2016 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 at www.ASSHAnnualMeeting.org.

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A Randomized, Double-Blinded, Placebo-Controlled Clinical Trial Assessing the Therapeutic Efficacy of Botulinum Toxin in Treating Scleroderma-Associated Raynaud’s Phenomenon

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Eitan Melamed, MD
Keith E. Follmar, MD
Fred J. Wigley, MD
Scott D. Lifchez, MD

Hypothesis: Local injections with Botulinum Toxin Type-A (Btx-A) will improve blood flow to the hands of patients with Raynaud’s phenomenon secondary with scleroderma, as measured by Laser Doppler Imaging and patient-reported outcomes.

Methods: We conducted a randomized, double-blind, placebo-controlled clinical trial to assess the therapeutic efficacy of Btx-A in treating scleroderma-associated Raynaud’s phenomenon. Eligible patients’ hands received 7 injections each with Btx-A (50 units in 2.5 mL) in one randomly selected hand or sterile saline (2.5 mL) in the opposite hand. Injections were performed using a 30-gauge syringe through the dorsal surface in 7 locations per hand: adjacent to the 2nd, 3rd, and 4th common digital arteries through the web spaces (10 units each = 30 units or 1.5 mL), and the radial side of the index finger metacarpal head, the ulnar side of the small finger metacarpal head, and each side of the thumb metacarpal head (5 units each = 20 units or 1 mL). Follow-up at 1 and 4 months post-injection included physical exam, Laser Doppler Imaging of hands, and collecting patient-reported outcome data. We used paired t-test and population average models with generalized estimating equations to compare outcomes.

Results: We enrolled 40 patients who completed all follow-up visits. Twenty-five patients had limited scleroderma and 15 had diffuse scleroderma; 31 patients were female. Mean age was 52 years (range: 21-75); median time since onset of Raynaud’s phenomenon was 15.56 years (IQR: 10.59-23.48). Change in blood flow from baseline to 1-month follow-up, as measured by non-invasive laser Doppler imaging, showed an average decrease in hands treated with Btx-A compared to placebo. However, generalized estimating equations showed only weak statistical evidence for this difference (average difference at 1-month follow-up: -25.73, 95% CI: -52.29 to 0.83, P-value = 0.058). Planned subgroup analysis showed that this negative trend was mainly driven by patients with longer time since Raynaud’s phenomenon onset (>15.56 years), diffuse scleroderma, and those who were not being treated with calcium channel blockers at baseline. Change in blood flow at 4-month follow-up and secondary outcomes, including patient-reported outcomes, were not statistically significant.

Summary Points:
- Our data does not support the use of Btx-A in the treatment of Raynaud’s phenomenon in all patients with scleroderma.
- Further research is required to evaluate the effectiveness of Btx-A in patients with earlier, limited forms of scleroderma and in the setting of acute ischemic ulcers and critical digital ischemia.
This research was supported by a 2010 Clinical Research grant from the American Foundation for Surgery of the Hand.

COI:
There is no financial information to disclose.

Hypothesis: The application of adipose-derived stem cells (ASCs) to the surface of repaired intrasynovial flexor tendons will modulate the early inflammatory response and improve matrix remodeling compared to controls.

Methods: Autologous ASCs were isolated from the subcutaneous fat of adult canines 2 weeks prior to tendon surgery and cell sheets were generated by culturing cells on collagen films. To track the implanted cells, some ASCs were transduced with GFP-expression lentivirus. Flexor digitorum profundus (FDP) transection and repair was carried out on the 2nd and 5th forepaws of 10 adult canines. Cell sheets were applied to the repairs of one-half of the sutured tendons and secured in place with a gelling hyaluronic acid (HA). The remaining repairs were treated with the HA only. At 7 days, cell viability was determined by live/dead staining followed by 3-D confocal imaging. Tissue localization of the cells was determined by tracing GFP-expression cells in whole mount tissues. Gene expression was determined by real-time qPCR for genes related to inflammation, macrophage polarization and tendon matrix synthesis.

Results: At 7 days, an intense inflammatory response was noted in the control tendons. Longitudinal sections from the experimental ASC-treated tendons revealed that the GFP-expressing cells from the tendon surface had filled the gaps between the tendon stumps and had infiltrated the midsubstance to lie adjacent to native tendon fibroblasts. ASC treatment significantly increased the expression of the M2 (anti-inflammatory macrophage) stimulating genes IL-4 and IL-13 and M2 marker genes CD163, VEGF and MRC1 in cell-treated tendons compared to control. These results were validated by CD163 immunostaining demonstrating the effect of ASCs in stimulating an M2 phenotype. ASC treatment modulated the expression levels of both tendon matrix genes and related regulator genes toward normal levels, indicating improved matrix synthesis compared to control.

Summary Points:
- An intense inflammatory response was noted by gene expression and histological studies in repaired intrasynovial tendons at an early interval following repair.
- A novel method of ASC delivery was validated in a clinically relevant animal model.
- ASCs applied to the tendon surface migrated into the repair site and infiltrated tendon substance adjacent to the repair.
- ASCs modulated the local inflammatory response via promotion of the M2 (anti-inflammatory) macrophage phenotype and facilitated repair by regulating tendon matrix remodeling.
A Critical Review of the First 100 Procedures
Clinic-Based Wide Awake Hand Surgery Practice: Wide awake local anesthesia no tourniquet (WALANT) hand surgery was developed to improve access to hand surgery care while optimizing medical resources. Hand surgery in the clinic setting may result in substantial cost savings and provide a safe alternative to performing similar procedures in the operating room.

Methods: A prospective cohort study was performed on the first 100 consecutive clinic-based WALANT hand surgery procedures performed at a military medical center from January 2014 to September 2015 by a single hand surgeon. Cost savings analysis was performed by utilizing the Medical Expense & Performance Reporting System (MEPRS), the standard cost accounting system for the military healthcare system (MHS), to compare procedures performed in the clinic versus the operating room during the study period. Utilizing a study-specific questionnaire, patient satisfaction, pain, and perioperative anxiety analyses were performed.

Results: The WALANT procedures consisted of carpal tunnel release (CTR, n = 34), A1 pulley release (APR, n = 33), de Quervain release (dQR, n = 4), hardware or foreign body removal (n = 14), phalangeal fracture pin fixation (n = 9), tendon repairs (n = 3), nail horn excisions (n = 2), and extensor carpi ulnaris debridement (n = 1). For CTR and APR alone, there was an 85% and 70% cost savings by having the procedures performed in clinic under WALANT compared to the main operating room (OR), respectively. During the 21-month study period, CTR, APR, and dQR were performed in the clinic, instead of the OR, amounted to $393,099.53 in cost savings for the MHS. Overall, 94% (62 of 66) of patients stated that they would choose WALANT again for a subsequent procedure. For 71% (47 of 66) of patients, the perioperative pain was less than a dental procedure and the mean anxiety levels (10 being the worst amount of anxiety) before, during, and after the procedures were 2.8 ± 3.4, 2.4 ± 3.2, and 0.4 ± 1.0 respectively. There were 3 complications; however, none were attributable to the WALANT procedure.

Summary Points:
- A clinic-based WALANT hand surgery program results in considerable cost savings.
- Performing clinic-based WALANT hand surgery is safe with no increase in complications attributed to the WALANT procedure.
- Patients tolerate the WALANT procedures well with low peri-operative pain and anxiety.
- Patient satisfaction is high for clinic-based WALANT hand surgery.

PAPER 04

Best Papers
Thursday, September 29, 2016 • 2:36–2:41 PM
Treatment; Prognosis/Outcomes; Billing/Coding

Cost Savings, Safety, and Patient Satisfaction of a Clinic-Based Wide Awake Hand Surgery Practice: A Critical Review of the First 100 Procedures

Level 2 Evidence

Peter Charles Rhee, DO, MS
Michelle M. Fischer, FACHE
Laura S. Rhee, DO
Ha McMillan, RN
Anthony E. Johnson, MD

COI:
Speakers Bureau: Trined Inc.(Rhee)

Hypothesis: Wide awake local anesthesia no tourniquet (WALANT) hand surgery was developed to improve access to hand surgery care while optimizing medical resources. Hand surgery in the clinic setting may result in substantial cost savings and provide a safe alternative to performing similar procedures in the operating room.

Methods: A retrospective cohort study of patients undergoing elective total elbow arthroplasty was conducted with the use of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database from 2005-2013. Patients were followed for postoperative outcomes within 30-days of surgery. Patients’ preoperative comorbidities were tested for association with postoperative mortality, major complications, and minor complications.

PAPER 05

Clinical Paper Session 1: Hand/Wrist Reconstruction 1
Friday, September 30, 2016 • 8:45–8:50 AM
Prognosis/Outcomes

Thirty-day Morbidity and Mortality after Elective Total Elbow Arthroplasty

Level 3 Evidence

Joshua William Hustedt, MD, MHS
David Rhodes, MD
Daniel D. Bohl, MPH
Andrew S. Chung, DO
Neil Olmscheid, BS
Scott Edwards, MD

COI:
There is no financial information to disclose.

Hypothesis: Total elbow arthroplasty is growing in popularity among upper extremity surgeons. However, it is a relatively new procedure and postsurgical outcomes have not been clearly defined. This study was designed to measure morbidity and mortality of patients undergoing elective total elbow arthroplasty.

Methods: A retrospective cohort study of patients undergoing elective total elbow arthroplasty was conducted with the use of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database from 2005-2013. Patients were followed for postoperative outcomes within 30-days of surgery. Patients’ preoperative comorbidities were tested for association with postoperative mortality, major complications, and minor complications.
Results: 222 patients met inclusion criteria. The average age was 62.8 years, and 73.9% of patients were female. 30-day mortality and morbidity rates were 0.5% mortality, 2.7% major complication, and 7.2% minor complication. The most common complications were postoperative anemia requiring transfusion (3.6%), deep surgical site infection (0.9%), and superficial surgical site infection (0.9%). Patients with greater than 3 cumulative comorbidities had significantly higher rates of postoperative complications (odds ratio [OR], 13.5; 95% confidence interval [CI], 1.8, 97.7; P < 0.001). Operative time greater than 175 minutes was independently associated with increased postoperative complications (OR, 3.7; 95% CI, 1.3, 10.7; P < 0.001).

Summary Points:
- Based on comparison of our results to those available in the literature, patients undergoing elective total elbow arthroplasty have slightly higher complication rates than those undergoing shoulder, hip, or knee arthroplasty.
- Patients with greater than 3 comorbidities should be carefully counseled prior to undergoing total elbow arthroplasty due to significantly higher risks of postoperative complications.

PAPER 06
Clinical Paper Session 1: Hand/Wrist Reconstruction 1
Friday, September 30, 2016 • 8:52–8:57 AM
Treatment
Long-term Outcomes and Arthroscopic Assessments of Radial Osteotomy for Kienböck Disease
Level 4 Evidence
Masahiro Tatebe, MD, PhD
Hitoshi Hirata, MD
Michio Yamamoto, MD
Katsuysuki lwatsuki, MD
Shigeru Kurimoto, MD, PhD
Takanobu Nishizuka, MD

COI:
There is no financial information to disclose.

Hypothesis: Kienböck disease is an aseptic necrosis of the lunate of unknown etiology, prevalent in young adults, and treatment aims to lower forces on the lunate, decrease pain and improve function. We conducted a retrospective evaluation of the 10-year clinical and radiological outcomes of radial osteotomy as a treatment for Kienböck disease.

Methods: We analyzed pain, grip strength, wrist range of motion (ROM), radiological carpal geometry and staging of osteoarthritic changes under arthroscopy. Between 1993 and 2005, we identified 67 cases of unilateral Kienböck disease treated by radial osteotomy, with arthroscopic evaluation. Of these cases, 18 included a follow-up period over 10 years and formed our study group. The Mayo wrist score was used as an overall measure of outcome. Outcomes for 2 types of osteotomies were included: a step-cut osteotomy with fixed screws and an updated technique of 2 linear transverse osteotomies with volar plating using locked-plates. For cases with negative ulnar variance, resection of the radius was included to obtain a final ulnar variance of -1 to 0 mm. For positive ulnar variance, the goal was to obtain a correction of radial inclination of 10 degrees-15 degrees. Arthroscopic assessment was performed on the same day as the radial osteotomy, lesions of the articular cartilage were defined as softening, fibrillation, erosion, or defects of the joint cartilage, with an absence of lesions defined by a smooth appearance of the cartilage surface. All arthroscopic findings were classified in terms of the location of cartilage lesions.

Results: Improvements in pain, ROM and grip strength were maintained over the 10-year follow-up, without radiological improvement in geometry (carpal height ratio and Stahl’s index). Mild osteoarthritic changes were identified in 33% of patients, with no effect on clinical results. Degree of cartilage damage determined post-operative grip strength improvement. The Mayo wrist score at the final follow-up was excellent in 1 patient, good in 9, and fair in 8.

Summary Points:
- Radial osteotomy can decrease overload and mechanical malalignment of the lunate, and simultaneously improve the vascularity of the carpus and provides reasonable, long-term clinical benefits.
- The clinical results were good at long-term follow-up, but the radiological improvement was not large.
- Pre-operative arthroscopic evaluation of cartilage damage can inform treatment decisions.

PAPER 07
Clinical Paper Session 1: Hand/Wrist Reconstruction 1
Friday, September 30, 2016 • 8:59–9:04 AM
Treatment; Surgical Technique; Prognosis/Outcomes
Silicone Metacarpophalangeal Joint Arthroplasty for Osteoarthritis: Long Term Outcomes
Level 4 Evidence
Nathan Morrell, MD
Travis Spangler
Arnold-Peter C. Weiss, MD

COI:
Royalty: DePuy (Weiss)
Receipt of Intellectual Property Rights/Patent Holder: DePuy (Weiss)

Hypothesis: Silicone metacarpophalangeal (MCP) joint arthroplasty with implants are well-established in the rheumatoid patient population. The long term outcomes and survivorship for patients with osteoarthritis of the MCP joint are less clear given the higher functional demands of this patient group. Our study hypothesizes that silicone MCP arthroplasty provides excellent long term outcomes with a low complication rate in osteoarthritic patients.

Methods: A consecutive case cohort of 35 patients with osteoarthritis of one or more MCP joints undergoing anatomically-neutral silicone MCP arthroplasty were followed in an IRB-approved longitudinal study of outcomes and survivorship over a 15-year period. Functional outcome parameters were assessed along with ROM/Strength and complications related to the implant or surgical procedure. All patients were available for long term assessment including radiographs.

Results: Average follow-up exam for the consecutive cohort of 35 patients (40 implants) was 7.2 years. Average age was 60 years (range of 41-79 years) with 22 males and 13 females. In 31 patients, a single MCP joint was involved (MF = 20; IF = 10; SF = 1). In 4 patients, multiple MCP joints were involved (IF/MF = 3; IF/MF/RF = 1). The dominant hand was involved in 23 patients. Seven (of 14) patients had a concomitant radial collateral ligament reconstruction of the index finger; no other digit had a collateral ligament reconstruction. Average VAS pain scores were 0.3 out of 10. Average final AROM was extension of 4 degrees (range of 0-21) and flexion of 73 degrees (range of 50-90). One patient had a revision MCP arthroplasty due to extensor lag and ulnar deviation (previous complicated history of infection and flexor tendon grafting in the same digit), providing a 97% survivorship. Radiographs demonstrated fractured implants in 4 of 40 implants but none exhibited instability, pain or ROM deterioration.

Summary Points:
- The use of silicone MCP implants for the treatment of osteoarthritis appears sound.
- Survivorship is 97% (clinical) and 90% (radiographic) in long term follow-up.
- Collateral ligament reconstruction does not appear to effect stability or outcome (including the index finger).
- Radiographic fracture of the implant does not imply clinical deterioration of results.
Clinical Paper Session 1: Hand/Wrist Reconstruction 1
Friday, September 30, 2016 • 9:06–9:11 AM
Treatment; Prognosis/Outcomes

Seven Year Outcomes of the Silicone Arthroplasty in Rheumatoid Arthritis (SARA) Study

Level 2 Evidence
Kevin C. Chung, MD, MS
Sandra Kotis, MPH
Patricia B. Burns, MPH
Frank D. Burke, MD
E. F. Shaw Wilgis, MD
Hyungjin M. Kim, ScD

Grant received from: National Institute of Arthritis and Musculoskeletal and Skin Diseases - 2R01 AR047328-06 - An Outcome Study of Rheumatoid Hand Arthroplasty

COI:
There is no financial information to disclose.

Hypothesis: Rheumatoid arthritis (RA) often causes debilitating deformities of the hand. Silicone metacarpophalangeal joint arthroplasty (SMPA) has been used for over 50 years to correct hand deformities, but high level evidence for effectiveness is lacking. The SARA study is an NIH-funded, multicenter study following a large cohort of RA patients with severe hand deformities. The purpose of this paper is to compare outcomes for a surgical and a non-surgical cohort of rheumatoid arthritis patients after 7 years of follow-up.

Methods: RA patients with a defined level of deformity were enrolled from 1 of 3 study sites. Patients were not randomized owing to strong patient preference and chose whether to undergo SMPA or not. Patients were assessed at 6 months and then yearly for up to 7 years. Outcomes included the Michigan Hand Outcomes Questionnaire (MHQ), Arthritis Impact Measurement Scales (AIMS2), and functional measures (grip/pinch strength, Jebsen-Taylor test, and ulnar drift, extensor lag and arc of motion measurements at the metacarpophalangeal (MCP) joints).

