, and 1 wrist, severe pain. Two wrists indicated loss of supination range by 30 degrees. Complete re-stabilization of the DRUJ was noted in 12 wrists, moderate instability in 4 wrists. Severe DRUJ instability remained in 1 wrist. One wrist indicated expansion of the bone tunnel on radiographic evaluation, which is considered major problem in the ligament reconstruction. Size of the bone tunnel was unchanged in 9 wrists.
as opposed 7 wrists indicated closure of the bone tunnel (Fig. 2). There were 11 excellent, 1 good, 4 fair and 1 poor results with modified Mayo wrist score.

**SUMMARY POINTS:**
- Anatomical reattachment technique of the TFCC to the ulnar fovea using ECU half-slip tendon is long lasting.
- On radiographs, 7 wrists indicated bone tunnel closure, while the bone tunnel still existed in 9 wrists.
- Bone tunnel expansion was only seen in one wrist (poor result case) among 17 wrists at final follow.

**REFERENCES:**

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**HS-Paper 48**

Saturday, September 5, 2009 * 10:19-10:26 AM
Clinical Paper Session 10: Arthroscopy/Arthroplasty

**Arthroscopic STT Arthroplasty**
Level 4 Evidence

Tyson Cobb, MD, Davenport, IA

**HYPOTHESIS:**
Arthroscopic STT arthroplasty is an effective surgical option for STT arthritis.

**METHODS:**
A retrospective review was performed of 39 patients who underwent arthroscopic STT arthroplasty over a 3-year period. Preoperative data collected included 10 point self reported Pain Scale, DASH, range of motion, grip strength, key and chuck pinch, length of symptoms and treatment. Post operative data included the above plus patient satisfaction graded on a 1 to 5 scale. Data were collected at post operative weeks 4, 12, 26 and 52.

**RESULTS:**
There were 30 females and 9 males. Average age was 63, (range 46 to 79). Preoperative length of symptoms averaged 195 weeks. Follow up time averaged 444 Days. No patients required formal therapy post operatively. Average time of post operative immobilization was less than 3 weeks. All patients retained their preoperative range of motion.

Preoperative DASH score averaged 45, pain averaged 7 of 10. Average Key pinch on the operative side was 7 and non-operative side 11 (64%). Chuck averaged 9 operative and 12 non-operative (75%). Grip strength at 2nd JAMAR setting was 40 operative and 51 non operative (78%).

Week four data showed average DASH of 36, Pain rating of 4, Satisfaction of 4, Key pinch 5 operative and 13 non operative (36%), Chuck 4 operative and 11 non operative (36%), Grip 27 operative and 39 non operative (70%).

Week 12 average DASH was 28, Pain rating of 3, Satisfaction of 4, Key pinch 8 operative – 13 non operative (61%), Chuck 8 operative – 12 non operative (67%), Grip 37 operative – 53 non operative (70%).

Week 26 average DASH – 17, Pain – 2, Satisfaction- 4, Key pinch 11 operative – 14 non operative (79%), Chuck 11 operative – 14 non operative (79%)and Grip 41 operative – 54 non operative (76%).

Week 52 averages DASH- 14, Pain 1, Satisfaction 4, Key pinch 14 operative – 15 non operative (93%), Chuck 14 operative- 14 non operative (100%), and Grip 52 operative – 58 non operative (90%).
SUMMARY POINTS:
- Arthroscopic STT arthroplasty provides satisfactory relief of pain and return of strength and function.
- Patients progressively improved over time with most improvement seen between 3 to 6 months.
- Key pinch doubled from preoperative levels, Chuck pinch increased by 64% and grip strength showed an overall increase of 77%.
- Short post operative immobilization of three weeks and no formal therapy required.

HYPOTHESIS:
Arthroscopic hemitrapeziectomy without interposition may offer good short-term and long-term subjective and objective outcomes for patients with Stage III thumb carpometacarpal arthritis compared to historical controls for standard open procedures.

METHODS:
23 patients underwent arthroscopic hemitrapeziectomy without interposition and were evaluated by preoperative and postoperative grip and pinch strength, digital and wrist motion, DASH and analog pain scores. Radiographs evaluating metacarpal subsidence and translation were taken preoperatively and postoperatively. All postoperative data was collected at twelve weeks and again at a minimum of 48 months (range: 48 to 67 months). Patients were asked about their overall satisfaction regarding the procedure (“pleased”, “satisfied” or “dissatisfied”) and about the cosmesis of their hand. Complications were noted and recorded.

RESULTS:
At twelve weeks, DASH scores improved 60.8 to 9.6 and pain scores decreased from 8.3 to 1.5. Grip and key pinch strength improved 15 lbs and 3 lbs, respectively. Wrist and digital motion remained unchanged from preoperative measurements. Proximal migration of the first metacarpal averaged 3mm and translation decreased from 30% to 10%. Nineteen out of twenty-three patients reported to be “pleased” with their overall outcomes. At fours years, DASH scores, grip and pinch strengths, motion, and patient satisfaction remained unchanged. Subsidence and translation on radiographs also remained unchanged.