Results: A total of 73 SMPA and 97 non-SMPA subjects were enrolled at baseline. Because of withdrawals, deaths, and loss to follow-up, 25 SMPA and 52 non-SMPA patients had data at 7 years follow-up. Although nonsurgical subjects had better mean MHQ scores at baseline, the surgical subjects had improved scores over time. After adjusting for baseline differences, surgical patients had significantly better outcomes for overall MHQ score and the function, aesthetics and satisfaction domains. Additionally, SMPA subjects had significantly better measures for ulnar drift, extensor lag and MCP joint arc of motion 7 years after adjusting for baseline covariates. No significant improvements in grip or pinch strength were observed in either group.

Summary Points:
• The benefits of SMPA reported at earlier assessments were maintained at the 7 year postoperative follow-up.
• Non-surgical subjects remained stable in hand function over time.
• SMPA subjects reported substantial improvements in ulnar drift and extensor lag, their ability to perform activities of daily living, and decreased pain.

Clinical Paper Session 1: Hand/Wrist Reconstruction 1
Friday, September 30, 2016 • 9:13–9:18 AM
Treatment; Surgical Technique, Prognosis/Outcomes

5-10 Year Prospective Follow-up of Wrist Arthroplasty in 56 Non-rheumatoid Patients

Level 2 Evidence
Ole Reistad, MD, PhD
Trygve Holm-Glad, MD
Bjørn J. Bolstad, PT
Christian Grimsgaard, MD
Rasmus Thorkildsen, MD
Magne Rekkum, MD, PhD

COI:
There is no financial information to disclose.

Hypothesis: Total wrist arthroplasty is increasing worldwide. The available implants vary greatly in concept and design, and long-term results are scarce. Since 2006, all patients operated with total wrist arthroplasty in our department were included in a prospective follow-up study. We present minimum 5-year follow-up of a cementless prosthesis in non-rheumatoid wrists.

Methods: Fifty-seven (40 male) destroyed and painful wrists (SNAC/SLAC = 30, lunate malacia = 9, sequela distal radius fracture = 7, primary osteoarthritis = 7 and other radiocarpal destruction = 4) in 57 patients, mean age 52 (22-76) years, received anuncemente ball-and-socket total wrist arthroplasty (Motec® Wrist, Swemac AB, Linkoping, Sweden). Independent physiotherapists evaluated the function preoperatively and at the yearly follow-ups. Visual analog pain scale (VAS) at rest and activity, quick disability of arm, shoulder and hand (QDASH), active range of motion (AROM) and grip-strength were recorded. Standardized radiographs were taken, and osteolysis, lines and subsidence were assessed. All patients had CT scans preoperatively, and at follow-up if radiographs were difficult to interpret.

Results: Fifty-six patients were followed-up 7.6 (5.1-10.0) years (one drop out). Eight wrists were reoperated with arthrodesis (5) or a new arthroplasty (3) due to distal component loosening (3), infection (2), pain/fixed malposition (2) or proximal and distal component loosening (1) after 2 (0.6-5.8) years. One radiocarpal dislocation was reduced closed and remained stable 4 years later. The clinical results were good. Statistically significantly decreased (P < 0.05) QDASH score (38.7 versus 24.8) and VAS pain score at rest (3.4 versus 0.8) and activity (6.9 versus 2.0) were found at the last follow-up compared to preoperatively, as well as statistically significant (P < 0.05) increased AROM (97 degrees versus 126 degrees) and grip-strength (20.8 versus 24.3 kgs). The radiological follow-up demonstrated loosening in 2 wrists (both components in one after 5 years, the distal component in the other after 7 years), revision has been postponed in both due to minor symptoms. Thirty-five patients were working at surgery.
Out of all applicants, de 

Summary Points: 
- A modern un cemented total wrist arthroplasty can provide long- lasting unrestricted hand function with an acceptable revision rate in young and active patients.

REFERENCES

PAPER 10
Clinical Paper Session 2: Education/Practice Management Friday, September 30, 2016 • 8:45–8:50 AM
Education
Primary Residency Training Pre-determines Post-fellowship Clinical Practice in Board-certified Hand Surgeons
N/A - Not a clinical study
Patrick L. Reavey, MD, MS
Neil F. Jones, MD
COI: There is no financial information to disclose.
Hypothesis: This study seeks to identify the relationship between the type of residency training (general, plastic, or orthopaedic surgery) and the clinical practice profiles of hand surgeons in the United States.
Methods: Membership applications to the American Society for Surgery of the Hand (ASSH) from 2011-2015 were obtained with permission. Data on type of residency training, practice type (private, private-university, hospital, or other), the percentage of hand surgery in practice, and the time to application from fellowship and CAQ completion were collected. The total number of cases as well as the number of cases in each key clinical category were collected from surgical case logs. Categorical variables were evaluated with chi-squared tests and continuous variable with Mood's median tests and Kruskal-Wallis tests; the numbers of surgical cases were analyzed with Poisson regression. All statistical analysis were performed with STATA (v. 13.1, Mac).
Results: From 2011-2015, a total of 451 hand surgeons applied for ASSH membership. 73.8% were orthopaedic surgeons (16.0% plastic surgeons and 10.2% general surgeons). After excluding outliers, the median time to application after fellowship graduation and completion of the CAQ was 5 and 1 years, respectively, and was similar between groups.
Plastic surgeons were more likely to be in an academic practice (48.3% versus 17.0% for orthopedics and 7.7% for general surgery, P < 0.0001). General surgeons were most likely to be in private practice (71.8% versus 59.2% for orthopedics and 39.7% for plastic surgery). Plastic surgeons had the smallest and most variable proportion of their cases in each key clinical category; orthopaedic surgeons had the highest volume of cases (median 306, P < 0.0001). Out of all applicants, deficiencies in joint contracture (40.7%), congenital (80.5%), and microvascular surgery (47.6%) were the most common. Orthopaedic surgeons were most likely to perform bone and joint, nerve, tendon and muscle and tumor cases. Plastic surgeons were the most likely to perform skin and wound, congenital and microvascular cases. General surgeons did notably fewer bone and joint, tendon and muscle, and congenital cases relative to both plastic and orthopaedic surgeons. See Figure 1 for detailed results.
Summary Points:
- Orthopaedic, plastic, and general surgery-trained hand surgeons early in their career seek varied practice types and have different clinical case profiles.

REFERENCES

PAPER 11
Clinical Paper Session 2: Education/Practice Management Friday, September 30, 2016 • 8:52–8:57 AM
Treatment
Collagenase Dose Related Correction of Flexion Deformity in Dupuytren Contracture: A Prospective Randomized Study
Level 1 Evidence
Nash H. Naam, MD
Abdel Hakim A. Massoud, MD
COI: There is no financial information to disclose.
Hypothesis: Collagenase injections have been used in treatment of Dupuytren contracture. The recommended dose is 0.58 mg per cord. We hypothesized that increasing the collagenase dose may increase the likelihood of correcting the flexion deformities.
Methods: A prospective randomized study was conducted comparing 2 groups of patients with Dupuytren contracture. Patients were selected...
randomly for either injection of 0.9 mg of collagenase (group I) or 0.58 mg (group II). The injection technique was the same. Patients were seen after 24 hours for the extension procedures under local anesthesia.

There were 37 digits in 27 patients in group I and 34 digits in 29 patients in group II. Age averaged 58 years in group I and 61 years in group II. There were 23 males in group I and 24 in group II. Isolated Metacarpophalangeal (MP) joints were involved in 21 digits in group I and 18 digits in group II. Isolated proximal interphalangeal (PIP) joints were involved in 4 digits in group I compared to 6 in group II. Both MP and PIP joints were involved in 12 digits in group I and 10 digits in group II. Flexion deformities of MP joints averaged 69 degrees in group I compared to 72 degrees in group II while PIP joint flexion deformities averaged 41 degrees in group I compared to 39 degrees in group II.

Results: All patients in both groups exhibited bruising and swelling of the involved hand after injection with no significant difference. Correction of flexion deformities of MP joints to 0 degrees-5 degrees was achieved in 26 digits (79%) in group I compared to 17 digits (61%) in group II, which was statistically significant ($P = 0.01$). Correction of PIP joints to 0 degrees-5 degrees was achieved in 10 digits (63%) in group I compared to 8 digits (50%) in group II ($P = 0.02$). The mean improvement in MP joints was 40 degrees in group I compared to 28 degrees in group II ($P = 0.02$). The mean improvement of PIP joints was 27 degrees in group I compared with 17 degrees in group II ($P = 0.02$). DASH scores were similar in both groups ($P = 0.3$). In terms of complications, 1 patient in group I had axillary lymphadenopathy that improved in 1 week. Four patients in group I and 1 patient in group II had skin tears that healed within 2 weeks.

Summary Points:
- Increasing the dosage of collagenase injections to 0.9 mg increases the effectiveness of correcting flexion deformities with Dupuytren contractures.
- There is no increase of risk or complications.

REFERENCES

PAPER 12
Clinical Paper Session 2: Education/Practice Management
Friday, September 30, 2016 • 8:59–9:04 AM
Medical/Legal

Inadequate Hand Surgical Operating Room (OR) Size Allocation: A Comparative OR Space Utilization Study
N/A - Not a clinical study

Jue Cao, MD
Seth Tebockhorst, MD
Krister Freese, MD
Michael Pensak, MD
Stephanie D. Malliaris, MD
Kyros Ipaktchi, MD

COI:
There is no financial information to disclose.

Hypothesis: Inadequate operative room (OR) size assignment for hand surgical cases is common. We hypothesize that hand surgery cases require more square footage than assigned by schedulers.

Methods: Two typical cases were chosen for general surgery, orthopaedic surgery and hand surgery. Required equipment was documented and measured during routine OR setup. Total OR space needed, in square feet ($ft^2$), for each case was calculated by adding measured area occupied by equipment and personnel. Laparoscopic appendectomy and cholecystectomy were selected for general surgery. Cephalomedullary nail (CMN) fixation of intertrochanteric femur fractures and anterior total hip arthroplasties (THA) were selected as large orthopaedic cases. Closed reduction and percutaneous pinning (CRPP) of phalanx fractures and microvascular finger replantation were selected as hand procedures. Space needed for anesthesia staff, circulating OR nurse, and anesthesia equipment were deemed comparable in between disciplines and excluded. Percentage differences between total space needed for all cases were calculated.

Results: With 101.5 $ft^2$, microvascular finger replantation necessitated the most OR space compared to general surgery and large orthopaedic procedures. Both general surgery cases needed 55.8 $ft^2$. 93.5 $ft^2$ and 95.5 $ft^2$ were respectively needed for CMN fixation of an intertrochanteric femur fracture and anterior THA. CRPP of phalanx fractures required 73.3 $ft^2$. There was a 58.1% difference between space needed for microvascular finger replantation versus laparoscopic appendectomy/cholecystectomy. Compared to CMN or anterior THA, finger replantation respectively needed 8.2% and 6.1% more space (rounded percentages). While CRPP of phalanx fractures did not require more OR space than both large orthopaedic cases, it utilized more space than the general surgery cases with a percentage difference of 27.1%.

Summary Points:
- There exists no data on OR space requirements for hand surgical cases. The preconceived notion of matching OR room size to operated body part is common practice, even in large microvascular tertiary referral centers.
- In this study, CRPP of phalanx fractures required more OR space than typical general surgery cases. Space needed for complex microvascular finger replantations far exceeded that needed for typical general surgery cases, even surpassing the space utilization of large orthopaedic procedures.
- The misconception of scheduling small body part surgery into small operating rooms may lead to OR crowding of resource intensive hand procedures, possible sterile field breach and decreased operative workflow efficiency.
**Hypothesis:** Despite the increasing availability of healthcare utilization data and emphasis on price transparency, little is known about the extent to which physician charges and Medicare payments for hand surgery vary across the United States. We assessed national and state-level variation in physician charges and Medicare payments for common hand procedures.

**Methods:** Using the Medicare Provider Utilization and Payment Data Public Use File for 2012, we evaluated national and state variation in physician charges and Medicare payments for carpal tunnel release, trigger finger release, trigger finger injection, closed treatment of distal radius fracture, and interposition arthroplasty, intercarpal or carpometacarpal joints. We assessed variation using the coefficient of variation. We also determined the correlation between charges and payments, as well as the association of patient volume with charges and payments.

**Results:** There was wide state-level variation in physician charges for carpal tunnel release (11-fold), trigger finger release (9.6-fold), and trigger finger injection (5.5-fold). On a national level, physician charges varied substantially for carpal tunnel release, trigger finger release, trigger finger injection, closed treatment of distal radius fracture, and interposition arthroplasty, intercarpal or carpometacarpal joints. Medicare payments varied to a lesser extent. The correlations between physician charges and Medicare reimbursements were not strong. Weak to no correlations were noted between patient volume and both charges and payments.

**Summary Point:**
- Physician charges for hand surgery vary substantially across states and nationally, and they do not correlate well with Medicare payments and surgeon volume.

**REFERENCE**

**PAPER 15**
Clinical Paper Session 3: Hand/Wrist Reconstruction 2 Friday, September 30, 2016 • 10:05—10:10 AM
Treatment; Prognosis/Outcomes

**Early Mobilization After Basal Joint Arthroplasty: Preliminary Clinical Results**
Level 2 Evidence
Margaret K. Jain, MD
Martin C. Skie, MD
Jacob Stirton, MD
Sarah Williams, BS

**COI:** There is no financial information to disclose.

**Hypothesis:** Traditional rehabilitation for basal joint arthroplasty involves prolonged thumb immobilization prior to initiating motion and strengthening. We hypothesize that early motion following basal joint arthroplasty is safe and will result in equivalent clinical outcomes to traditional rehabilitation.

**Methods:** Patients undergoing ligament reconstruction and tendon interposition (LRTI) were randomized to 1 of 2 rehabilitation protocols. All patients were immobilized following surgery in a thumb-spica plaster splint for 2 weeks. The accelerated rehabilitation group (Group 1) was then transitioned into a removable neoprene thumb CMC-wrap with activity as tolerated, while the traditional rehabilitation group (Group 2) were placed in a thumb-spica cast or splint to be worn full-time for an additional 4 weeks. Patients were examined pre-operatively and at 6 and 12 weeks post-operatively. Outcome measures included the Disabilities of the Arm, Shoulder...
and Hand (DASH) score, a visual analog scale for pain (VAS), pinch and grip strength and thumb range of motion. A descriptive analysis was run on data for both groups along with a repeated measure analysis of variance to compare the 2 groups at each time point with significance set at $P < 0.05$.

**Results:** Twenty seven patients were randomized, 13 in Group 1 and 14 in Group 2. There were no statically significant differences between the two groups with respect to age, preoperative DASH, VAS, pinch or grip strength or thumb CMC range of motion. There were no statistically significant difference between the 2 groups with respect to post-operative DASH, VAS, pinch or grip strength or thumb range of motion at both six and 12 weeks post-operatively. All pre-operative and 12-week post-operative outcomes data are presented in Tables 1 and 2 respectively. There were no intraoperative complications.

**Summary Points:**
- Early (12-week) outcomes suggest that early mobilization of patients following CMC arthroplasty does not compromise clinical results, with no significant difference demonstrated in DASH, VAS score, thumb strength or range of motion.
- Longer term data and increased sample size will determine the lasting effects of accelerated rehabilitation.
- An accelerated rehabilitation protocol may offer equivalent clinical results with earlier return to pre-morbid function than traditional rehabilitation.

### Table 1: Preoperative Patient Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (Accelerated)</th>
<th>Group 2 (Traditional)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Age (yrs)</td>
<td>62.4</td>
<td>55.9</td>
<td>0.052</td>
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<tr>
<td>DASH</td>
<td>44.1</td>
<td>50.7</td>
<td>0.420</td>
</tr>
<tr>
<td>VAS</td>
<td>4.9</td>
<td>6.5</td>
<td>0.200</td>
</tr>
<tr>
<td>3-point pinch (lbs)</td>
<td>9.3</td>
<td>6.4</td>
<td>0.397</td>
</tr>
<tr>
<td>Key pinch (lbs)</td>
<td>10.2</td>
<td>7.64</td>
<td>0.341</td>
</tr>
<tr>
<td>Grip Strength (lbs)</td>
<td>68.2</td>
<td>47.4</td>
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</tr>
<tr>
<td>Radial Abduction</td>
<td>49°</td>
<td>43°</td>
<td>0.737</td>
</tr>
<tr>
<td>Palmar Abduction</td>
<td>45°</td>
<td>45°</td>
<td>0.666</td>
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</table>

### Table 2: 12-Week Post-Op Data

<table>
<thead>
<tr>
<th></th>
<th>Group 1 (Accelerated)</th>
<th>Group 2 (Traditional)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DASH</td>
<td>26.68</td>
<td>35.95</td>
<td>0.480</td>
</tr>
<tr>
<td>VAS</td>
<td>2.9</td>
<td>3.1</td>
<td>0.898</td>
</tr>
<tr>
<td>3-point pinch (lbs)</td>
<td>6.7</td>
<td>4.4</td>
<td>0.327</td>
</tr>
<tr>
<td>Key pinch (lbs)</td>
<td>7.2</td>
<td>5.9</td>
<td>0.619</td>
</tr>
<tr>
<td>Grip Strength (lbs)</td>
<td>45.4</td>
<td>36.5</td>
<td>0.410</td>
</tr>
<tr>
<td>Radial Abduction</td>
<td>49°</td>
<td>51°</td>
<td>0.877</td>
</tr>
<tr>
<td>Palmar Abduction</td>
<td>50°</td>
<td>51°</td>
<td>0.953</td>
</tr>
</tbody>
</table>
Hypothesis: We hypothesized arthroscopic distal scaphoid resection only for scapho-trapezio-trapezoidal (STT) osteoarthritis would obtain feasible clinical results and that excessive resection of the distal scaphoid may lead to postoperative carpal malalignment and worsen functional outcomes.