SUMMARY POINTS:
- Arthroscopic hemitrapeziectomy offers a minimally invasive alternative in which patients with Eaton stage III arthritis may expect increased function and decreased pain within three months.
- These results are expected to last a minimum of four years and are comparable to those reported for open techniques involving complete trapeziectomy.
- The omission of substance interposition does not appear to have any adverse effects on outcome.
The SBI Avanta Total CMC Implant: Not Ready For Prime-Time
Level 4 Evidence

Daniel S. Sellers, MD, Bountiful, UT
Karen Wight, LPRT, Bountiful, UT

HYPOTHESIS:
The Small Bone Innovations Avanta 1st CMC total implant arthroplasty, because of its high wear surface and cemented stability which makes it akin to a total hip implant, should provide excellent joint stability as well as dependable correction of the pain of 1st CMC arthritis in non-pan-trapezial arthritic individuals.

METHODS:
An essentially consecutive series of patients presenting to the author’s practice for relief of basal joint arthritis pain who did not have pan-trapezial degeneration were implanted with the SBI Avanta implant. Over a 19 month period, 42 implants were placed. Standardized therapy protocols were followed.

RESULTS:
Failure, defined as persistent pain occurring after the achievement of a painless surgical outcome, occurred in 37%. Nearly all failures were due to loosening of the cemented cup component within the trapezium. In two patients the trapezium fractured. All failures were detectable on in-office fluoroscopic examination.

SUMMARY POINTS:
• The Avanta implant provides excellent early pain relief, rapid attainment of full Range of Motion, and minimal surgical pain, with a high degree of patient satisfaction.
• The implant design does not induce sufficient adherence of the trapezial component to the bone, leading to pistoning and toggling of the trapezial component and pain in some patients, especially higher demand and younger patients.
• Although one might argue that the implant has its best use in the very oldest population with very low demand on their hands, the high cost of the implant, and the extremely high success rate of the LRTI procedure mitigates against its routine use in the elderly.
• The high degree of failure in the “younger” population mitigates against its use in this population as well.

REFERENCES:

Blinded, Prospective, Randomized Clinical Trial Comparing Volar, Dorsal, and Custom Thermoplastic Splinting in the Treatment of Acute Mallet Finger
Level 2 Evidence

Jeffrey M. Pike, MD, FRCSC, Vancouver, BC, Canada
Kishore Mulpuri, MBBS, MS (Ortho), MHSc (Epi), Vancouver, BC, Canada
Mark A. Metzger, OT, Vancouver, BC, Canada
Gordon Ng, OT, Vancouver, BC, Canada
Neil J. Wells, MD, FRCSC, Vancouver, BC, Canada
Thomas J. Goetz, MD, BSc (Eng), FRCSC, Vancouver, BC, Canada

HYPOTHESIS:
Custom thermoplastic splints are superior to both dorsal and volar non-custom splints for the treatment of Doyle I acute mallet finger injuries.

METHODS:
A novel outcome lag measurement was developed using the contralateral normal digit as an internal control for establishing the approximate pre-injury maximal extension of the mallet finger. The difference in maximal distal interphalangeal joint extension between the injured and contralateral normal digit was defined as the radiographic lag difference.

Eighty-seven subjects meeting the inclusion criteria were randomized to one of three splint types- volar aluminum, dorsal aluminum, and custom thermoplastic. Splints were continued for 6 weeks full-time. Seventy-seven subjects were available for measurement of the primary outcome measure: radiographic lag difference at week-12. Secondary outcome measures were recorded at week-7 and week-24, including between-group analyses and whole-cohort analyses.

RESULTS:
No lag difference was demonstrated at week-12 (p=0.12) although a trend suggesting superiority (closest value to zero difference) of the custom thermoplastic splint was observed. The mean radiographic lag differences were -16.2 degrees (95% CI -21.3, -11.0) for the dorsal aluminum splint, -13.6 degrees (95% CI -18.0, -9.2) for the volar aluminum splint, and -9.0 degrees (95% CI -14.5, -3.4) for the custom thermoplastic splint. Secondary between-group analyses showed no differences for radiographic or clinical lag. Michigan Hand Outcome Questionnaire (MHQ) Scores, or complications. Secondary analyses of the whole cohort suggested that 1) clinical measurement overestimates true lag, 2) increased lag occurs after discontinuation of splinting, and 3) clinically measured recovery of lag is noted at week-24. Increased age
and the presence of complications (r= -0.35, p=0.002) correlated with worse lag differences at week-12. The weak correlation at week-12 (r=0.23, p=0.04) between poor MHQ scores and worse lag difference was no longer evident at week-24.

**SUMMARY POINTS:**
- No lag difference was demonstrated between custom thermoplastic, dorsal aluminum, and volar aluminum splinting for Doyle I acute mallet fingers.
- Clinical measurement overestimates true lag in mallet injuries.
- Increased lag occurs following discontinuation of splinting.
- Increased age and complications correlate with worse radiographic lag.