Methods: We performed arthroscopic distal scaphoid resection for 16 consecutive wrists with symptomatic STT osteoarthritis. The average age was 60 years. Four wrists were Stage 2 and 12 wrists were Stage 3 by modified Eaton and Glickel classification. We evaluated visual analog scale (VAS) for pain, grip strength, pinch strength, the disabilities of the arm, shoulder and hand (DASH) score and patient rated wrist evaluation (PRWE) score and compared the preoperative values with that of final follow up using student’s t-test. We also analyzed correlations of the resection height of distal scaphoid with changes of capito-lunate (C-L) angle and improvement ratio of functional outcomes.

Results: The average follow-up period was 30 months. There was no postoperative complication such as infection or nerve palsy. Average pre- and post-VAS was 49 and 14mm ($P < 0.01$), grip strength was 17 and 21kg ($P = 0.19$), pinch strength was 3.2 and 5.5kg ($P < 0.01$), DASH score was 38 and 28 ($P = 0.17$), PRWE score was 53 and 24 ($P < 0.01$). Average resection height of distal scaphoid was 2.5mm (0.1-5.8mm). The height was less than 3mm in 12 wrists, and the height was over 3mm in four wrists. Average increase of C-L angle in the 12 wrists was 1 degree, and average increase of C-L angle in the 4 wrists was 12 degrees. One wrist that was resected over 5mm had osteoarthritic change at the C-L joint. At the final follow up, average %VAS was 21% in the 12 wrists and 98% in the 4 wrists. Average %PRWE was 45% in the 12 wrists and 65% in the 4 wrists.

Summary Points:
- Acceptable results can be obtained by an arthroscopic distal scaphoid resection for STT osteoarthritis.
- Over 3mm resection of distal scaphoid may result in carpal malalignment and worsen clinical result.
- Less than 3mm resection of distal scaphoid may minimize change of carpal alignment and can be obtained better clinical results.

REFERENCES

PAPER 18
Clinical Paper Session 3: Hand/Wrist Reconstruction 2
Friday, September 30, 2016 10:26–10:31 AM
Treatment; Surgical Technique; Prognosis/Outcomes
Dreaded Ulnar Wrist Pain: Long-term Results of Pisiformectomy for Painful Pisotriquetral Arthritis or Instability
Level 4 Evidence
Maureen A. O’Shaughnessy, MD
Marco Rizzo, MD
Steven J. Moran, MD
Alexander Y. Shin, MD
David G. Dennison, MD
Bassem T. Elhassan, MD

COI:
There is no financial information to disclose.

Hypothesis: Ulnar-sided wrist pain can be a daunting problem for hand surgeons. Pisiform pathology, including pisotriquetral arthritis or instability, may be the culprit. At our institution, pisiformectomy has been clinically found to have good outcomes, with formal review lacking. This study reviews the long term outcomes of patients treated with pisiformectomy, focusing on need for and time to revision procedure.

Methods: This IRB-approved retrospective study was performed over a 27-year period (1988-2015) of all patients undergoing pisiformectomy. At latest follow-up, data including range of motion, grip strength, complications and need for revision surgery were recorded.

Results: The series includes 61 wrists in 60 patients (45 female, 15 male) with an average age at surgery of 46 (range 18 to 74). Average follow up was 98 months (8.2 years) (range 3-288 months). The main diagnosis in this series was pisotriquetral degenerative arthritis (idiopathic osteoarthritis 81%, post-traumatic arthritis 13%, inflammatory arthritis 6%); no patients had pisotriquetral instability. 63% of patients had documentation of failed nonoperative management (splinting, injections, and immobilization).

Surgery consisted of open pisiformectomy in all patients. Patients underwent concomitant procedures in about half of cases (48%). Most common procedures included TFCC/DRUJ debridement or repair (12), diagnostic arthroscopy (10), synovectomy (5), Guyon’s canal release (4) and CMC procedure (4).

Two complications were noted (3%): a postoperative ulnar nerve palsy (resolved with observation) and symptomatic retained suture (taken for operative removal). Four patients required repeat surgery, which included removal of symptomatic suture and FCU debridement (1), volar ganglion excision (1), DRUJ stabilization procedure (1) and four-corner fusion (1). Average time to revision surgery was 92 months (range 15-177). The majority of the patients in the series did not require revision procedures for pain or instability at average follow up of 98 months (range 3-288).

At final follow-up, average flexion to extension arc was 81% (expressed as percent of contralateral), radioulnar deviation arc was 88% and average grip strength was 89%.

Summary Points:
- Pisiformectomy is a reliable motion-preserving procedure with low complication rates for patients with chronic ulnar-sided wrist pain related to pisotriquetral arthritis or instability.
- In this series, 66% of patients experienced pain relief and did not require further procedures at an average of 8.2 years of follow up.
- The significance of these results better enable surgeons to give time estimates and expectations regarding pain control following pisiformectomy.

COI:
Royalty: Trimedia Inc. and Mayo Medical Ventures (Shin)
Speakers Bureau: Trimedia Inc. (Shin)

Hypothesis: Pisiformectomy: View After Excision

Pisiformectomy: View After Excision

COI:
There is no financial information to disclose.

Hypothesis: Pisiformectomy: View After Excision

Pisiformectomy: View After Excision
Surgical Technique

Early Clinical Failure of a Cementless Thumb Basal Joint Hemiarthroplasty for the Treatment of Trapeziometacarpal Osteoarthritis

Level 4 Evidence

Patrick Gaetano Marinello, MD
Peter J. Evans, MD, PhD
Mark C. Shreve, MD

COI:
There is no financial information to disclose.

Hypothesis: Multiple surgical procedures and implants have been developed to treat trapeziometacarpal joint osteoarthritis. Recently, a promising thumb basal joint hemiarthroplasty was reported in the literature to provide pain relief and improved function. The authors reported a 94% implant survivorship with revision as an endpoint at a mean follow up of 72.1 months. The purpose of our study was to evaluate the senior author’s clinical results and survivorship of thumb basal joint hemiarthroplasty using the same device.

Methods: We performed 35 basal joint hemiarthroplasties in 32 patients from 2011 to 2014. Of these, 26 thumbs (25 patients) had clinical follow up of at least 12 months. Mean age of the patients was 54 years (range 43-68 years) with 88% females. All patients had Eaton-Littler Stage II or III arthritis preoperatively. Average follow up was 22.5 months (range 12-41 months). The main outcomes were revision rate and time to revision. Pre- and post-operative radiographs were examined to determine the amount of overall thumb ray lengthening and amount of subsidence of the implant between those revised and unrevised. Student’s t-test and Fisher exact test was used for statistical analysis ($P < 0.05$).

Results: At minimum of 12 month follow up, 16 of 26 thumbs (61.5%) had been revised with implant removal, resection of remaining trapezium, and ligament reconstruction with tendon interposition (LRTI). Another 3 thumbs were symptomatic and planning on future revision. Continued pain, stem loosening, and implant subsidence into the trapezium were the clinical reasons for revision. Mean time to revision was 18.1 months (range 8-41 months). Those needing revisions trended towards being younger, but this was not significant (52.9 versus 56.5 years $P = 0.17$). The revised cohort had the index procedure more often on the dominant side (56% versus 10%; $P = 0.037$). There was no significant difference between those revised and unrevised in terms of percentage of thumb ray lengthening and amount of trapezial subsidence.

Summary Points:
- Although a limited number of cases were examined, we found poor implant survivorship and an unacceptably high rate of re-operation with the studied thumb basal joint hemiarthroplasty device.
- These results are in stark contrast to previous reports in the literature.
- Therefore, we cannot advocate for continued use of the device and no longer use this implant for thumb basal joint arthroplasty.

Table 1 – Patient Data on Revised Cohort

<table>
<thead>
<tr>
<th>Thumb</th>
<th>Age</th>
<th>Gender</th>
<th>Operative Side</th>
<th>Diagnosis</th>
<th>Reason for Revision</th>
<th>Time to Revision (months)</th>
<th>Revision Surgery</th>
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<tbody>
<tr>
<td>1</td>
<td>64</td>
<td>M</td>
<td>R/R</td>
<td>OA/3</td>
<td>Trapezial subsidence; Pain</td>
<td>12</td>
<td>LRTI</td>
</tr>
<tr>
<td>2</td>
<td>56</td>
<td>F</td>
<td>R/R</td>
<td>OA/3</td>
<td>Pain</td>
<td>41</td>
<td>LRTI</td>
</tr>
<tr>
<td>3</td>
<td>52</td>
<td>F</td>
<td>R/R</td>
<td>OA/3</td>
<td>Trapezial subsidence</td>
<td>22</td>
<td>LRTI</td>
</tr>
<tr>
<td>4</td>
<td>45</td>
<td>F</td>
<td>L/R</td>
<td>OA/2</td>
<td>Trapezial subsidence; Pain</td>
<td>20</td>
<td>LRTI</td>
</tr>
<tr>
<td>5</td>
<td>53</td>
<td>F</td>
<td>R/L</td>
<td>OA/3</td>
<td>Trapezial subsidence; Subluxation</td>
<td>14</td>
<td>LRTI</td>
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<tr>
<td>6</td>
<td>53</td>
<td>F</td>
<td>R/R</td>
<td>OA/3</td>
<td>Trapezial subsidence; Pain</td>
<td>39</td>
<td>LRTI</td>
</tr>
<tr>
<td>7</td>
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<td>R/R</td>
<td>OA/2</td>
<td>Trapezial subsidence</td>
<td>8</td>
<td>LRTI</td>
</tr>
<tr>
<td>8</td>
<td>56</td>
<td>F</td>
<td>R/L</td>
<td>OA/3</td>
<td>Stem loosening; Trapezial subsidence; Pain</td>
<td>13</td>
<td>LRTI</td>
</tr>
<tr>
<td>9</td>
<td>43</td>
<td>F</td>
<td>R/L</td>
<td>OA/2</td>
<td>Trapezial subsidence</td>
<td>10</td>
<td>LRTI</td>
</tr>
<tr>
<td>10</td>
<td>55</td>
<td>M</td>
<td>R/L</td>
<td>OA/2</td>
<td>Trapezial subsidence</td>
<td>8</td>
<td>LRTI</td>
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<tr>
<td>11</td>
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<td>L/L</td>
<td>OA/3</td>
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<td>LRTI</td>
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<tr>
<td>12</td>
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<td>OA/3</td>
<td>Trapezial subsidence</td>
<td>18</td>
<td>LRTI</td>
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<td>13</td>
<td>46</td>
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<td>R/L</td>
<td>OA/3</td>
<td>Stem loosening; Trapezial subsidence; Pain</td>
<td>14</td>
<td>LRTI</td>
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<tr>
<td>14</td>
<td>46</td>
<td>F</td>
<td>R/R</td>
<td>OA/3</td>
<td>Stem loosening; Trapezial subsidence; Pain</td>
<td>10</td>
<td>LRTI</td>
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<tr>
<td>15</td>
<td>54</td>
<td>F</td>
<td>R/R</td>
<td>OA/3</td>
<td>Stem loosening; Trapezial subsidence; Pain</td>
<td>23</td>
<td>LRTI</td>
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<tr>
<td>16</td>
<td>45</td>
<td>F</td>
<td>R/L</td>
<td>OA/3</td>
<td>Stem loosening; Trapezial subsidence; Pain</td>
<td>8</td>
<td>LRTI</td>
</tr>
</tbody>
</table>

Figure 1 – Immediate post-op (a) and revision at 12 months (b) demonstrating significant complete trapezial subsidence necessitating revision to LRTI. (A)


REFERENCES


Patients are able to achieve range of motion and strength that allows the limb to be functional for normal activities of daily living.

**PAPER 22**

Clinical Paper Session 4: Elbow/Forearm Reconstruction
Friday, September 30, 2016 • 10:19—10:24 AM
Treatment

**Prospective Randomized Comparison of Scar Appearances between Cograft of Acellular Dermal Matrix with Autologous Split Thickness Skin and Autologous Split Thickness with Skin Graft Alone for Full Thickness Skin Defects on the Extremity**
Level 2 Evidence

Jae Kwang Kim, MD, PhD

Grant received from: Daewoong Bio Incorporation

**COI:**

There is no financial information to disclose.

**Hypothesis:** The purpose of this study was to evaluate clinical outcomes of cograft of acellular dermal matrix with autologous split thickness skin and autologous split thickness skin graft alone for full thickness skin defect on the extremity.

**Methods:** This is prospective randomized study. Nineteen consecutive patients with full-thickness skin defect on the extremity following trauma underwent grafting using either cograft of acellular dermal matrix with autologous split thickness skin graft (9 patients, group A) or autologous split thickness skin graft alone (10 patients, group B) from June 2011 to December 2012. The postoperative evaluations included observation of complications including graft necrosis, graft detachment or seroma formation, and Vancouver Scar Scale (VSS).

**Results:** No statistically significant difference was found regarding complications including graft necrosis, graft detachment or seroma formation. At week 8, significantly lower VSS for vascularity, pliability, height and total score was found in Group A compared to Group B. At week 12, lower score for pliability, height and total score was identified in Group A when compared to Group B.

**Summary Point:**

For cases with traumatic full-thickness skin defects on the extremity, significantly better results can be achieved with cograft of acellular dermal matrix with autologous split thickness skin graft rather than with autologous split-thickness skin graft alone in terms of VSS.

**REFERENCES**


**PAPER 23**

Clinical Paper Session 4: Elbow/Forearm Reconstruction
Friday, September 30, 2016 • 10:26—10:31 AM
Treatment; Prognosis/Outcomes; International

**Outcomes of Massive Proximal Upper Extremity Reconstruction in the Resource-Poor Setting**
Level 4 Evidence

Aviram M. Giladi, MD
R. Raja Shanmugakrishnan, MS, MRCS
Kevin C. Chung, MD, MS
R. Raja Sabapathy, MS, MCh

**COI:**

There is no financial information to disclose.

**Hypothesis:** Considering current limitations in prosthetics and hand transplantation, limb salvage remains the dominant reconstructive option for proximal upper extremity trauma. This is especially true in countries where social services are not available to support the disabled. At Ganga Hospital in Coimbatore, India, a unique approach is applied to treat massive upper limb injuries. However, long-term outcomes of complex reconstruction performed in this resource-limited setting are not known. We hypothesize that patient-reported outcome questionnaires (PROs) can measure functional and health-related quality-of-life (QoL) outcomes after upper extremity salvage, and determine what injury components and outcomes predict long-term success.

**Methods:** Forty-six patients were evaluated 6 months or more after massive upper extremity reconstruction at Ganga Hospital. Demographic and employment data were collected. Patients completed isolated functional tests, Jebsen-Taylor composite functional test (JTT), and PROs — Michigan Hand Questionnaire (MHQ), Disability of Arm, Shoulder, and Hand questionnaire (DASH), and Short-Form 36 (SF-36). Correlations between outcomes metrics were assessed with Pearson’s correlation coefficients. Linear regression modeling evaluated associations between injury severity, reconstruction required, and outcomes.

**Results:** MHQ and DASH had significant correlations with functional tests, JTT, and SF-36 (Figure 1). Mean MHQ score was 79 +/- 15 and mean DASH score was 13 +/- 15, not significantly different than long-term
outcomes after other upper extremity procedures. injury severity score, as well as most fractures and vessel injuries, did not predict outcomes; however, the following factors did predict patient-reported outcomes and functional performance after reconstruction: extent of soft tissue reconstruction, multi-segmental ulna fractures, median nerve injury, and ability for patients to return to work and maintain their current job after injury (Table 1).

Summary Points:
- Complex proximal upper extremity salvage can be performed in the resource-limited setting with excellent long-term functional and patient-reported outcomes.
- PRO questionnaires are useful for reporting outcomes that correlate to functional and sensory testing.
- Extent of soft tissue reconstruction and need for median nerve repair are more predictive of outcomes and satisfaction than other elements of reconstruction.
- Facilitating return to work is critical in improving outcomes and satisfaction for patients in the developing world.

Table 1. Results of multivariable linear regression models evaluating different injury and demographic factors that affect outcomes after major proximal upper extremity salvage procedures.

<table>
<thead>
<tr>
<th>Soft tissue reconstruction w/ graft</th>
<th>DASH score</th>
<th>DASH score</th>
<th>MCS score</th>
<th>PCS mean</th>
<th>MHQ mean</th>
<th>JTT score</th>
<th>VF mean</th>
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</thead>
<tbody>
<tr>
<td>Intact</td>
<td>4.4 (±2.2)</td>
<td>66 (±12.5)</td>
<td>0.5 (±0.2)</td>
<td>0.5 (±0.2)</td>
<td>0.5 (±0.2)</td>
<td>0.5 (±0.2)</td>
<td>0.5 (±0.2)</td>
</tr>
<tr>
<td>Intact</td>
<td>4.4 (±2.2)</td>
<td>66 (±12.5)</td>
<td>0.5 (±0.2)</td>
<td>0.5 (±0.2)</td>
<td>0.5 (±0.2)</td>
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<td>0.5 (±0.2)</td>
</tr>
<tr>
<td>Soft tissue reconstruction w/ graft</td>
<td>13.2 (±6.8)</td>
<td>7.8 (±5.5)</td>
<td>4.4 (±2.5)</td>
<td>4.1 (±0.3)</td>
<td>4.1 (±0.3)</td>
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<tr>
<td>Soft tissue reconstruction w/ graft</td>
<td>13.2 (±6.8)</td>
<td>7.8 (±5.5)</td>
<td>4.4 (±2.5)</td>
<td>4.1 (±0.3)</td>
<td>4.1 (±0.3)</td>
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<tr>
<td>Arterial injury 0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
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</tr>
<tr>
<td>Multimodular nerve injuries 0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
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<tr>
<td>Repair of ulnar function 0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
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<tr>
<td>Repair of median nerve function 0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
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<tr>
<td>Repair of ulnar nerve function 0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
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<tr>
<td>Repair of median nerve function 0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
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<td>0.6 (±0.3)</td>
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<tr>
<td>Repair of ulnar nerve function 0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
<td>0.6 (±0.3)</td>
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REFERENCES

PAPER 24
Clinical Paper Session 4: Elbow/Forearm Reconstruction
Friday, September 30, 2016 • 10:33–10:38 AM
Treatment; Surgical Technique

Which Nerve to Use? Comparison Between Donor Nerves to Motorize the Free Functional Gracilis Muscle Transfer for Elbow Flexion in Traumatic Brachial Plexus Injuries
Level 4 Evidence
Gustavo Bersani Silva, MD
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Marina J. Pisani, MD
Raquel I. da Costa, MD
Marcelo R. Rezende, MD
Alvaro B. Cho, MD, PhD

COI:
There is no financial information to disclose.

Hypothesis: Elbow flexion deficit is a frequent problem in traumatic brachial plexus injuries and reestablishment of this function is the primary treatment goal. When management is delayed or the initial acute approach fails, free functional transfer of the gracilis muscle for elbow flexion is the treatment of choice: the authors seek to determine which donor nerve (spinal accessory, intercostal, median or ulnar) results in better elbow flexion after microsurgical reconstruction.

Methods: Retrospective analysis of patients with traumatic brachial plexus injuries who underwent functional free gracilis muscle flap for elbow flexion between February 2003 and October 2014 was carried out at Sao Paulo University. Post-operative function of the gracilis functional flap was recorded and patients were divided into 4 groups according to donor nerve: spinal accessory nerve (SAN), intercostal nerves (ICN), motor fascicles of the median (MED) and ulnar nerve (ULNAR). Cases in which a primary neurorrhaphy was not possible were further subdivided into two groups: spinal accessory nerve with graft interposition (SAN graft) and intercostal nerves with graft interposition (ICN graft). The final elbow flexion strength was evaluated by the British Medical Research Council (BMRC) scale and time in months when the authors first observed M3 muscle power was also of note.

Results: Fifty-nine patients met inclusion criteria for this retrospective study. Two cases were excluded due to flap loss (3%) and 3 were lost to follow-up (5%). Of the 54 patients enrolled, 53 were male (98.2%) with a mean age of 29 years. The mean follow-up period was 28 months. Thirty-four cases obtained muscle strength = M3 (62.9%), six M0 (11.1%), four M1 (7.5%), ten M2 (18.5%), thirteen M3 (24%) and twenty-one M4 (38.9%). The mean interval to first-recorded M3 muscular strength was 16 months. Patients stratified by donor nerve achieving = M3 had the following distribution: SAN 83.3% (15/18) SAN graft 50% (2/4), ICN 50% (2/4), ICN graft 33.3% (1/3), MED 40% (2/5) and ULNAR 60% (12/20). No statistical difference for final muscle strength was found between donor nerve groups. SAN transfer with graft interposition took longer to reach = M3 muscle strength (P < 0.05).

Summary Points:
- Free functional gracilis muscle flap for traumatic brachial plexus injuries is a viable option for elbow flexion recovery.

Figure 1. Pearson’s correlation coefficient results from analysis between the questionnaires and Jhena Taylor Test (JTT). *indicates significant with p<0.05. MHQ = Michigan Hand Questionnaire; PCS = Physical Component Summary of the SF-36; MCS = Mental Component Summary of the SF-36; DASH = Disability of the Arm, Shoulder, and Hand questionnaires.
Comparison between four different nerve transfers - spinal accessory nerve, intercostal nerve, motor fascicles of the median and ulnar nerve - has not clearly indicated a better alternative over the others.

### Table 1 – British Medical Research Council (BMRC) Scale

<table>
<thead>
<tr>
<th>BMRC Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M0</td>
<td>No contraction</td>
</tr>
<tr>
<td>M1</td>
<td>Trace contraction</td>
</tr>
<tr>
<td>M2</td>
<td>Able to move with gravity eliminated</td>
</tr>
<tr>
<td>M3</td>
<td>Active movement against gravity</td>
</tr>
<tr>
<td>M4</td>
<td>Able to move the joint against combination of gravity and some resistance</td>
</tr>
<tr>
<td>M5</td>
<td>Normal power</td>
</tr>
</tbody>
</table>

### Table 2 – Results by donor nerve (without graft interposition)

<table>
<thead>
<tr>
<th></th>
<th>Global</th>
<th>SAN</th>
<th>ECR</th>
<th>MED</th>
<th>ULNAR</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>s M3</td>
<td>3147(65.2%)</td>
<td>1518(33.3%)</td>
<td>24(0.0%)</td>
<td>255 (42.0%)</td>
<td>1220(25.0%)</td>
<td>0.160*</td>
</tr>
<tr>
<td>M0</td>
<td>2447(47.0%)</td>
<td>0(0.0%)</td>
<td>24(0.0%)</td>
<td>95 (0.0%)</td>
<td>220(0.0%)</td>
<td>200(10.0%)</td>
</tr>
<tr>
<td>M1</td>
<td>2447(47.0%)</td>
<td>0(0.0%)</td>
<td>24(0.0%)</td>
<td>95 (0.0%)</td>
<td>220(0.0%)</td>
<td>200(10.0%)</td>
</tr>
<tr>
<td>M2</td>
<td>2447(47.0%)</td>
<td>0(0.0%)</td>
<td>24(0.0%)</td>
<td>95 (0.0%)</td>
<td>220(0.0%)</td>
<td>200(10.0%)</td>
</tr>
<tr>
<td>M3</td>
<td>2447(47.0%)</td>
<td>0(0.0%)</td>
<td>24(0.0%)</td>
<td>95 (0.0%)</td>
<td>220(0.0%)</td>
<td>200(10.0%)</td>
</tr>
<tr>
<td>M4</td>
<td>2447(47.0%)</td>
<td>0(0.0%)</td>
<td>24(0.0%)</td>
<td>95 (0.0%)</td>
<td>220(0.0%)</td>
<td>200(10.0%)</td>
</tr>
</tbody>
</table>

* Fisher exact test

### REFERENCES


### PAPER 25

**Clinical Paper Session 5: Hand/Wrist Reconstruction 3**

**Friday, September 30, 2016**  
**11:25–11:30 AM**

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

**Donor Site Outcomes with Osteocutaneous versus Fasciocutaneous Radial Forearm Free Flap Harvest**

**Level 3 Evidence**

Ellen Stolle Satteson, MD  
Joshua D. Waltonen, MD  
Adam C. Satteson, MD  
Benjamin C. Graves, MD

**PAPER 26**

**Clinical Paper Session 5: Hand/Wrist Reconstruction 3**

**Friday, September 30, 2016**  
**11:32–11:37 AM**

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

**Electrodiagnostic Severity and Carpal Tunnel Release Outcomes: A Prospective Analysis**

**Level 2 Evidence**

Michael Rivlin, MD  
Amir Reza Kachooei, MD  
Mark L. Wang, MD, PhD  
Asif Ilyas, MD

**COI:**  
There is no financial information to disclose.

**Hypothesis:**  
The value of electrodiagnostic testing (EMG) severity as a prognostic indicator of clinical results following carpal tunnel release (CTR) remains controversial, and our current understanding is largely limited to retrospective reviews. The aim of this study was to (1) prospectively evaluate the degree of symptomatic and functional...
postoperative improvement relative to preoperative EMG severity, and (2) test the hypothesis that symptom relief after CTR will differ based on EMG severity.

Methods: Consecutive cases of EMG-confirmed CTR were prospectively enrolled. Data was collected preoperatively and at 2 weeks and 3 months postoperatively. Demographic, EMG severity (mild, moderate, or severe), surgical parameters, QuickDASH questionnaire, Symptom Severity Scale (SSS), Functional Status Scale (FSS), Pain Catastrophizing Scale (PCS), and Visual Analogue Scale (VAS) data were collected and analyzed.

Results: A total of 295 patients were enrolled. By EMG severity, there were 20 patients with mild, 126 with moderate, and 110 patients with severe grades preoperatively. There was a significant improvement in QuickDASH, SSS, and FSS scores from the pre-operative to the 2-week and 3-month postoperative visits in all categories of EMG severity ($P < 0.05$). Catastrophic thinking (PCS) did not have a significant effect on any of the 3 groups ($P > 0.05$). Pain decreased dramatically at 2 week post-op ($P < 0.05$). Postoperative pain improvement occurred regardless of EMG severity. Lastly, there were no major complications or re-operations in any groups.

Summary Points:
- CTR demonstrated consistently significant improvement in functional outcomes regardless of EMG severity at 3 months.
- The extent of postoperative improvement following CTR was not statistically different between groups with differing EMG severity.
- This information can be of value to surgeons and patients as they plan surgery and discuss postoperative outcomes.

PAPER 27
Clinical Paper Session 5: Hand/Wrist Reconstruction 3
Friday, September 30, 2016 • 11:39—11:44 AM
Treatment; Therapy/Rehabilitation; Prognosis/Outcomes; Education

Caffeine Does Not Reduce Blood Flow Following Arterial Anastomosis in the Rat

Robert J. Strauch, MD
Gabrielle Shaughness, BA
Yelena Akelina, DVM
Jordan H. F. McKittrick, BA

COI:
There is no financial information to disclose.

Hypothesis: Patients are usually advised not to consume caffeine following digital replantation owing to concerns of compromised perfusion. This study examined the effect of caffeine on blood flow distal to the site of anastomosis in the femoral arteries of rats.

Methods: Twenty-eight Sprague-Dawley rats were used for this study. The femoral arteries were exposed bilaterally, and baseline blood volume flow measurements were taken on intact arteries using a transit time flow-meter probe. All rats underwent transection and microvascular anastomosis of the femoral artery on the right side while the left side remained intact. The rats were then divided into 2 groups. In group one, we administered caffeine immediately following completion of the anastomosis (intraperitoneal injection of 40mg caffeine/kg body-weight dissolved in saline) and in group two, no caffeine was administered. In both groups, bilateral flow measurements were recorded at 30 and 60 minutes after completion of the anastomosis.

Results: Caffeine had no statistically significant effect on blood flow. In the anastomosed arteries, average blood flow increased above pre-op levels by 35% at 30 minutes and by 44% after 60 minutes. There was no statistically significant difference between the caffeinated and the non-caffeinated rats (Figure 1). The control arteries that did not undergo anastomosis also displayed an increase in average blood flow of 42% at 30 minutes and 67% at 60-minutes with no statistically significant difference between the caffeinated and the non-caffeinated rats (Figure 2).

Summary Point:
- Caffeine did not have a statistically significant effect on blood flow following anastomosis of the rat femoral artery.

PAPER 28
Clinical Paper Session 5: Hand/Wrist Reconstruction 3
Friday, September 30, 2016 • 11:46—11:51 AM
Evaluation/Diagnosis; Treatment

Prospective Study of Vascular Assessment with Laser Angiography of the Upper Extremity
Level 4 Evidence

Helen G. Hui-Chou, MD
Kenneth R. Means, MD
James P. Higgins, MD

Grant received from: American Foundation for Surgery of the Hand, Raymond Curtis Research Foundation

COI:
There is no financial information to disclose.

Hypothesis: We hypothesized that Luna, an indocyanine green laser angiography imaging system, could replace or supplement the use of clinical and Doppler examination for evaluation of upper extremity perfusion. Our goal was to demonstrate the immediate, accurate, and minimally-invasive evaluation of upper extremity tissue perfusion with the Luna.
Methods: This was an IRB-approved, prospective study using Luna imaging to evaluate perfusion in patients with upper extremity vascular compromise. We determined the Luna scan values of tissues that ultimately survive or are lost. All patients had Luna imaging pre-intervention, intra-operatively if applicable, and at 1 week, 2 weeks, and 2 months post-intervention. For each scan, we selected a standardized control area with normal skin perfusion to compare to the tissues being studied.

Results: Twelve patients (16 extremities) were evaluated. Mean patient age was 53 years. There were 7 men and 5 women; half were smokers. Etiologies of hand vascular compromise in this study included amputations, primary and secondary vasospastic disease, scleroderma, intravascular drug injection, ballistic trauma, and crush traumatic injury. Interventions included surgical repair or reconstruction including addressing vascular injuries as needed, botulinum toxin injections, and/or medications. A mixed-effects multilevel linear regression model was chosen to quantify the association between mean Luna score and study time point. We discovered a statistically significant improvement in perfusion, demonstrated by an increase in Luna score, by 2-weeks post-intervention when compared to pre-intervention scans. A multivariate logistic regression model was used to determine the independent association of Luna score on digit/tissue loss while controlling for smoking status and presence/absence of Doppler signal. Using this analysis, only the Luna score was statistically significantly correlated with digit/tissue loss. There was a reduction of approximately 50% in odds of digit/tissue loss per 10-point incremental increase in Luna score. A sustained value of 10% or less in Luna perfusion score, when compared to the normal control area, resulted in eventual tissue loss and/or amputations.

Summary Points:
- In this study, the use of the Luna provided objective data to document improved tissue perfusion following surgical vascular interventions and chemical sympathectomy.
- When Luna tissue perfusion value is less than 10%, tissue is severely threatened and will result in eventual loss if no interventions are performed.

REFERENCES

This research was supported by a 2014 Fast Track grant from the American Foundation for Surgery of the Hand.

PAPER 29
Clinical Paper Session 5: Hand/Wrist Reconstruction 3
Friday, September 30, 2016 ● 11:53–11:58 AM
Billing/Coding

Which Upper Limb Quality Measures Should We Be Utilizing?
Level 4 Evidence
Robin Kamal, MD
Hypothesis: The majority of current upper limb quality measures are not important, feasible to complete, and suitable for upper limb surgeon accountability.

Methods: We completed a modified RAND/UCLA Delphi consensus process of 134 quality measures found through a systematic review. Nine fellowship-trained hand/upper limb surgeons reviewed quality measures and were asked to evaluate whether each measure was important for care, was feasible to complete in practice, and if upper limb surgeons should be held accountable for their completion.

Results: Of the 134 measures evaluated, consensus was achieved on 43% (58) of the measures rated as important for care, and 36% (48) rated as unimportant for care. Fifty-five percent (74) of the measures achieved consensus on feasibility to complete in practice, and 45% (60) were indeterminate. The panel achieved consensus that upper limb surgeons should not be held accountable for only 29% (39). Of the 58 measures rated as important for care, 86% (50) were rated as feasible to complete, and 67% (39) were rated that upper limb surgeons should be held accountable. There were only 33 measures (25%) that reached consensus for being important, feasible, and that upper limb surgeons should be held accountable for their completion. These measures address carpal tunnel syndrome, osteoporosis, infection, referrals, pediatric supracondylar humerus fractures, and distal radius fractures.

Summary Points:
- Only a small portion (25%) of current upper limb quality measures are important, feasible to complete, and suitable for upper limb surgeon accountability.