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**HS-Paper 52**

HS-Paper 52 withdrawn.
Hemi-Contralateral C7 Transfer for Shoulder Function: Outcomes and Complications

Level 4 Evidence

Douglas M. Sammer, MD, St. Louis, MO
Michelle F. Kircher, RN/BSN, Rochester, MN
Allen T. Bishop, MD, Rochester, MN
Robert J. Spinner, MD, Rochester, MN
Alexander Y. Shin, MD, Rochester, MN

HYPOTHESIS:
The use of the contralateral-C7 nerve transfer (hemi or whole) for restoration of shoulder function after traumatic brachial plexus injury has not been well-studied. The hypothesis of this study is that the hemi-C7 transfer can be used to restore clinically significant shoulder function following traumatic pan-brachial plexus injury.

METHODS:
A retrospective review of all patients at a single institution from 2001 through 2008 who underwent hemi-C7 transfer to the shoulder after traumatic brachial plexus injury was performed. Objective outcome measurements included electrodiagnostic study results, BMRC motor grading, and ROM measurements of shoulder abduction and external rotation in patients with at least 18 months of postoperative followup. Subjective outcome measurements included pre- and postoperative DASH scores and VAS pain scores. Student’s t-test was used to compare pre- and postoperative DASH and VAS scores. Complications were recorded.

RESULTS:
Thirty-four patients underwent hemi-C7 transfer using non-vascularized nerve grafts to the suprascapular and axillary nerves. The mean age at the time of surgery was 26 years (range 3 to 41), and the average time from injury to surgery was 150 days (range 53 to 279). EMG-proven reinnervation occurred in 93% of patients (n=14), with the first signs of reinnervation occurring at 17 months postoperatively (range 6 to 27) (Table I). Clinical evaluation of shoulder abduction at an average of 34 months postoperatively showed 8% of patients (n=13) with a motor grade of M4, 15% with M3, 15% with M2, 46% with M1, and 15% with M0 (Table II). Mean shoulder abduction was 10 degrees (range 0 to 65). DASH and VAS pain scores were unchanged postoperatively. All patients developed subjective C7-distribution sensory changes on the donor side that improved over time, and 10 patients (29%) developed mild transient motor deficits. The average 2-point discrimination on the donor side was 5 mm at an average of 14 months post-operatively. Two patients had abnormal 2-point discrimination (9 mm, 15 mm) at final follow-up. No patient developed profound or prolonged motor deficits.

REFERENCES:
Outcomes of Silicone Arthroplasty Stratified by Fingers for the Rheumatoid Metacarpophalangeal Joints

Level 2 Evidence

Kevin C. Chung, MD, MS, Ann Arbor, MI
Sandra V. Kotsis, MPH, Ann Arbor, MI
Frank D. Burke, MD, Derby, United Kingdom
Marian Regan, MD, Derby, United Kingdom
E. F. Shaw Wilgis, MD, Baltimore, MD
David A. Fox, MD, Ann Arbor, MI

HYPOTHESIS:
Previous studies have demonstrated that the outcomes for the ulnar digits appear to be worse than the radial digits after silicone metacarpophalangeal joint arthroplasty (SMPA) for the rheumatoid hand. This study examines various components of hand deformities in an effort to understand precisely the functional outcomes of the hand after SMPA. We hypothesize that the ulnar fingers will have worse residual deformity marked by greater ulnar drift, extension lag, and less metacarpophalangeal joint arc of motion than the radial fingers.

METHODS:
70 surgical patients were recruited from 3 sites in this multi-center international prospective cohort study. All patients had a diagnosis of rheumatoid arthritis, were between the ages of 18-80, and were eligible to undergo SMPA based on measured hand deformities (extensor lag and ulnar drift). Ulnar drift, extension lag, and arc of motion for the metacarpophalangeal joint of each finger were measured at baseline (pre-surgical) and 1-year after SMPA.

RESULTS:
All fingers showed an improvement in ulnar drift from baseline to 1 year after surgery. The smallest improvement was in the index finger (12°) and the largest improvement was in the little finger (32°). Similar to the ulnar drift scores, the largest improvement in extension lag was seen in the little finger (38°) and the smallest improvement was seen in the index finger (15°). In terms of metacarpophalangeal joint arc of motion, all fingers moved to a more extended posture after SMPA, but the biggest improvement was observed in the 2 ulnar fingers and less so in the 2 radial fingers.

SUMMARY POINTS:
Although past experiences have indicated that it is more difficult to maintain posture for the ring and little fingers due to the deforming forces, it is certainly possible if attention to adequate bone resection and realigning of the extensor mechanism is carefully taken during the surgical procedure.

When reconstructing rheumatoid hands, hand surgeons can assuredly indicate to the patient that all the fingers have an equal chance of being aligned from the SMPA procedure.

Grant support received from R01-AR047328

The Use of the Functional Independence Measure to Determine Outcomes of Upper Extremity Reconstruction in Tetraplegia

Level 4 Evidence

Dora Rendulic, BS, Sacramento, CA
Mary Ann O’Dell, OTR, Sacramento, CA
Michelle A. James, MD, Sacramento, CA

HYPOTHESIS:
Upper extremity reconstruction improves independence for people with tetraplegia as measured by the Functional Independence Measure (FIM), an outcome measure designed to assess rehabilitation progress.