REFERENCES

PAPER 30
Clinical Paper Session 6: Nerve 1
Friday, September 30, 2016 • 11:25-11:30 AM
Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Significance of Cervical MRI in Surgical Decision Making in Brachial Plexus Birth Injury
Level 2 Evidence
Petra Grahn, MD
Tiina Poyhia, PhD
Antti Sommarhem, PhD
Aarno Y. Niemtsovaara, MD, PhD
COI: There is no financial information to disclose.
Hypothesis: Evidence of cervical root avulsion injury in MRI is a good indicator for surgical repair of brachial plexus birth injury (BPBI).
Methods: During a prospective study period between 2006 and 2015, high resolution cervical MRI (1.5T Philips Medical Systems, Achieva) was performed at median 3.7 months (range 0.3-14) in 10 BPBI patients with a flail upper extremity at birth, and in 24 patients (one bilateral injury) without antigravity biceps function by 3 months of age (14 with total plexus involvement and 11 with C5-C6(7) palsy at birth). Type (no avulsion, partial avulsion, avulsion) and number of root injuries, as well as location of pseudomeningoceles, were registered. Findings in MRI and surgery were compared to clinical outcome (mean follow-up 4 years, range 1-8). Time to MRI from its referral was calculated.
Results: Root avulsions (1-4) were detected on MRI in 8/10 patients (C7 one, C8 four, C8-T1 two, C6-8 one) with a flail upper extremity, in 4/14 patients (C6 one, C8 one, C7-8 two) with total plexus involvement, and in none of the patients with upper plexus palsy. Partial root avulsions were registered in 6 (C6 four, C7 one, C8 three) and meningoceles with intact roots in 2 patients. Plexus reconstruction was done to 8 of the 10 patients with a flail upper extremity (1 patient denied), to 4/14 patients with total plexus involvement (1 patient denied) and none of the patients with partial palsy at birth. MRI findings were concurrent with the clinical findings in all 9 cases that had adequate surgical exposure for comparison. Seven patients’ wrist and hand function recovered to normal without surgical intervention despite a C8 lesion (avulsion 4, partial avulsion 3) in MRI. Elbow flexion recovered well in all 4 patients with partial C6 avulsions. MRI delayed surgery by median 44 days (range 5-114).
Summary Points:
- Both flail upper extremity at birth and root avulsion(s) detected by MRI are good indicators for brachial plexus reconstruction in BPBI.
- Spontaneous recovery of hand function is good in some patients despite evidence of C8 avulsion in MRI.
- Partial root avulsions seem to be of little importance.

PAPER 31
Clinical Paper Session 6: Nerve 1
Friday, September 30, 2016 • 11:32-11:37 AM
Treatment; Surgical Technique; Prognosis/Outcomes
Complication Rates of Cubital Tunnel Surgery: In situ Cubital Tunnel Release Compared with Ulnar Nerve Transposition
Level 3 Evidence
Dafang Zhang, MD
Brandon E. Earp, MD
Philip E. Blazar, MD
COI: There is no financial information to disclose.
Hypothesis: The purposes of this study are to determine the rate and types of complications of in situ cubital tunnel release compared with ulnar nerve transposition. Our null hypothesis is that complication rates are the same after in situ cubital tunnel release and ulnar nerve transposition.
Methods: An IRB-approved retrospective cohort study was performed over a 5-year period at a single institution. The hospital medical records database was queried using Common Procedural Terminology code for all patients who underwent open cubital tunnel release from August 2008 to July 2013, yielding 426 patients who underwent cubital tunnel surgery. Application of exclusion criteria of acute trauma, revision surgery, neoplasm, age less than 18, misdated procedure, miscoded procedure, insufficient records, and non-study surgeon resulted in 340 patients who underwent cubital tunnel decompression, including 225 in situ cubital tunnel releases and 115 ulnar nerve transpositions. Computerized medical records were analyzed for surgical complications.
Results: Of 340 cubital tunnel surgeries performed, 19 were noted to have a complication by final follow-up (5.6%). There were 8 complications out of 225 in situ cubital tunnel releases (3.6%), including 3 cases of ulnar nerve instability (1.3%), 2 cases of persistent or recurrent cubital tunnel syndrome

REFERENCES
(0.9%) treated with ulnar nerve transposition, 2 cases of postoperative infection (0.9%) treated with antibiotics and wound care, and 1 case of a postoperative seroma (0.4%) not requiring reoperation. There were 11 complications out of 115 nerve transpositions (9.6%), including 9 cases of persistent or recurrent cubital tunnel syndrome (7.8%), 8 of which were treated with revision ulnar nerve transposition, 1 case of postoperative infection (0.9%) treated with surgical debridement, and 1 case of MACN injury (0.9%) repaired intraoperatively. The revision surgery rate was 4.7% overall, 1.8% for in situ cubital tunnel release and 7.8% for ulnar nerve transposition. Ulnar nerve transposition was associated with increased rates of complication \( (P = 0.02) \) and revision surgery \( (P = 0.01) \).

**Summary Points:**
- The short-term complication rates of cubital tunnel surgery are low (5.6%), but higher for ulnar nerve transposition (9.6%) than in situ cubital tunnel release (3.6%), \( P = 0.02 \).
- The revision surgery rate after cubital tunnel surgery was 4.7% overall, but higher for ulnar nerve transposition (7.8%) than in situ cubital tunnel release (1.8%), \( P = 0.01 \).
- The most common complications following in situ cubital tunnel release are ulnar nerve instability (1.3%), persistent or recurrent cubital tunnel syndrome (0.9%), and infection (0.9%).
- The most common complication following ulnar nerve transposition is persistent or recurrent cubital tunnel syndrome (7.8%).

**REFERENCES**


**PAPER 32**

Clinical Paper Session 6: Nerve 1
Friday, September 30, 2016 11:39–11:44 AM

**Treatment**

**Examining Reduced Regeneration Associated with Increasing Length in Nerve Autografts**

*N/A - Not a clinical study*

Gwendolyn M. Hoben, MD, PhD
Xueping Ee, MD, PhD
Daniel Hunter, RA
Amy Moore, MD
Susan E. Mackinnon, MD
Matthew Wood, PhD

Grant received from: Plastic Surgery Foundation (PSF)/American Society for Peripheral Nerve Pilot Research Grant

**COI:** There is no financial information to disclose.

**Hypothesis:** Nerve autograft has long been considered the gold standard. However, functional outcomes of nerve autografting are often merely adequate to poor, especially over longer defects. We hypothesize that increasing length in nerve autografts results in a worsening microenvironment for regeneration characterized by increased cellular senescence and reduced gene expression for regenerative factors. Moreover, this deleterious microenvironment of the long autograft affects motoneuron regeneration.

**Methods:** A rat sciatic nerve transection model was used to compare short (2cm) and long (6cm) isografts (equivalent to autograft in syngeneic animals). Grafts were analyzed after 4 or 8 weeks for quantity of senescent cells through staining for senescence-associated β-galactosidase (SAβgal), electron microscopy, gene expression changes, histology, and number of regenerated axons from motoneurons using retrograde labeling.

**Results:** Electron microscopy images showed Schwann cell changes consistent with senescence throughout both the short and long grafts. However, 56% of the long graft area remained stained for SAβgal, while on 26% of the short area had positive staining. Similarly, cell cycle markers associated with senescence were elevated in both short and long grafts at 4 weeks, and 2 of the markers remained elevated in the only the long grafts at 8 weeks. The nerve proximal to the graft was also found to be differentially affected by the length of the autograft. SAβgal staining was measured in the proximal nerve stump: 39% of the area adjacent to the long graft stained for senescent cells, while only 5% of the area adjacent to the short graft stained positively. Gene expression for IL-6 was significantly elevated in the long graft. Retrograde labeling demonstrated that significantly more motoneurons regenerated axons into the short graft: 116±129 versus 86±306 in the long graft.

**Summary Points:**
- Longer grafts have greater senescence accumulation and are associated with greater senescence in the nerve proximal to the graft.
- Fewer motoneurons regenerate axons into a longer graft.
- These data suggest retrograde signaling from the graft, dependent on graft characteristics, affects motoneuron regeneration.
- Understanding reduced regeneration in the accepted gold standard, autograft repair of nerve defects, will facilitate improving nerve autograft outcomes.

**PAPER 33**

Clinical Paper Session 6: Nerve 1
Friday, September 30, 2016 11:46–11:51 AM

**Treatment, Prognosis/Outcomes**

**Evaluation of Protective Sensation after Hemi-contralateral C7 Nerve Root Transfer to Median Nerve in Total Root Avulsion Brachial Plexus Injury**

*Level 4 Evidence*

Penpun Lertwattanachai, MD
Roongskak Limthongthang, MD
Torpon Vathana, MD
Panai Laohaprasitiporn, MD
Saichol Wongtrakul, MD
Panupan Songcharoen, MD

**COI:** There is no financial information to disclose.

**Hypothesis:** Hemi-contralateral C7 nerve root (hemi-CC7) transfer to median nerve has been done in total root avulsion brachial plexus injury to restore protective sensation of the hand and finger flexion. The hypothesis of this study is that hemi-CC7 transfer to median nerve can provide useful protective sensation of the hand in the brachial plexus injury patients.

**Methods:** Brachial plexus injury patients who underwent hemi-CC7 transfer to median nerve from 2000 to 2012 at a single institution were evaluated with multimodality of sensory evaluation, including simple light touch, the Semmes-Weinstein monofilament testing, 2-point discrimination and vibration perception threshold. The measurements performed at least 4 years after the operation.

**Results:** Fifty patients underwent hemi-CC7 transfer to median nerve using a vascularized ulnar nerve graft were evaluated. The mean age at the time of injury was 25 years. The average time from injury to surgery was 9 months (range, 2-25 mo). The average postoperative follow-up time was 89 months (range, 48 – 191 mo.).

Nine patients (18%) showed response with the simple light touch. Sixteen patients (32%) could sense the Semmes-Weinstein monofilament testing. Five patients recognized the 4.56 filament and 11 patients recognized the 6.65 filament. No patients developed 2-point discrimination sense less than 15mm. No patient responded to vibration testing with 256 Hz tuning.
for. Nine patients (18%) had S3 recovery, according to British Medical Research Council grading system.

**Summary Points:**
- According to monofilament testing and 2-point discrimination interpretation, no patient had the sensory recovery at the level of protective sensation.
- Previous studies reported recovery of the sensation more than 80% of the patients, however, most of them had difficulty to localize the stimulus.
- Our study used multimodality sensory testing to evaluate the quality of neural recovery.

**REFERENCES**


**PAPER 34**

Clinical Paper Session 6: Nerve 1
Friday, September 30, 2016 ● 11:53–11:58 AM
Treatment; Surgical Technique; Prognosis/Outcomes

**Can Processed Nerve Allografts be Used to Repair Nerve Injuries Greater than 4cm for the Return of Critical Function in the Upper Extremity?**

Level 3 Evidence

Bauback Safa, MD
Jozef Zoldos, MD
Timothy Niacaris, MD, PhD
Leon Nesti, MD, PhD
Jason Ko, MD
Gregory M. Buncke, MD

**COI:**
Consulting Fee: AxoGen, Inc. (Safa)
Speakers Bureau: AxoGen, Inc. (Safa, Buncke)
Contracted Research: Lead site for Axogen-sponsored RANGER study (Buncke)

**Hypothesis:** Recent animal studies suggest acellular nerve allografts may provide inadequate regeneration compared to autografts for gaps greater than 40mm in rodents. To examine whether this observation translates to clinical practice, we queried a national nerve registry on processed nerve allograft (PNA) with autograft controls for injuries between 40-70mm. Based on clinical evidence and historical controls, we hypothesized that PNA would perform similar to nerve autograft in long gap upper extremity nerve injuries in humans.

**Methods:** The RANGER registry is an IRB-approved, active database designed to collect injury, repair, safety and outcomes data for processed nerve allografts (Avance® Nerve Graft, AxoGen, Inc). Recently active control groups for autograft and conduit repair were added to RANGER. The registry database was queried for >40mm upper extremity nerve repairs with at least 9 months of quantitative follow-up data. Subject demographics and injury information were also evaluated for observable trends. Outcomes data were incorporated into the Medical Research Council Classification (MRCC) for sensory and motor function with meaningful recovery defined as S3/M3 or higher on the MRCC scale. Outcomes were compared to registry matched controls and historical data for nerve autograft.

**Results:** Twenty-seven subjects with 35 injuries were included. The groups consisted of PNA (n=23) and nerve autograft (n=12). Subject demographics, medical history, and concomitant injuries were comparable. PNA repairs were single stranded, caliber matched epineural repairs, while autografts were multi-strand cabled repairs. The PNA group contained a higher incidence of neuroma resections of digital nerves repaired in a delayed fashion. The average gap was 46±6mm and 48±8mm for PNA and nerve autograft respectively. Meaningful recovery was comparable between the groups at 74% for the PNA and 67% for nerve autograft. In mixed nerve repairs reporting motor function, outcomes were also comparable with 5 of 6 and 6 of 7 repairs reporting return of motor function in the PNA and autograft groups respectively. There were no reported adverse events related to the treatment groups. See Table 1 for summary.

**Summary Points:**
- Clinically reported levels of meaningful recovery for >40mm processed nerve allografts are comparable to nerve autografts with both sensory and motor function outcomes.
- No adverse events or revisions were reported.
- Outcomes compare favorably to historical literature for nerve autograft.
- The registry remains ongoing and continues to collect outcomes data on processed nerve allografts in long gap nerve reconstructions.

**Table 1: Summary of PNA and Autograft Repairs in Gaps ≥ 40mm**

<table>
<thead>
<tr>
<th>Subjects</th>
<th>PNA</th>
<th>Autograft</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Repairs</td>
<td>23</td>
<td>12</td>
</tr>
<tr>
<td>Average Age (years)</td>
<td>38 ± 13 mm</td>
<td>36 ± 15 mm</td>
</tr>
<tr>
<td>Nerve Repaired</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensory</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Mixed</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Mechanism of Injury</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laceration</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Amputation/Avidion</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Blast/Gunshot</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Crush</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Neuroma Resection</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Median Time to Repair (days)</td>
<td>220</td>
<td>7</td>
</tr>
<tr>
<td>Average Gap Length (mm)</td>
<td>46 ± 6mm</td>
<td>48 ± 8mm</td>
</tr>
<tr>
<td>Meaningful Recovery (%)</td>
<td>74%*</td>
<td>67%*</td>
</tr>
</tbody>
</table>

*Not significant differences detected between PNA and Autograft outcomes.

**REFERENCES**


**PAPER 35**

Clinical Paper Session 7: Hand/Wrist Trauma 1
Saturday, October 1, 2016 ● 8:45–8:50 AM
Surgical Technique; Prognosis/Outcomes

**Complications of Distal Radius Malunion Osteotomies**

Level 4 Evidence

Neil Gregory Harness, MD
Justin C. Haghverdian, BA

**COI:**
There is no financial information to disclose.

**Hypothesis:** Osteotomy of the distal radius for fracture malunion is a challenging procedure. The purpose of this study was to review the osteotomies
performed in a large patient population to determine the type and risk of complications.

Methods: A retrospective cohort study was performed, including all enrollees from our institution who were aged 18 years or older between January 1, 2007 and June 5, 2015 and underwent osteotomy for an extraarticular distal radius fracture malunion. Charts were reviewed for demographic data, comorbidities, osteotomy type (hinged versus distraction), implant, and bone graft type. Injury radiographs were classified using the AO classification system and measurements were made for preoperative and postoperative images. Complications including infection, nonunion, loss of reduction, implant failure, nerve injury, tendon injury and complex regional pain syndrome (CRPS) were recorded.

Results: There were 1222 distal radius operative procedures between 2007 and 2015, 16 of which were osteotomies for distal radius malunion. The mean age was 47.5 years (range, 20-70). There were 8 AO type A fractures and 8 type C fractures. The initial treatment was non-operative for all osteotomies. There were 8 distraction (intervening bone graft) and 8 hinge type (volar cortical contact maintained) osteotomies. The initial radial inclination improved from 14.3 to 23.14 degrees, palmer tilt from -18.8 degrees to +9.3 degrees and ulnar variance from +2.4mm to +1.6mm. Seven out of 16 patients had complications related to the procedure requiring 9 subsequent procedures. There were 2 nonunions with implant fracture. Of the 2 nonunions, both had failure of a volar plate implant. One had used tricortical iliac crest bone graft and the other nonstructural bone graft. One of the 2 nonunions was treated for presumed infection and subsequently had a second nonunion with plate failure after revision surgery with nonstructural graft. There was 1 partial extensor pollicis longus (EPL) laceration at the time of osteotomy and 1 EPL ruptured several months after surgery. The latter required a tendon transfer. One patient had persistent ulnocarpal impaction requiring revision radial osteotomy. Two patients had persistent wrist tenosynovitis after surgery. There were no neurovascular injuries or cases of CRPS. The type of osteotomy (distraction or hinged) did not correlate with the risk of complication.

Summary Points:
- Implant failure/fracture may occur with distraction type osteotomy unless structural bone graft is incorporated.
- EPL tendon injury is a risk when performing volar based osteotomy.

Results: There were 182 volar plates applied that made up the study group. There were 10 cases (5.5%) of anomalous PCBs entering the FCR sheath. In 4 cases the PCB pierced the radial FCR sheath proximally, crossed beneath the tendon, and traveled distally on the ulnar side. In 4 other cases, the PCB entered the FCR sheath proximally on the ulnar or central aspect of the sheath and remained within the sheath, staying along the ulnar or dorsal side of the tendon. In 1 case, the PCB pierced the ulnar distal aspect of the sheath and split into 2 branches. In 1 case, the PCB ran within the sheath along the radial aspect of the FCR.