METHODS:
From 1999-2006, 26 people with tetraplegia underwent either elbow extension transfers alone (13) or pinch reconstruction combined with elbow extension transfers (13) by a single surgeon. FIM scores were measured pre- and post-operatively by occupational therapists, rating the level of assistance needed (7 point scale, ranging from 1=total assistance, to 7=total independence) to perform 12 activities (eating, grooming, bathing, upper body dressing, lower body dressing, toileting, bladder management, bowel management, bed transfers, toilet transfers, tub transfers, wheelchair locomotion) with a maximum total score of 84. Results were analyzed using paired t-tests to compare pre- and post-operative FIM scores.

RESULTS:
The mean total FIM score for the elbow extension transfer group was 18 (range 11-38) pre-operatively and 23 (11-48) after surgery; this difference was not significant at p<0.015. The mean total FIM score for the pinch reconstruction group was 25 (11-38) pre-operatively and 32 (20-57) post-operatively; this change was not significant at p<0.019. The only activity that showed a statistically significant increase in FIM score was eating for the pinch reconstruction group (mean score increased from 4 pre- to 6 post-operatively; p=0.006).

SUMMARY POINTS:
• Elbow extension transfer and pinch reconstruction improve function for people with tetraplegia, but this improvement has not been well quantified. People with complete tetraplegia require assistance with daily activities regardless of intervention, and are unlikely to become independent for most FIM activities.
• Elbow extension transfer and pinch reconstruction were not associated with significant changes in total FIM score in this population of people with tetraplegia. Some of the possible reasons for this are: a) more subjects are needed to detect a difference in the FIM; b) the FIM may have a “floor” effect in this population; c) these operations may help with activities the FIM does not test, such as improving reachable workspace and writing; or d)a measure of participation (what the person chooses to do) may be more appropriate for this population than a measure of daily activities.

Grant support received from R01-AR047328
Pinch reconstruction is associated with improved independence with eating.

The FIM may have limited usefulness as a measure of change following upper extremity reconstruction for tetraplegia. A larger study cohort with longer follow-up is needed to compare the results of the FIM with other measures, especially performance measures such as the Canadian Occupational Performance Measure.

Research or institutional support received from Shriners Hospital for Children, Northern California (Rendulic; James)

Full- or part-time employment or consulting arrangement with Shriners Hospital for Children, Northern California (O’Dell; James)

HS-Paper 56

Saturday, September 5, 2009 * 3:35-3:42 PM
Clinical Paper Session 12: Replant/Microsurgery

A Standardized Protocol for Management of Artery only Fingertip Replantations
Level 4 Evidence

Darrell Brooks, MD, San Francisco, CA
Rudolf F. Buntic, MD, San Francisco, CA
Harry J. Buncke, MD, San Francisco, CA

HYPOTHESIS:
Artery only fingertip replantation can be reliable if combined with a post-operative protocol which promotes low-resistance flow through the replant until venous outflow is restored.

METHODS:
This is a retrospective study of patients with artery-only fingertip replantation. Artery-only fingertip replantation is defined as a complete amputation distal to the distal interphalangeal (DIP) joint replanted with repair of an inflow artery but without benefit of an outflow vein due to level or mechanism of amputation. All patients had the replant nail-plate removed and received intravenous Dextran and heparin to promote fingertip bleed and low-pressure flow across the repaired vessel. Anticoagulation was titrated to promote a controlled bleed until physiologic venous outflow was restored. Medicinal leeches and mechanical heparin scrubs were utilized for acute decongestion. By post-operative day 6 bleeding was no longer promoted. Fluorescein studies were initiated to assess circulatory (arterial and venous) competence and direct further anticoagulant intervention. Lack of bleeding associated with a rise and fall in fluorescein concentration would trigger a weaning of anticoagulation. Lack of bleeding associated with congestion or lack of a fall in fluorescein concentration would result in reinstitution and maintenance of bleed from the fingertip.

RESULTS:
Two surgeons following the described protocol between 2001-2007 performed seventeen artery-only replants in 16 patients. Seventeen of 17 replants survived. Average length of hospital stay was 9 days, range 7-17 days. Eleven patients received blood transfusions. The average transfusion was 1.5 units, range 0-9 units. All patients were happy with their decision to replant, and their cosmetic result.

SUMMARY POINTS:
- A protocol, which promotes temporary, controlled egress of blood from the fingertip, is protective of “artery-only” replants distal to the DIP joint until physiologic venous outflow is restored.
- Our study establishes that the protocol, as described, is both safe and reliable.
- It also establishes what may be required with regard to need of transfusion or duration of hospitalization, factors that can help the physician and patient decide whether to proceed with such a procedure.
HYPOTHESIS:
Our objective is to evaluate all patients flown to a tertiary care hand trauma center for finger amputation and assess the rate of eventual replantation versus non-replantation. Our hypothesis is that a significant number of patients flown to our center do not undergo replantation surgery and not require a sophisticated microsurgical procedure.

METHODS:
Between 2003 and 2007, data were collected prospectively on all patients with traumatic hand injuries as part of a predesigned hand trauma database. Inclusion criteria for this study were all patients transferred by air with isolated amputations distal to the metacarpophalangeal joints. Patients with additional bodily injuries and thumb amputations were excluded. Following initial evaluation, all patients were individually examined by the on call hand surgeon prior to surgery. Informed consent included the information regarding the number of additional surgeries that may be needed for the particular type of injury, possible expected functional outcome and time to return to work. As a result, three different groups were identified: 1. Attempted Replantation, 2. Refused Replantation, 3. Replantation not possible. Mean age, past medical, surgical and psychiatric history, mechanism and level of injury, time from injury to surgery and patients’ response to informed consent were analyzed.

RESULTS:
Of the 40 patients meeting inclusion criteria, the mean age was 36.2 years (5.1 to 68.6) and mean time of transport 5.15 hours (0.93 to 24.7). Other variables are summarized on table 1. The most common reason for the refusal of replantation was inability to return to work immediately. All patients in this group have stated that they would have stayed in the local hospital if they were given the information before the transfer. The most common reasons for surgeon decision to not replant, were single digit amputations proximal to FDS attachment (n=7), crush/avulsion type injuries (n=7), premorbid health status (n=2) and age (n=2).

SUMMARY POINTS:
• Two of every three patient did not undergo replantation surgery.
• Early identification of these cases prior to transport could reduce unnecessary air transports, decrease patient anxiety, and spare important resources.

REFERENCES:
**HS-Paper 58**

**Soft Tissue Coverage of Complex Dorsal Hand and Finger Defects using the Turn Over Adipofascial Flap**

**Level 4 Evidence**

♦ D. Nicole Deal, MD, Winston-Salem, NC  
Jonathan Barnwell, MD, Winston-Salem, NC  
Zhongyu J. Li, MD/PhD, Winston-Salem, NC

**HYPOTHESIS:**  
Complex hand wounds with exposed tendon or bone often require free tissue transfer. Although many flaps have been described with good success, free tissue transfer is associated with technical difficulty, prolonged postoperative hospital stay and donor site morbidity. The purpose of this study was to review and report our experience using a reversed adipofascial flap combined with skin grafting to reconstruct complex hand wounds.

**METHODS:**  
Thirteen patients with traumatic dorsal degloving injuries ranging from the wrist crease to the dorsum of the middle phalanx underwent soft tissue reconstruction using a reversed adipofascial flap and skin grafting over a 35 month period. There were 11 males and 2 females. The mean age was 44 years (range: 20-71 years). Mean number of procedures prior to the index surgery was 1.46 (range: 0-3). Mechanism of injury included: 3 gunshot injuries, 4 degloving injuries, 1 table saw injury, 3 chain saw injuries, 1 thumb avulsion injury, and 1 crush injury with subsequent infection. Four patients were associated with exposed comminuted phalangeal fractures. Two flaps were used for wounds involving the web space. Flap sizes varied from 2x5 to 10x18 centimeters and involved the dorsum of the hand in 4 patients, the thumb in 2 patients, the index finger in 1 patient, the long finger only in 3 patients, the long and ring fingers in 1 patient and the web space in 2 patients.

**RESULTS:**  
Skin graft survival was 100% in 12 patients. One patient who did not have good results had a below elbow amputation for non-healing wounds secondary to generalized poor health and ultimately died of sepsis from unrelated medical conditions. All fractures were healed at follow-up. There were no donor site complications. All patients were satisfied with the surgery. Laser Doppler fluxmetry (LDF) measurements demonstrated excellent cutaneous perfusion of the grafted skin comparable to the neighboring normal skin.

**SUMMARY POINTS:**  
- May be done at the time of presentation provided a clean recipient bed is achievable at the time of initial debridement or may be delayed as needed.  
- Can be done as an outpatient procedure.  
- Technically easy to perform.

**HS-Paper 59**

**Vascularized Toe Phalanges for Small Complex Bony Defects**

**Level 4 Evidence**

♦ Francisco del Piñal, MD, PhD, Santander, Spain  
Francisco J. Garcia-Bernal, MD, PhD, Santander, Spain  
Higinio Ayala, MD, Santander, Spain  
Alexis Studer, MD, Santander, Spain  
Leopoldo Cagigal, MD, Santander, Spain  
Javier Regalado, MD, Santander, Spain

**PURPOSE:**  
Vascularized bone transplants resist infection and allow rapid healing but keeping small bony segments vascularized, as needed for a finger defect, is a challenge. We present a cohort of patients with intercalated compound bony defects in the fingers or carpus that were reconstructed by a vascularized toe phalanx (or part of a phalanx) in a single stage.

**METHODS:**  
From a total of 21 patients, seventeen has been included in the present study fulfilling the inclusion criteria of at least a 12-month follow-up. The patients were treated with an intercalary vascularized bone graft that included a part of the proximal phalanx (8 patients), most of the middle phalanx (8 patients), or a portion of each phalanx (1 patient) of a second toe (totaling 18 bone blocks). There was an associated soft-tissue defect in all finger defects (14 cases), an infection in 7, and cartilage loss in 7 of them.
Three middle phalanges were used for difficult scaphoid nonunions. The toes were pedicled on the proper digital artery (13 patients) or a segment of the first dorsal or second plantar metatarsal artery (4 patients). A mean length of 13.9 mm of vascularized bone was transferred. Bleeding from all of the bone surfaces was evidenced once the clamps were released. No toe was amputated. The homolateral digital nerve and the contralateral neurovascular pedicle of the toe were kept in place. The toe defect was treated by soft-tissue arthroplasty or arthrodesis, and/or sindactily or skin shortage.