Summary Points:
- Anomalies in the course of the PCB are more common than often considered.
- These variant branches are at risk during volar surgical approaches to the wrist that proceed through the FCR sheath.
- Surgeons must remain vigilant during this surgical approach.
- Although a dissection that proceeds along the radial side of the FCR sheath may protect the PCB in most cases, great care must be taken to identify anomalous branches (if present) and protect them during surgery.
PAPER 37

Clinical Paper Session 7: Hand/Wrist Trauma 1
Saturday, October 1, 2016 • 8:59—9:04 AM
Evaluation/Diagnosis; Prognosis/Outcomes

The Impact of Safety Regulations on the Incidence of Power Saw Injuries in the United States
Level 4 Evidence

Carl M. Harper, MD
Michael Vosbikian, MD
Matthew L. Iorio, MD

COI:
There is no financial information to disclose.

Hypothesis: To date, no study has demonstrated the effect of safety regulations on the incidence of power saw injuries. We hypothesize that, despite the evolution of power saw technology and improved safety guidelines, there has been no decrease in the frequency or morbidity of injuries associated with these devices.

Methods: The National Electronic Injury Surveillance System (NEISS) database was queried for all injuries associated with power saws from 1997-2014. The database provides both an incidence of injury seen at all participating institutions as well as an estimate of historical incidence within the United States. The subset of patients sustaining injuries to an upper extremity were selected for analysis. Demographic information including age, gender, date of injury, device involved, location, body part involved, emergency room diagnosis, and the patient’s disposition were recorded. Statistical analysis included LOESS (locally weighted scatterplot smoothing), which was used for analysis of the temporal trends of total number of injuries. Student t-tests were used to compare patient age between years.

Results: A gradual annual increase of 18.0% in the incidence of power saw injuries was seen from 1997 (772 incidence and 44,877 estimate) to 2004 (1,350 incidence and 75,037 estimate), at which point the incidence of table saw injury reached a peak (R = 0.72, P < 0.001, Fig 1). From 2006 to 2015, a gradual and consistent annual decrease of 5.8% was observed with the total number of injuries decreasing from 1,370 (71,160 estimate) to 1,042 (57,992 estimate). This decrease was found to be statistically significant (R = 0.25, P = 0.014). The decline in rate of injury correlates with several landmark publications outlining safe and effective use of power saws by the Consumer Product Safety Commission (CPSC), the first of which was published in 2003.

The average patient age increased slightly over the study time period from 48.8 --16.7 years in 1997 to 52.9 --16.3 years in 2014, with the proportion of subjects younger than 50 years decreasing from 52.8% to 41.9% (P for trend < 0.001).

Summary Points:
• Incidence of power saw injuries increased from 1997 to 2004.
• From 2006 to 2015, the incidence of power saw injuries decreased by 5% annually.
• Implementation of safer operating procedures and improvements in equipment, mandated by a landmark report from the CPSC in 2003, has been successful in precipitating a marked decrease in the overall incidence of power saw injuries to the upper extremity.

REFERENCES

PAPER 38

Clinical Paper Session 7: Hand/Wrist Trauma 1
Saturday, October 1, 2016 • 9:06—9:11 AM
Evaluation/Diagnosis

The Factors Correlated with the Extensor Carpi Ulnaris Tendon and Distal Radioulnar Joint Disorder in Patients with Chronic Triangular Fibrocartilage Tears
Level 3 Evidence

Shigeru Santo, MD
Shohei Omokawa, MD, PhD
Takamasa Shimizu, MD
Aki Iida, MD
Yujiro Tanaka, MD, PhD

COI:
There is no financial information to disclose.

Hypothesis: The purpose of this study was to analyze the predictor of extensor carpi ulnaris (ECU) tendon and distal radioulnar joint (DRUJ) disorders in patients with chronic triangular fibrocartilage (TFCC) tears. We hypothesized that magnitude of ulnar variance, age and duration of symptoms would be correlated with these disorders.

Methods: Since 2006 to 2013, a total of consecutive 596 wrists that underwent wrist MRI were collected. We excluded rheumatoid arthritis, acute injury and patients under the age of 15. As the TFCC tears group, consecutive 70 cases that were diagnosed of chronic TFCC tears were selected. We classified the TFCC tears group as 40 cases of foveal tear and 30 cases of disc tear. As a control group, we selected 70 cases that were age and gender matched with TFCC tears group without any ulnar-sided wrist pain. We measured ulnar variance and investigated ECU tendon and DRUJ disorders on MRI. Regarding ECU tendon disorder, we focused on ECU tenosynovitis and longitudinal

• Age at time of injury is increasing, the etiology of which is likely multifactorial.
rupture of the ECU tendon (Figure 1). We compared the incidence of
the ECU tendon and DRUJ disorders between the TFCC tears group
and the control group. In the TFCC tears group, we investigated the
correlation between the variables including age, gender, duration of
symptoms, ulnar variance, foveal tear or disc tear and the ECU tendon
and DRUJ disorders.

Results: In the TFCC tears group, there were 29 wrists (41%) with the
DRUJ arthritis, 30 wrists (43%) with the ECU tenosynovitis, and 22
wrists (31%) with the longitudinal rupture of the ECU tendon. Mean-
while, in the control group, we found 9 wrists (13%) with the DRUJ
arthritis, 5 wrists (7%) with the ECU tenosynovitis, and 14 wrists (20%)
with the longitudinal rupture of ECU tendon. There were significant
differences regarding the incidence of these associated pathologies be-
tween the 2 groups (DRUJ arthritis: $P = 0.001$, ECU tenosynovitis: $P =
0.000$, longitudinal rupture of the ECU tendon: $P = 0.001$) (Table 1).
Ulnar variance and disc tear were significantly correlated with the DRUJ
arthritis ($P = 0.04$ and 0.02, respectively). There was no significant
correlation between the ECU tendon disorders and variables including
gender, age, duration of symptoms, ulnar variance, foveal tear or disc
tear.

Summary Points:

1. We found a higher frequency of accompanying ECU tendon and/or DRUJ
   disorders in patients with chronic TFCC tears as compared to the control
group.
2. UV and disc tear were significant predisposing factors for the DRUJ
   arthritis.

Figure 1:
White arrow head indicating DRUJ arthritis. White arrow indicating ECU tenosynovitis
at the ECU groove of the ulnar head. Asterisk indicating longitudinal rupture of the ECU
tendon.

Table 1

<table>
<thead>
<tr>
<th>TFCC tears (n=70)</th>
<th>DRUJ arthritis</th>
<th>ECU tenosynovitis</th>
<th>Longitudinal rupture of the ECU tendon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>41% (n=29)</td>
<td>44% (n=31)</td>
<td>51% (n=46)</td>
</tr>
</tbody>
</table>

Control (n=70): 13% (9/9) 7% (n=5) 20% (n=14)

P value: 0.001 * 0.000 * 0.001 *

Chi-squared test: * $P < 0.05$ Statistically significant.

REFERENCES

1. Sachar K. Ulnar-sided wrist pain: evaluation and treatment of triangular fibro-
cartilage complex tears, unocarpal impaction syndrome, and lunotriquetral
2. Tang JB, Ryu J, Kish V. The triangular fibrocartilage complex: an important
3. Palmer AK, Werner FW. The triangular fibrocartilage complex of the wrist—
4. Allende C, Le Viet D. Extensor carpi ulnaris problems at the wrist—classification,
This research was supported by a 2014 Fast Track grant from the American Foundation for Surgery of the Hand.

PAPER 40
Clinical Paper Session 7: Hand/Wrist Trauma 1
Saturday, October 1, 2016 • 9:20—9:25 AM
Treatment; Prognosis/Outcomes

Do Patients with Inferior Subjective Results 12 Months after a Distal Radius Fracture Improve over Time? A Prospective Register Study
Level 4 Evidence

Magnus Tägil, MD, PhD
Philippe Kopylov, MD, PhD
Antonio Abramo, MD, PhD
Marcus Landgren, MD

COI:
There is no financial information to disclose.

Hypothesis: The majority of patients with a distal radius fracture recover during the first half year, but approximately 10-15% still have substantial problems after 1 year when evaluated using patient-reported outcome scores. In the present study, we used the data from a prospective register to evaluate the longer-term subjective outcome in patients who had a suboptimal subjective outcome at the 12-months follow-up. We hypothesized that the subjective outcome would improve over time.

Methods: At our hospital, approximately 500 adult patients (18 years and older) are treated for a distal radius fracture each year. Since 2001, these patients are prospectively and consecutively registered and a subjective outcome questionnaire (Disability of the Arm, Shoulder and Hand—DASH) is sent to the patients after 3 and 12 months. In the present study, we identified patients in the register with a suboptimal DASH score, which we arbitrarily defined as >35. Four-hundred sixty-three out of 2666 patients in the register with a fracture between 2003-2012 exceeded DASH 35 at 12 months and, in fall 2014, 2 to 9 years after the fracture, a DASH-enquiry was sent to the surviving 351 patients.

Results: Two-hundred seventy-nine patients returned the new DASH enquiry. Forty-six percent had improved over time, reporting a DASH score below the cut-off, but 56% remained at a high suboptimal level of >35. No time-dependent improvement could be detected, regardless if the minimum 2 or the maximum 9 years had passed since the fracture. Patients with a persisting high DASH score were older at the time of fracture (66, 5 years versus 63, 6, P = 0.04). Men seemed to improve more than women, from median 52 at 12 months after fracture to 25, compared to women who improved from median 50 to 39 (P = 0.02). The men, however, had a substantially lower mean age at time of fracture (53, 7), compared to the women (67, 4, P < 0.01).

Summary Points:
- An inferior result after 1 year will remain over time for many patients.
- About half the patients improve and end up below the arbitrarily set threshold.
- About half the patients continue to report a suboptimal subjective outcome.
- No trend was found indicating that these patients get better with time.
- Given the high incidence of a distal radius fracture, also a small proportion of suboptimal results do matter, and every effort should be made to improve the early results.

REFERENCE

PAPER 41
Clinical Paper Session 8: General Principles
Saturday, October 1, 2016 • 8:45—8:50 AM
Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Dialysis-Dependent Patients Experience Increased Mortality and Risk of Complications following Hand Surgery
Level 2 Evidence

Joshua William Hustedt, MD, MHS
Daniel D. Bohl, MPH
Andrew S. Chung, DO
Neil Olmscheid, BS
Scott Edwards, MD

COI:
There is no financial information to disclose.
Hypothesis: Dialysis-dependent patients have been shown to experience increased surgical risk in orthopedic surgery. However, little evidence exists regarding risk for dialysis-dependent patients following hand surgery. We hypothesized that dialysis-dependent patients experience greater postoperative morbidity than non-dialysis dependent patients when undergoing elective surgery of the hand.

Methods: A retrospective cohort study of patients undergoing elective hand surgeries was conducted using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database from 2005-2013. Two-hundred forty-nine dialysis-dependent patients were compared to 28,557 non-dialysis-dependent patients. Dialysis dependence was tested for association with 30-day postoperative mortality, major complications, and minor complications.

Results: Dialysis-dependent patients experienced significantly increased risk of mortality (7.32% versus 0.199%; \( P < 0.001 \)), major complications (10.16% versus 0.339%, \( P < 0.001 \)), and minor complications (17.67% versus 1.77%, \( P < 0.001 \)) as compared to non-dialysis-dependent patients. In a multivariate analysis controlling for patient and procedural factors, dialysis-dependence was associated with a two-fold increase in risk of mortality (odds ratio [OR] 1.97, 95% confidence interval [CI] 1.18-3.29, \( P = 0.01 \)), major complications (OR 2.47, 95% CI 1.56-3.93, \( P < 0.001 \)), and minor complications (OR 2.20, 95% CI 1.50-3.23, \( P < 0.001 \)).

Summary Points:
- Hand surgery in dialysis-dependent patients presents higher postoperative risk, with 30-day mortality rates 30 times greater and complication rates 10 to 30 times greater than non-dialysis-dependent patients.
- Hand surgery in dialysis-dependent patients should be approached with caution, and preferably deferred until after renal transplantation when possible.

PAPER 43
Clinical Paper Session 8: General Principles
Saturday, October 1, 2016 • 8:52—8:57 AM
Evaluation/Diagnosis; Treatment; Surgical

Thumb Basal Joint Arthroplasty: Prospective Comparison of Perioperative Analgesia and Opioid Consumption
Level 2 Evidence
Andrew J. Miller, MD
Nayoung Kim, BS
Asif Ilyas, MD, FACS

COI: There is no financial information to disclose.

Hypothesis: Trapeziectomy alone or in combination with a suspensionplasty technique is a common surgical treatment for symptomatic basal joint arthritis, but is considered one of the more painful procedures of the hand. Various modalities for perioperative pain control are employed in the endeavor to manage postoperative pain, including peripheral nerve blocks and the infiltration of local anesthetics into the surgical site. We undertook a prospective comparative study with the hypothesis that peripheral nerve blocks would provide better pain control than local anesthesia with Marcaine or Exparel with respect to pain scores and opioid pill consumption.

Methods: All consecutive patients undergoing thumb basilar joint arthroplasty were prospectively enrolled and allocated to one of three perioperative analgesia groups: (1) peripheral nerve block, (2) local anesthesia with Marcaine and (3) local anesthesia with Exparel. Total opioid pill consumption and visual analog scale (VAS) pain scores were reported and collected for the first 5 postoperative days (POD).

Results: Seventy-eight patients were enrolled in the study with 27, 23, and 28 patients assigned to the peripheral nerve block (Group 1), Marcaine (Group 2) and Exparel (Group 3) groups, respectively. All groups experienced an increase in both opioid pill consumption and VAS scores from POD 0 to POD 1 (\( P < 0.05 \)). Postoperative VAS was lowest in Group 3 from POD 0 to 2, although not statistically significant. During the same period, except for POD 0, average VAS scores were highest in Group 1 (Peripheral block). However, after POD 2, VAS scores normalized between all Groups and decreased uniformly thereafter. Total opioid consumption was lowest in Group 3 (11 pills) compared to Group 1 (17 pills) and Group 2 (19 pills), \( P = 0.06 \).

Summary Points:
- There was a trend in all groups towards increase postoperative pain and opioid consumption between POD 0 and 1. After POD 2, pain decreased uniformly in all groups.
- Total opioid consumption was found to be least in Group 3 (Exparel). Similarly, there was a trend towards better postoperative VAS in the Exparel group, but the trend was not statistically significant and did not continue beyond POD 2.
- Peripheral nerve blocks were not found to be superior in terms of postoperative pain beyond POD 0. Moreover, peripheral nerve blocks and Marcaine alone had higher pain scores and opioid consumption after POD 0.
- The effectiveness of each modality, as well as their potential risks and costs, should be considered when determining the optimal strategy.

PAPER 44
Clinical Paper Session 8: General Principles
Saturday, October 1, 2016 • 8:59—9:04 AM
Evaluation/Diagnosis; Therapy/Rehabilitation

Photography-Based Method for Measuring Wrist Range of Motion
N/A - Not a clinical study
Samir K. Trehan, MD
Schneider Rancy, BS
Parker Johnsen, BS
Steve K. Lee, MD
Scott W. Wolfe, MD

COI: There is no financial information to disclose.

Hypothesis: We hypothesized that at-home photography-based wrist range of motion (WROM) measurements would be as reliable as traditional physician-performed goniometry.

Methods: Sixty-nine post-operative patients who had wrist surgery greater than 3 months prior were enrolled in this study according to an approved IRB protocol. Active and passive wrist flexion/extension and radial/ulnar deviation were recorded by 1 of 2 attending surgeons with a one-degree resolution goniometer at the last post-operative office visit. Patients were then provided an illustrated instruction sheet detailing how to take digital photographs at home in 6 wrist positions (active and passive flexion/extension and radial/ulnar deviation). Photographs were reviewed by both attending surgeons in a randomized, blinded fashion on 2 separate occasions greater than 2 weeks apart using the same goniometer. Reliability analysis was performed using the intraclass correlation coefficient (ICC) to assess agreement between clinical and photography-based goniometry, as well as intra- and inter-observer agreement.

Results: Out of 69 enrolled patients, 30 patients sent digital images (43% response rate). Of the 180 digital photographs taken by patients at home, only 9 (5%) were missing or deemed inadequate for WROM measurements. Agreement between clinical and photography-based measurements was “almost perfect” for passive wrist flexion/extension (ICC > 0.80, \( P < 0.01 \)) (Figure 2).

Summary Points:
- This study validates a photography-based goniometry protocol allowing accurate and reliable WROM measurements without direct physician contact. Passive WROM was more accurately measured from photographs than active WROM.
- This study builds on previous photography-based goniometry literature by validating a protocol in which patients take their own photographs.
- Patient-performed photography-based goniometry represents an alternative to traditional clinical goniometry with the potential to enable longer-term patient follow-up, overcome travel or distance impediments to office visits, improve patient convenience, and increase cost savings.
PAPER 44

Clinical Paper Session 8: General Principles
Saturday, October 1, 2016 ● 9:06—9:11 AM

Breast Radiation Exposure in Orthopaedic Surgeons

N/A - Not a clinical study

Lindsey C. Sheffler, MD, MAS

Grant received from: OREF, UCSF, CTSI

COI:
There is no financial information to disclose.

Hypothesis: Breast cancer prevalence is higher in female orthopaedic surgeons compared to the United States population. The most common site of all breast cancers, the upper outer quadrant of the breast, may not be adequately shielded from intra-operative radiation. Factors associated with higher breast radiation exposure (apron size, type, surgeon position and C-arm position) have yet to be established.

Methods: A female torso phantom was placed adjacent to a standard operating table, simulating the female surgeon. Dosimeters were placed on the breasts and extra-large), 2 apron types (cross-back and vest), 2 surgeon positions (arm position) have yet to be established.

Results: Median radiation dose equivalent rate was 0.98 mREM/h as compared to the AP projection (0.13 mREM/h) (P < 0.001).

Summary Points:
- Standard lead aprons and vests may not adequately protect the upper outer quadrant of the breast.
- Factors that may reduce radiation exposure include lead protection of appropriate size and distancing the axilla from the patient and the C-arm x-ray tube.
- New apron designs may be warranted to better protect the orthopaedic surgeon from intra-operative radiation exposure to breast tissue.

REFERENCES

PAPER 45

Clinical Paper Session 8: General Principles
Saturday, October 1, 2016 ● 9:13—9:18 AM

Treatment; Prognosis/Outcomes; Billing/Coding

Incidence of Serious Complications in Hand Surgery: A 10-Year Review

Level 4 Evidence

Avi D. Goodman, MD
Joseph A. Gil, MD
Adam M. Starr, MD
Edward Akeelman, MD
Arnold-Peter C. Weiss, MD

COI:
There is no financial information to disclose.

Hypothesis: While the rate of serious complications following hand surgery is thought to be low, the unplanned readmission and/or reoperation rate for the most common procedures is not described. Therefore, we aimed to calculate the incidence and identify the risk factors associated with these complications at a high volume academic practice.

Methods: Our Orthopaedic Surgery Quality Assurance (QA) database was retrospectively examined for all serious complications (unplanned readmission and/or reoperation within 30 days) for 2 senior attending surgeons on the Hand Surgery service over a 10-year period, from February 2006 — January 2016. Each was classified as a patient problem, judgment problem, technical problem, multiple factor, infection (not clean case), or infection (clean case). The Hand Surgery billing database, available for 2 of the 5 attending surgeons, was also examined for the number of procedures performed over the same time period.

Results: Our cohort consisted of 18,081 surgeries, in which 27 serious complications of unplanned readmission and/or reoperation within 30 days occurred. Of these, 6 (22.2%) were patient problems, 1 (3.7%) was a judgment problem, 1 (3.7%) was a technical problem, 8 (29.6%) involved multiple factors, 1 (3.7%) was infection (not clean case), and 10 (37.0%) were infections (clean case) [Figure 1]. The incidence of infection from both clean and not-clean cases, requiring reoperation and/or readmission, was 0.06%. Furthermore, 5 patients (18.5%) required reoperation, 17 (63.0%) required outpatient readmission, 1 (3.7%) was a technical problem, 8 (29.6%) involved multiple factors, 1 (3.7%) was infection (not clean case), and 10 (37.0%) were infections (clean case) [Figure 2]. Our cohort consisted of 18,081 surgeries, in which 27 serious complications of unplanned readmission and/or reoperation within 30 days occurred. Of these, 6 (22.2%) were patient problems, 1 (3.7%) was a judgment problem, 1 (3.7%) was a technical problem, 8 (29.6%) involved multiple factors, 1 (3.7%) was infection (not clean case), and 10 (37.0%) were infections (clean case) [Figure 1]. The incidence of infection from both clean and not-clean cases, requiring reoperation and/or readmission, was 0.06%. Furthermore, 5 patients (18.5%) required reoperation, 17 (63.0%) required outpatient readmission, 1 (3.7%) was a technical problem, 8 (29.6%) involved multiple factors, 1 (3.7%) was infection (not clean case), and 10 (37.0%) were infections (clean case) [Figure 2]. Of these, 10 (37.0%) were clean case infections, with an incidence of infection of 0.06%.

Summary Points:
- Complications after hand surgery requiring unplanned readmission and/or reoperation are infrequent.
- The incidence of serious complications for elective hand surgery varies based on the type of procedure performed.
- Infections are responsible for almost half of unplanned readmissions and/or reoperations.
- Serious complications are most likely to occur within 3 weeks after surgery.
REFERENCES


PAPER 46

Clinical Paper Session 8: General Principles Saturday, October 1, 2016 • 9:20–9:25 AM
Treatment; Billing/Coding
Regional Variation of Medicare Payments for Hand Surgery Procedures in the United States
Level 3 Evidence

David Veltre, MD
Antonio Cusano, BS
Robert L. Parisien, MD
Andrew Stein, MD
Scott F. M. Duncan, MD, MBA
Xinning Li, MD

COI:
There is no financial information to disclose.

Hypothesis:
Medicare reimbursement payments for inpatient orthopedic surgeries, such as total joint arthroplasty and spinal fusion, have been shown to exhibit geographic variation. We seek to evaluate whether similar geographic variations exist in Medicare reimbursement payments for outpatient hand surgeries.

Methods:
We analyzed 2012 and 2013 Medicare Provider Utilization and Payment Data provided by the Centers for Medicare & Medicaid Services (CMS) to evaluate average allowed charges and reimbursement payments for the four most common hand surgeries performed across the country.

Results:
Open carpal tunnel surgery was the most commonly performed outpatient Medicare hand procedure (n = 21,944), followed by trigger finger release (n = 15,345), endoscopic carpal tunnel surgery (n = 7,106), and basal joint arthroplasty/LRTI (n = 2,408). In terms of dollars per procedure, institutions received the highest Medicare reimbursement payments for basal joint arthroplasty ($613), followed by endoscopic carpal tunnel surgery ($363), open carpal tunnel ($295), and trigger finger release ($195). Open carpal tunnel surgery, trigger finger release, and endoscopic carpal tunnel surgery showed statistically significant variation across geographic regions for both allowed charges and reimbursement. Institutions in the West and Northeast on average had the highest charges and received the highest payments for the surgeries, while hospitals in the South and Midwest generally charged the least and received the lowest payments. The percent reimbursement throughout the regions and surgeries remained similar with rates between 77.79%.

Summary Points:
- Similar to Medicare payment trends in total joint arthroplasty and spinal fusion, hand surgery payments exhibit statistically significant variation across geographic regions.
- Despite the regional differences in the charges and payments, the percent reimbursement has remained similar. However, in 3 of the 4 surgeries investigated (open carpal tunnel surgery, trigger finger release and basal joint arthroplasty), the division with the highest charge was also the one with the lowest reimbursement percentage.
- Further research must be done to determine why these regional variations exist and whether cost of living is the primary explanation for these disparities.

Table 1: Average Charges and Medicare Payments for Outpatient Hand Surgeries

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Average Charge</th>
<th>Average Payment</th>
<th>Percent Reimbursement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Carpal Tunnel Surgery</td>
<td>$364.42</td>
<td>$294.42</td>
<td>79.9%</td>
</tr>
<tr>
<td>Trigger Finger Release</td>
<td>$194.42</td>
<td>$14.42</td>
<td>79.9%</td>
</tr>
<tr>
<td>Endoscopic Carpal Tunnel Surgery</td>
<td>$364.42</td>
<td>$294.42</td>
<td>79.9%</td>
</tr>
<tr>
<td>Basal Joint Arthroplasty/LRTI</td>
<td>$613.12</td>
<td>$493.12</td>
<td>79.9%</td>
</tr>
</tbody>
</table>

Table 2: Percent Reimbursement for Outpatient Hand Surgeries

<table>
<thead>
<tr>
<th>Division</th>
<th>Average Charge</th>
<th>Average Payment</th>
<th>Percent Reimbursement</th>
</tr>
</thead>
<tbody>
<tr>
<td>New England</td>
<td>$78.9%</td>
<td>$78.9%</td>
<td>$78.9%</td>
</tr>
<tr>
<td>Middle Atlantic</td>
<td>$78.9%</td>
<td>$78.9%</td>
<td>$78.9%</td>
</tr>
<tr>
<td>East North Central</td>
<td>$78.9%</td>
<td>$78.9%</td>
<td>$78.9%</td>
</tr>
<tr>
<td>West North Central</td>
<td>$78.9%</td>
<td>$78.9%</td>
<td>$78.9%</td>
</tr>
<tr>
<td>South Atlantic</td>
<td>$78.9%</td>
<td>$78.9%</td>
<td>$78.9%</td>
</tr>
<tr>
<td>East South Central</td>
<td>$78.9%</td>
<td>$78.9%</td>
<td>$78.9%</td>
</tr>
<tr>
<td>West South Central</td>
<td>$78.9%</td>
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</tr>
<tr>
<td>Pacific</td>
<td>$78.9%</td>
<td>$78.9%</td>
<td>$78.9%</td>
</tr>
<tr>
<td>Mountain</td>
<td>$78.9%</td>
<td>$78.9%</td>
<td>$78.9%</td>
</tr>
</tbody>
</table>

REFERENCES


**PAPER 47**

Clinical Paper Session 9: Hand/Wrist Trauma 2  
Saturday, October 1, 2016 • 10:12–10:17 AM  
*Joseph H. Boyes Award Winner*

This paper will be chosen at the 34th Adrian E. Flatt Residents and Fellows Conference on Wednesday, September 28, 2016.

**PAPER 48**

Clinical Paper Session 9: Hand/Wrist Trauma 2  
Saturday, October 1, 2016 • 10:19–10:24 AM  
*Treatment; Basic Science*

*Ex vivo Tendon Repair Augmented with Bone Marrow Derived Mesenchymal Stem Cells Stimulated with Myostatin for Tenogenesis*  
N/A - Not a clinical study

Andre E. Cheah, MD, MBA  
Wei Le, MD  
Jeffrey Yao, MD

**COI:**  
Consulting Fee: Arthrex (Yao)

**Hypothesis:** We performed an *ex vivo* study to investigate the effect of bone marrow derived mesenchymal stem cells (BMSC) stimulated with myostatin on tenogenesis in the setting of tendon repair. We hypothesized that BMSC that were delivered to a tendon repair site after being seeded onto sutures would improve tenogenesis if they were stimulated with myostatin.

**Methods:** Cadaveric upper limb flexor tendons were harvested, decellularized, and divided into 1 cm segments. Sutures seeded with BMSC were passed through 2 tendon segments to simulate repair. The repaired tendons were then cultured either with or without myostatin for 3, 5, and 7 days. The experiment was also repeated with non-decellularized tendons to make a total of 4 groups. The presence of tenomodulin and scleraxis using immunofluorescence analysis was measured at 3, 5, and 7 days for all 4 groups.

**Results:** Viable BMSC were found at all 3 time points in all 4 groups. Myostatin stimulation lead expression of tenomodulin and scleraxis at 5 and 7 days in both the decellularized and non-decellularized tendons. In the tendons that were not treated with myostatin, tenomodulin and scleraxis were detected only at day 7 for the decellularized tendons and at days 5 and 7 for the non-decellularized tendons. There were also more cells expressing tenomodulin and scleraxis for the groups treated with myostatin at days 5 and 7. For all 4 groups, no tenomodulin or scleraxis was detected at 3 days.

**Summary Points:**  
- BMSC delivered to tendon repair sites with sutures can survive for at least 7 days.  
- There is at least a 3 day delay before the markers of tenogenesis are detectable after BMSC delivery to the tendon repair site.  
- Myostatin results in an earlier, more robust and sustained expression of tenomodulin and scleraxis in this tendon repair model, implying that it facilitated earlier and increased differentiation of BMSC into tenocytes and/or upregulation of tenomodulin and scleraxis production by the tenocytes present.  
- Treatment of BMSC with myostatin following their delivery using coated sutures to a tendon repair site may result in improved tenogenesis, implying earlier and better healing of the injured tendon.

**REFERENCES**


**PAPER 49**

Clinical Paper Session 9: Hand/Wrist Trauma 2  
Saturday, October 1, 2016 • 10:26–10:31 AM  
*Evaluation/Diagnosis; Treatment; Therapy/Rehabilitation; Prognosis/Outcomes*

*Early Detection of Healing of Scaphoid Fracture Nonunions Using Computed Tomography*  
Level 4 Evidence

Jeff M. Coppage, MD  
Krystle A. Hearns, MA  
Michelle Gerwin Carlson, MD

**COI:**  
There is no financial information to disclose.

**Hypothesis:** We hypothesized that evidence indicative of healing of scaphoid fracture nonunions would be present on computed tomography (CT) scans at 6 weeks and allow for early decision regarding further management.

**Methods:** We retrospectively reviewed 25 consecutive scaphoid fracture nonunions treated with single screw fixation by a single surgeon over a 10-year period from 2005–2015. All patients had postoperative CT scans between 22–54 days after surgery to evaluate for extent of osseous bridging. Measurement of mean percent bridging was performed for all coronal and long-axis sagittal slices as described by Singh et al. The number of CT slices with 2 or more millimeters of bridging was also measured. A combination of radiographs and clinical examination were used to assess final union.

**Results:** The mean interval between surgery and the initial postoperative CT scan was 43 days (range, 22–54 days). The mean osseous bridging was 44% (13–100%). The mean number of slices with 2 or more millimeters of osseous bridging was 55% (range, 14–100%) on coronal slices and 73% (range, 27–100%) on sagittal slices. The minimum bridging was 13%. Percent bridging was strongly correlated with the percentage of slices with 2 or more millimeters of osseous bridging in the coronal (r = 0.90) and sagittal (r = 0.73) planes.
Fractures with a minimum of 14% of coronal cuts with 2 or more millimeters of osseous bridging and 27% of sagittal cuts with 2 or more millimeters of osseous bridging went on to heal. In 2 cases, 6-week postoperative CT scan demonstrated absence of any osseous bridging and given complete lack of union (0% bridging) the senior author elected for revision ORIF and nonvascularized bone-grafting at 6 and 14 weeks postoperatively. Both fractures went on to union.

**Summary Points:**
- Scaphoid nonunions demonstrate findings indicative of progression to union on CT at a mean of 6 weeks and as early as 3 weeks postoperatively.
- All nonunions with osseous bridging, even as little as 13%, went on to union. This is analogous to the literature regarding tibia fracture healing, which demonstrates that any cortical bridging progresses to union.
- Thirteen percent bridging correlated with as few as one-seventh and one-fourth of slices on CT having 2 or more millimeters of bridging, in coronal and sagittal planes respectively.
- Early determination of progression to union may allow for accelerated rehabilitation or identification of nonunions at risk of not healing and which may benefit from early intervention.

**REFERENCES**

**REFERENCES**

**REFERENCES**
PAPER 51

Clinical Paper Session 9: Hand/Wrist Trauma 2
Saturday, October 1, 2016 • 10:40–10:45 AM

Treatment

A Randomized Phase 2A, Double-blind, Placebo-controlled, Dose-ranging Study to Evaluate the Safety and Effectiveness of Collagenase Clostridium Histolyticum in the Treatment of Dupuytren Disease Nodules

Level 1 Evidence

Bronier Costas, MD ▲
Stephen Coleman, FRACS ▲
Gregory Kaufman, MD ▲
Robert James, PharmD ▲
Brian Cohen, PhD ▲
R. Glenn Gaston, MD ▲

COI:
Salary: Auxilium Pharmaceuticals Inc. (Kaufmann, James, Cohen), Ferring Pharmaceuticals (Kaufmann), US WorldMeds (James), Endo Pharmaceuticals Inc. (Cohen)
Consulting Fee: Endo, BME, Biomet, Smith and Nephew (Gaston)
▲ This presentation will discuss Collagenase clostridium histolyticum.

Hypothesis: The objectives of this dose-ranging study were to assess the safety and effectiveness of CCH in treating palmar Dupuytren disease nodules. Nodules can cause significant pain and interference with patients’ activities of daily living (ADLs) involving gripping. Presently, there are no approved medical treatments for Dupuytren disease nodules.

Methods: Subjects (n = 76) with Dupuytren disease and at least 1 palpable palmar nodule were randomized to receive a single injection of either CCH (0.60mg, 0.40mg, or 0.25mg) or placebo on Day 1. Nodules were massaged twice daily from Days 8 - 29. Nodule (size, consistency, hardness, pain, ultrasound measurements, and patient satisfaction) and safety assessments were conducted at specific time points throughout the study. Safety was monitored continuously.

Results: Surface area and volume of nodules assessed by calipers were significantly reduced (P = 0.0001) in CCH 0.6mg and 0.4mg groups compared to placebo group at Day 57. Significant improvements from baseline at endpoint were observed in consistency (0.6mg, P < 0.0001; 0.4mg, P = 0.0002; and 0.25mg, P = 0.0139) and hardness in CCH groups (0.6mg, P = 0.0075; 0.4mg, P < 0.0001; and 0.25mg, P = 0.0031) compared with the placebo group.

83.3% (15/18) and 88.9% (16/18) of subjects in CCH 0.60-mg group and CCH 0.40-mg group, respectively, were very satisfied or quite satisfied with treatment. Significantly higher percentage of composite responders (subject with an improved investigator assessment and a satisfied subject assessment) at Day 57 was observed in CCH 0.6mg group (77.8%; P = 0.0349) and 0.4mg group (88.9%; P = 0.0033) compared to placebo group (37.5%). Ultrasound findings were not statistically different between the CCH groups and placebo.

Common adverse events in CCH subjects (= 25.0%) were local swelling, injection bruising, axillary pain, contusion, pain in extremity; most were mild/moderate and resolved in 14 days (median).