RESULTS:
Radiologic bony union was evident at 4 to 6 weeks in all fingers, except in 1 patient with an acute infection whose distal union failed to unite at 6 weeks because the infection recurred. Finger length loss averaged 3 mm. All 3 scaphoid nonunions united in less than 8 weeks. All returned to their preoperative occupation.

CONCLUSIONS:
The toe phalanx reliably maintained its vascularization, allowing us to solve compound osteocutaneous defects in the fingers or carpus in a single stage. Donor site morbidity was minimal.

REFERENCES:
Using the Force-time Curve to Identify Maximal versus Submaximal Efforts in People with Upper Extremity Injuries

Level 3 Evidence

Orit Shechtman, PhD, OTR/L, Gainesville, FL
Bhagwant Sindhu, PhD, OTR, Milwaukee, WI

HYPOTHESIS:
The force-time curve (F-T curve) test was shown to differentiate between maximal and submaximal effort in healthy people. We hypothesized that it would validly detect submaximal effort in people with upper extremity injury.

METHODS:
Forty participants (20 males and 20 females; average age 37 + 12 years) with unilateral upper extremity injuries performed maximal and submaximal grip efforts with both their injured and uninjured hands. The order of the efforts was randomized and the test administrator was blinded to the level of effort. A force-time curve was recorded for each grip effort using a modified Jamar dynamometer with a force transducer (Thought Technology Ltd.). The slopes of the force-generation phase and the force-decay phase were calculated based on the F-T curve for each grip effort. Repeated-measures analyses of variance (ANOVA) were performed to reveal differences in the slopes of the force-generation phase and the force-decay phase. The within-subject variables were effort (maximal vs. submaximal efforts) and injury (injured vs. uninjured hands) while the between-subject variable was gender. Sensitivity and specificity values were calculated and receiver operating characteristic (ROC) curves were plotted to find the optimal cut-off values for detecting sincerity of effort.

RESULTS:
There were significant differences in the slopes of the force-generation phase (F = 55.77, p < 0.0001; Figure 1) and the force-decay phase (F = 5.63, p < 0.02; Figure 2) between maximal and submaximal efforts, suggesting that the force-time curve test can detect feigned effort. Although the slope of the force-generation phase was the most effective in distinguishing between maximal and submaximal efforts, it still yielded an overall error rate of 55% (sensitivity = 0.6 and specificity = 0.85) for women and 60% (sensitivity = 0.85 and specificity = 0.55) for men. The proportional area under the ROC curve was 76% for women and 72% for men, indicating a relatively low differentiation between signal and noise.

SUMMARY POINTS:
- The significantly steeper slopes for the maximal efforts when compared to submaximal efforts indicate that the force-time curve test can differentiate between maximal and submaximal efforts in people with upper extremity injury.
- However, sensitivity and specificity values were insufficient to effectively differentiate maximal from submaximal efforts.
- In addition, the area under the ROC curve indicated a low ability of the test to discriminate between maximal and submaximal efforts.
- Thus, the force-time curve test is not a valid test for detecting sincerity of effort in patients with upper extremity injury.
REFERENCES:

Grant support received from ASHT’s Evelyn Mackin Research Grant 2006

HT-Paper 2
Thursday, September 3, 2009 * 8:12 – 8:24 AM
ASHT General Session

Using the Surface Electromyographic Signal to Identify Maximal versus Submaximal Efforts in People with Upper Extremity Injuries
Level 3 Evidence

Bhagwant S. Sindhu, PhD, OTR, Milwaukee, WI
Orit Shechtman, PhD, OTR/L, Gainesville, FL

HYPOTHESIS:
Median frequency (MF) indicates firing frequency during muscular contraction. During sustained forceful contraction, the muscle fatigues and MF decreases 1-7. We hypothesized that due to greater fatigue, MF-ratio of forearm muscles would be significantly smaller for maximal than submaximal grips and would, thus, validly detect feigned effort in people with upper extremity injury.

METHODS:
Forty participants (20 males and 20 females; average age 37 + 12 years) with unilateral upper extremity injuries performed maximal and submaximal grip efforts with their injured and uninjured hands. The order of the efforts was randomized and the test administrator was blinded to the level of effort. The surface electromyographic signal of forearm flexor and extensor muscles was recorded during each grip effort using the MyoScan Pro active electrode (Thought Technology Ltd.). For each isometric grip lasting six seconds, we computed the MF for two one-second intervals. The first interval began at peak force and the second interval consisted of the last second of the grip contraction. The MF-ratio was computed as the ratio of the second to first interval. Repeated-measures analysis of variance (ANOVA) were performed to reveal differences in the MF-ratio between maximal and submaximal efforts. The within-subject variables were effort and injury; the between-subject variable was gender. Sensitivity and specificity values were calculated and receiver operating characteristic (ROC) curves were plotted to find the optimal cutoff values for detecting sincerity of effort.

RESULTS:
There were significant differences in the MF-ratio of the forearm flexors (F = 30.27, p < 0.001) and the forearm extensors (F = 21.16, p < 0.001) between maximal and submaximal efforts suggesting that the MF-ratio can detect feigned effort. Although the MF-ratio of the forearm flexor muscles was the most effective in distinguishing between maximal and submaximal efforts, it still yielded overall error rates of 70% (sensitivity = 0.53 and specificity = 0.78). The proportional area under the ROC curve was 66%, indicating a relatively low differentiation between signal and noise.

SUMMARY POINTS:
- The significantly greater MF-ratio for maximal efforts, when compared to submaximal efforts, indicates that the median frequency of electromyographic signal can differentiate between maximal and submaximal efforts.
- However, sensitivity and specificity values were insufficient to effectively differentiate maximal from submaximal efforts.
- In addition, the area under the ROC curve indicated an inadequate ability of the test to discriminate between maximal and submaximal efforts.
- Thus, the MF-ratio is not valid for detecting sincerity of effort in patients with upper extremity injury.

Figure 1: MF ratio values of flexor electromyographic signal
REFERENCES:

Grant support received from ASHT’s Evelyn Mackin Research Grant 2006

HT-Paper 3

Thursday, September 3, 2009 * 9:07 – 9:21 AM
ASHT General Session

A Peak in Scar Characteristics during the Healing Period
Level 2 Evidence

Ronit Wollstein, MD, Pittsburgh, PA
John Rodgers, CHT, Pittsburgh, PA
Julio Clavijo, MD, PhD, Pittsburgh, PA
Lois Carlson, CHT, Hartford, CT

HYPOTHESIS:
An increase in scar rigidity at six-eight weeks following surgery in the hand and wrist has been observed, but never documented. The “tightness” surrounding the surgical scar seems to improve with time. The purpose of this study was to document this phenomenon in surgical wounds in the wrist by evaluating the wounds over time. Specifically, we evaluated the scars of patients having open reduction and internal fixation of distal radius fractures over a three-month period. We present our interim results.

METHODS:
Inclusion criteria: All consecutive patients being treated for distal radius fractures through a volar scar over the flexor carpi radialis (FCR) tendon.

Exclusion criteria: Patients with previous surgery on the hand or wrist, other previous injuries to this region, such as burns and fractures, since these may change the healing patterns; patients who do not have a volar scar over the FCR tendon, open fractures with significant soft tissue injury, and/or associated nerve or vessel injury.

Following surgery, the patients were evaluated at two, six, eight, 10 and 12 weeks following surgery. Repeated measures of ANOVA and post Hoc Tuckey-Krammer tests were used to evaluate differences among time points. Regression and ANOVA tests were used to determine causality between tightness and objective variables. P was considered significant at 0.05.

Patients were evaluated for scar thickness, volumetric evaluation, the Vancouver scale for burns, tenderness, subjective tightness in the scar and range-of-motion.

RESULTS:
Nine patients were available for biweekly evaluation. Average age was 38 (20-78), seven males, two females. All were non-smokers, one patient had diabetes, one was treated with corticosteroids.

Scar pliability and subjective tightness showed a peak at four-six weeks (Figure 1). The Vancouver scale and edema decreased with time, range-of-motion increased with time.

A significant correlation was found between scar pliability and the subjective feeling of tightness.
SUMMARY POINTS:

- The phenomenon of a peak in scar tightness exists.
- The subjective peak in tightness seems to correlate with the more objective measure of pliability.
- These measures peak at four-six weeks following surgery.
- Since this time frame and characteristics do not coincide with skin-healing, this may represent a peak in the healing of deeper tissues, such as fascia.

Figure 1: One-way analysis of scar pliability and tightness. There is a peak at four-six weeks.

REFERENCES:


HT-Paper 4

Thursday, September 3, 2009 * 10:24 – 10:36 AM
ASHT General Session

Radiographic and Functional Analysis of Movement Allowed by Four Wrist Immobilization Devices

Level I Evidence

♦ Timothy M. Mullen, PhD, OTR, CHT, Grand Rapids, MI
Julian E. Kuz, MD, Grand Rapids, MI

INTRODUCTION:

Immobilization of the wrist is a common practice throughout the healthcare industry. There is a large variety of options for an even larger list of diagnoses. It is accepted that each form of immobilization allows for some movement, but the amount each device allows is unknown. Establishing data that accurately describes the inadequacies of each immobilization device will allow evidence-based decisions.

HYPOTHESIS:

The purpose of this study is to identify the specific amount of motion allowed within four different immobilization devices and to identify the level of function allowed within each device. It was hypothesized that circumferential wrist splints will allow the least amount of mobility, and the pre-fabricated splint will allow the most mobility. It also was hypothesized that by allowing the most amount of mobility; the pre-fabricated splint will allow the most function and perceived function.

METHODS:

For each splint the exact range of motion in wrist flexion, extension, radial deviation and ulnar deviation were explored through radiographic analysis. In addition, the QuickDASH, Timed In-hand Manipulation Exam and the Jebsen-Taylor test of Hand Function were performed.

A convenience sample of 24 participants was recruited. All subjects wore each of the four different immobilization devices for 24 hours and then were evaluated for range of motion and functional abilities.

RESULTS:

MANOVA and post-hoc testing were performed on the data to identify significant differences in anterior-posterior total active motion between the cast (31.3°±730°), the volar wrist splint (48.3°±730°), circumferential wrist splint (54.8°±730°) and the pre-fabricated wrist splint (88.5°±730°). Significant differences were also measured in lateral total active motion between the cast (27.7°±730°), the volar wrist splint (36.7°±730°), the circumferential wrist splint (35.4°±730°) and the pre-fabricated wrist splint (51.7°±730°). Comfort ratings indicated a significant difference with the best average rating for the pre-fabricated wrist splint (3.2±10). QuickDASH scores of perceived function indicated a significant difference with the best score for the pre-fabricated wrist splint (28.24). Similarly, the fastest score on the Timed In-Hand Manipulation Exam was significant for the pre-fabricated wrist splint with an average of 13.88 seconds.
SUMMARY POINTS:
• Specific details for these four wrist immobilization devices allow clinicians to make evidence-based decisions with respect to degree of immobilization, comfort, function and perceived function.
• More research should be performed to identify an ultra-low profile external device that is highly conforming to maximize immobilization, while allowing as close to normal functional activities.

<table>
<thead>
<tr>
<th>Immobilization Device</th>
<th>Mean AP-TAM</th>
<th>SD</th>
<th>Mean/Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-Arm Cast</td>
<td>31.3</td>
<td>9.12</td>
<td>23.3%</td>
</tr>
<tr>
<td>Volar Splint</td>
<td>48.3</td>
<td>18.57</td>
<td>36%</td>
</tr>
<tr>
<td>Circumferential</td>
<td>54.8</td>
<td>25.3</td>
<td>40.8%</td>
</tr>
<tr>
<td>Prefabricated</td>
<td>88.5</td>
<td>20.67</td>
<td>66%</td>
</tr>
</tbody>
</table>

Significant relationships for functional testing comparing each of the immobilization devices:

<table>
<thead>
<tr>
<th>Evaluation Tool</th>
<th>Device 1 Score</th>
<th>Device 2 Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>QuickDASH</td>
<td>Prefab 28.2</td>
<td>Cast 54.6</td>
</tr>
<tr>
<td>Function</td>
<td>Prefab 28.2</td>
<td>Circum. 41</td>
</tr>
<tr>
<td>TIME</td>
<td>Test of In-hand Prefab 13.9</td>
<td>Cast 19</td>
</tr>
<tr>
<td>Jebsen Taylor</td>
<td>Test of Function Prefab 7.76</td>
<td>Cast 9.59</td>
</tr>
<tr>
<td>Comfort Likert 0-10</td>
<td>Prefab 3.2</td>
<td>Cast 4.7</td>
</tr>
</tbody>
</table>

HYPOTHESIS:
Osteoarthritis of the thumb (CMC OA) is prevalent in adults over 45, and a common diagnosis seen in hand therapy clinics. CMC OA may result in decreased motion, strength and pain. Splinting is the first line of conservative treatment, however, scientific evidence is lacking to support its effectiveness and there are no guidelines as to which splint is the most beneficial. The purpose of this study was to compare the effect of two different splints on self-reported hand function, pain and hand strength in adults with CMC OA in a crossover trial. The two splints were a pre-fabricated neoprene splint, the Comfort Cool and a custom-made thermoplastic and neoprene splint, the Hybrid. The specific hypothesis tested was for an equivalency trial: there will be a marginal difference in the effects of the two splints on hand function, grip and pinch strength and hand pain.

METHODS AND MEASURES:
Participants from three different clinics on Vancouver Island, British Columbia with CMC OA were assigned randomly to splint order in a two-phase crossover trial. Each splint was worn for four weeks, separated by a one-week wash-out period. Hand function, the primary outcome, was assessed using the Australian Canadian Hand Osteoarthritis Index (AUSCAN) NRS version. Secondary outcomes were the AUSCAN pain subscale, grip and lateral pinch strength measured with dynamometers. Participants were assessed at baseline, after each splint phase and after the wash-out period. Data were analyzed using descriptive statistics, paired t-tests and chi-square tests.

RESULTS:
Fifty four participants were randomized and completed the study. No carryover or order effects were present. The Hybrid splint improved function after four weeks (p = 0.023 and significantly reduced pain (p < 0.001) and). However, the Hybrid was significantly different from the Comfort Cool only in its effect on reducing pain (3.8 on a 0-90 point scale, p < 0.001). The effect was greatest for participants whose dominant hand was splinted. Grip and pinch measures improved slightly but not significantly with both splints. Interestingly, 63% of participants preferred the Comfort Cool splint.

SUMMARY POINTS:
• After four weeks of splint use, individuals with CMC OA had modest but significantly greater pain relief from the Hybrid splint than the Comfort Cool. This was the only significant difference between the two CMC stabilizing splints.
• Neither splint improved function, as measured by the AUSCAN.
• This adds to evidence that thumb splinting may reduce pain in individuals with CMC OA.

● Research or institutional support received from British Columbia Medical Services Foundation
● Grant support received from British Columbia Medical Services Foundation Research Grant