Summary Points:
- CCH-treatment groups (0.60mg and 0.40mg) showed significant reduction in surface area and volume and softening of the treated nodule.
- Subjective measures of investigator assessment of improvement and subject satisfaction with treatment were statistically significant.
- Safety profile of single injection of CCH into a Dupuytren nodule was similar to that observed after single injection of CCH in treatment of adults with Dupuytren contracture with a palpable cord.
dorsal displacement between 0- and 4-mm radial translations ($P < 0.05$, Figure 2). The greatest dorsal radius instability of DRUJ occurred with TFCC and DIOM sectioning.

Summary Points:

- Some studies have revealed that DIOM constrains the dorsal displacement of the distal radius.
- Based on our current study, we found that distal ulna malunion alone did not affect DRUJ stability and that TFCC disruption without malunion would mainly cause palmar radius instability.
- Moreover, bi-directional (dorsal and palmar) DRUJ instability was caused by DIOM dysfunction because of translation of the ulna after TFCC sectioning.

REFERENCES


PAPER 53

Clinical Paper Session 10: Congenital and Pediatrics
Saturday, October 1, 2016 • 10:12–10:17 AM
Treatment; Surgical Technique

Distal Humerus External Rotation Osteotomy for Hand Position in Arthrogryposis
Level 4 Evidence

Lindley Wall, MD
Valeri D. Calhoun, MS, OTR/L, CHT
Summer C. Roberts, MA
Charles A. Goldfarb, MD

COI:
- Consulting Fee: Arthrex $< 2,000 (Goldfarb)
- Speakers Bureau: Arthrex $< 5,000 (Goldfarb)

▲ This presentation will discuss Anika and Hyalomatrix.

Hypothesis: In the amyoplasia type of arthrogryposis, shoulder internal rotation in addition to limited muscle development and joint contracture may cause a reverse pronated grasp pattern. We hypothesized that repositioning the hands through distal humerus, external rotation osteotomies (DHO) to allow for palm-to-palm grasp without cross-over would improve function and parent/patient satisfaction.

Methods: The medical records of all patients treated surgically for arthrogryposis were reviewed at the Shriners Hospital in St. Louis, MO. Nine patients, 15 extremities, had undergone DHO to improve hand position. All patients had pre-operative and post-operative video recording of function. Pre-operative upper extremity position was graded as follows: 1 = facing away from midline, 2 = palm facing posterior, and 3 = palms facing midline.

Results: Mean patient age at the time of surgery was 6.5 years-old. There were 6 patients who underwent bilateral DHO. There were a total of 3.5 additional upper extremity procedures in this population (range 0–6). All patients had improved resting posture of the upper extremity after surgery, mean change 51 degrees (range, 15–90 degrees). Thirteen extremities had a change in hand position affecting their grasp pattern, 2 did not. There was a mean grade improvement of hand position of 1 level after surgery (range 0–3). There was a wide range in post-operative PODCI scores for Upper Extremity Function and Global function, but Happiness scores were high: mean 89 (range 60–100). Parents universally stated the procedure improved the child’s function “a great deal.” There was one complication of periprosthetic humerus fracture.

Summary Points:

- DHO is an effective procedure for correcting the internal rotation position of the upper extremity in arthrogryposis.
- DHO improves hand opposition in arthrogryposis by a mean of 1 grade.
- Universally, there was perceived improved function resulting from DHO.
- There is a high post-operative PODCI Happiness score in this population.
- There are minimal complications with DHO.

REFERENCES


PAPER 54

Clinical Paper Session 10: Congenital and Pediatrics
Saturday, October 1, 2016 • 10:19–10:24 AM
Treatment; Surgical Technique; Prognosis/Outcomes

Toe-to-thumb Transfer after Thumb Amputation in Children
Level 4 Evidence

James Clune, MD
Antony Hazel, MD
Neil F. Jones, MD

COI:
- There is no financial information to disclose.

Hypothesis: Traumatic amputations of the thumb are fortunately rare in children compared with adults, but hand surgeons remain reticent to
consider microsurgical reconstruction. We aim to demonstrate that toe-to-hand transfer is safe and reproducible in large numbers in children after traumatic thumb amputation.

Methods: Nineteen thumb amputations in 17 children (13 boys and 4 girls) between the ages of 2 and 16 years were referred for secondary reconstruction. Nine were isolated thumb amputations (R1 classification) and 10 were combined thumb and multiple finger amputations (R2 - R5 classification). Two children had bilateral thumb amputations due to burns. Of the unilateral thumb amputations, 8 were left thumbs and 7 were right thumbs. Three thumbs were amputated just distal to the CMC joint, 4 through the metacarpal head or MCP joint, 7 through the base of the proximal phalanx, 3 through the head of the proximal phalanx, and 2 through the base of the distal phalanx. Three children had previously undergone soft tissue coverage with a pedicled groin flap (2) and a reverse radial forearm flap (1) and 2 children underwent a reverse radial forearm flap simultaneously with their toe transfer.

Results: Nineteen toe-to-thumb transfers were performed, 12 second toe transfers, and 7 great toe transfers (3 great toe and 2 trimmed and 2 Morrison wrap-around variations). There were no immediate postoperative re-explorations of the microsurgical anastomoses, and all toe transfers were successful. All children rapidly regained pinch and grasp function and sensation. There were no gait problems in the donor foot/feet.

Summary Points:
- Microsurgical toe-to-thumb transfers are the optimal technique for post-traumatic thumb reconstruction in children for any level of amputation from just distal to the CMC joint out to the distal proximal phalanx.
- We present the largest presented series of this procedure for this indication, demonstrating safety and efficacy. Second toe transfers are preferred for younger children because of better growth potential and an inconspicuous donor site, but great toe transfers become more favored (1) for older children because of the better cosmetic appearance and (2) for combined thumb and multiple finger amputations.

**PAPER 55**

*Clinical Paper Session 10: Congenital and Pediatrics*

Saturday, October 1, 2016 ● 10:26–10:31 AM
*Treatment; Prognosis/Outcomes*

**A Direct Measure of Thumb Use in Children after Index Pollicization for Radial Longitudinal Deficiency**

Level 4 Evidence

Kathleen M. Kollitz, MD
Wendy Tomhave, OTR
Ann E. Van Heest, MD
Steven L. Moran, MD

**COI:**

There is no financial information to disclose.

**Hypothesis:** The assumption that good performance on dexterity and strength measures is correlated with use of the new thumb after index pollicization for congenital thumb hypoplasia has not previously been tested. The Thumb Grasp and Pinch assessment (T-GAP) is a new measure of thumb use that classifies grasp patterns used by children after index pollicization in age-appropriate activities of daily living. We hypothesize that thumb use and hand dexterity/strength are related but not equivalent; therefore, we hypothesize low to moderate correlation between T-GAP scores and standard dexterity and strength outcome measures.

**Methods:** Prospectively collected data from children with congenital thumb hypoplasia treated with index pollicization was reviewed. Standard outcomes measures included strength, range of motion, the Box and Blocks test (BBT), the Nine Hole Peg test (9HP), and the Functional Dexterity Test (FDT). Patients also completed the T-GAP consisting of 9 age-appropriate tasks designed to elicit specific hand and thumb use patterns. Grasp and pinch style were scored as follows: Palmar grasp without thumb (1 point); scissors between two most ulnar digits (2 points); scissors between radial digits (no thumb; 3 points); palmar grasp with thumb (4 points); key pinch (5 points); tip pinch (6 points); thumb to index and long (7 points). Scores for each task were summed to produce a final T-GAP score. Spearman correlation coefficients were calculated to describe the relationship between T-GAP scores and standard outcomes measures.

**Results:** Twenty-two patients were included in the study. T-GAP score was significantly correlated with scores on the BBT (R = 0.59), NHPT (R = 0.66), and FDT (R = -0.70) (P < 0.02 for all, Table 1). T-GAP score was also significantly correlated with tripod pinch, key pinch and grip strength (R = 0.75, 0.51, and 0.55 respectively) and with opposition and grasp span (R = 0.59 and 0.70) (P < 0.05 for all, Table 2).

**Summary Points:**
- The T-GAP effectively measures the complex active use of the pollicized digit during activities which require a variety of grasp and pinch styles.
- T-GAP score was correlated with strength, range of motion, and all 3 dexterity measures (BBT, 9HP, FDT). These correlations provide evidence for concurrent validity and construct validity of the T-GAP.
- Intermediate correlations imply that the T-GAP and standard dexterity tests measure related but distinct aspects of dexterity.
- The varied grasp and pinch styles employed by children with congenital thumb hypoplasia are not entirely captured by standard dexterity outcome measures, which are based on speed and allow any pinch pattern to be used, including those without use of the thumb.

**Table 1**

<table>
<thead>
<tr>
<th>Dexterity Measure</th>
<th>P-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box and Blocks Test</td>
<td>0.59</td>
<td>.006*</td>
</tr>
<tr>
<td>Functional Dexterity Test</td>
<td>0.66</td>
<td>.014*</td>
</tr>
<tr>
<td>Nine Hole Peg Test</td>
<td>-.70</td>
<td>.005*</td>
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**Table 2**

<table>
<thead>
<tr>
<th>Strength or Range of Motion Test</th>
<th>P-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kapandji Opposition</td>
<td>.59</td>
<td>.0051*</td>
</tr>
<tr>
<td>Active Distal Grasp Span</td>
<td>.70</td>
<td>.0005*</td>
</tr>
<tr>
<td>Active Web Span</td>
<td>.11</td>
<td>.07</td>
</tr>
<tr>
<td>Thumb Arc</td>
<td>.47</td>
<td>.08</td>
</tr>
<tr>
<td>Triped Pinch Strength</td>
<td>.75</td>
<td>&lt;.0001*</td>
</tr>
<tr>
<td>Key Pinch Strength</td>
<td>.51</td>
<td>.017*</td>
</tr>
<tr>
<td>Grip Strength</td>
<td>.55</td>
<td>.0083*</td>
</tr>
</tbody>
</table>

**PAPER 56**

*Clinical Paper Session 10: Congenital and Pediatrics*

Saturday, October 1, 2016 ● 10:33–10:38 AM
*Evaluation/Diagnosis*

**Quantitative Measurements of Cross-sectional Configuration of Flexor Pollicis Longus Tendon using Ultrasonography in Patients with Pediatric Trigger Thumb**

Level 3 Evidence

Jihyeung Kim, MD
Hyun Sik Gong, MD
Seung Hwan Rhee, MD
Kee Jeong Bae, MD
Goo Hyun Baek, MD
Hypothesis: Pediatric trigger thumb is characterized by flexion deformity of the interphalangeal joint of the thumb. It usually occurs spontaneously in childhood and can be resolved spontaneously without any treatments. The purpose of this study is to verify the causes of the flexion deformity of the thumb.

Methods: We enrolled 44 patients who were diagnosed as pediatric trigger thumb with unilateral involvement and underwent ultrasonographic measurements of the flexor pollicis longus tendon at the level of A1 pulley and 1 cm proximal to the A1 pulley. The measurements were repeated in the contralateral normal side. The average age at the time of measurements was 34.6 months.

Results: In the side of pediatric trigger thumb, the average anteroposterior and radioulnar diameters of the flexor pollicis longus tendon at the level of A1 pulley were 3.0mm and 2.4mm, respectively, and those 1cm proximal to the A1 pulley were 4.5mm and 2.7mm, respectively. In the contralateral normal side, the average anteroposterior and radioulnar diameters of the flexor pollicis longus tendon at the level of A1 pulley were 3.0mm and 2.0mm, respectively, and those 1cm proximal to the A1 pulley were 3.3mm and 1.9mm, respectively. The average ratio of the anteroposterior diameter of the flexor pollicis longus tendon 1cm proximal to the A1 pulley compared to the A1 pulley was 1.55 in the side of pediatric trigger thumb, and 1.09 in the contralateral normal side. The average ratio of the radioulnar diameter of the flexor pollicis longus tendon 1cm proximal to the A1 pulley compared to the A1 pulley was 1.12 in the side of pediatric trigger thumb, and 0.97 in the contralateral normal side.

Summary Points:
- In the comparison of the cross-sectional configuration of the flexor pollicis longus tendon and inner area of the A1 pulley, the anteroposterior and radioulnar diameters of the flexor pollicis longus tendon were more increased than those of inner area of the A1 pulley.
- The anteroposterior diameter of the flexor pollicis longus tendon was 55% longer than that of inner area of the A1 pulley, and the radioulnar diameter of the flexor pollicis longus tendon was 12% longer than that of inner area of the A1 pulley.
- The flexion deformity of the interphalangeal joint can be caused by increased anteroposterior diameter of the flexor pollicis longus tendon.

REFERENCES


PAPER 57

Clinical Paper Session 10: Congenital and Pediatrics
Saturday, October 1, 2016 • 10:40–10:45 AM
Evaluation/Diagnosis

Ultrasound Screening for Posterior Shoulder Dislocation in Infants with Brachial Plexus Birth Palsy
Level 4 Evidence

Andrea S. Bauer, MD ▲
Ryan Anderson, MS
Justin F. Lucas, MD
Nasser Heyrani, MD

Leslie A. Kalish, ScD
Michelle A. James, MD

COI:
- This presentation will discuss Materialise computer planning in skeletally immature patients.

Hypothesis: Clinical examination may fail to detect posterior shoulder dislocation in infants with brachial plexus birth palsy (BPBP).

Purpose of this study was to determine the prevalence of shoulder dislocation in this population on ultrasound (US) and to determine whether physical examination (PE) measurements correlate with US findings.

Methods: Infants presenting to our BPBP clinic receive serial shoulder US exams until age 1 year. We retrospectively reviewed data for infants with concurrent physical exam and US prior to 1 year of age, but before any surgical intervention. PE consisted of Active Movement Scale (AMS) and passive external rotation of the shoulder in adduction (PERAdd) and abduction (PERAbd). US measurements included percentage of humeral head displaced posterior to the axis of the scapula (PHHD) and the alpha angle (intersection of posterior scapular margin with a line tangential to the humeral head through the glenoid). Shoulder dislocation was defined as both PHHD > 0.5 and alpha angle > 30 degrees. PE results were compared between infants demonstrating dislocation at some time versus infants with no evidence of dislocation. We used receiver operating characteristic (ROC) analysis to evaluate the association between PE and concurrent US results.

Results: Sixty-six infants contributed a total of 118 ultrasound examinations (mean 1.8, range 1-5). Nineteen (28.8%) demonstrated shoulder dislocation, first detected at a range of 2.1-10.5 months of age. Of these, 14 (74%) presented with a dislocated shoulder at their first ultrasound. Infants with a dislocated shoulder demonstrated significantly less mean PERAdd (mean 46 versus 71 degrees) and a greater difference between internal rotation and external rotation scores on the AMS scale (mean 5.5 point versus 3.3 point difference) than those with a reduced shoulder (Table 1). PERAdd was better able to discriminate between concurrent evidence of dislocation and no dislocation (area under ROC curve [AUC] 0.89) than was the shoulder rotation difference (AUC = 0.73). A cut-off of 60 degrees for PERAdd yielded a sensitivity of 94% and a specificity of 69% for predicting dislocation on US (Figure 1).

Summary Points:
- Twenty-nine percent of infants seen in a BPBP specialty clinic had a shoulder dislocation during their first year of life.
- Limited PERAdd and a large internal rotation - external rotation (IR-ER) difference on the AMS were associated with dislocation.
- US screening is recommended for infants with BPBP, especially those with limited PERAdd.
- US screening when PERAdd is ≤ 60 degrees would identify an estimated > 90% of dislocations with a false positive rate < 30%.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Dislocated on US</th>
<th>N</th>
<th>Mean (SD)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMS Total Shoulder Score</td>
<td>Yes</td>
<td>34</td>
<td>3.9 (1.1)</td>
<td>3.9 (1.5)</td>
</tr>
<tr>
<td>No</td>
<td>76</td>
<td>4.0 (1.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMS Shoulder Rotation Total (IR + ER)</td>
<td>Yes</td>
<td>35</td>
<td>3.7 (1.4)</td>
<td>3.7 (1.7)</td>
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<tr>
<td>No</td>
<td>78</td>
<td>4.9 (1.7)</td>
<td></td>
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<tr>
<td>AMS Shoulder Rotation Difference (IR – ER)</td>
<td>Yes</td>
<td>35</td>
<td>5.5 (2.3)</td>
<td>5.5 (2.3)</td>
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<tr>
<td>No</td>
<td>78</td>
<td>3.3 (2.7)</td>
<td></td>
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<tr>
<td>ER in Abduction</td>
<td>Yes</td>
<td>27</td>
<td>45.8 (30.2)</td>
<td>45.8 (30.2)</td>
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<tr>
<td>No</td>
<td>53</td>
<td>71.4 (19.8)</td>
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<tr>
<td>ER in Abduction</td>
<td>Yes</td>
<td>27</td>
<td>76.1 (23.8)</td>
<td>76.1 (23.8)</td>
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<tr>
<td>No</td>
<td>53</td>
<td>86.4 (20.7)</td>
<td></td>
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</tr>
</tbody>
</table>

1Total available sample varied based on availability of the specific physical exam measures.
2Calculated as the sum of individual AMS scores (each 0-7) for shoulder external rotation, internal rotation, abduction, adduction, and forward flexion.
3Calculated as the sum of individual AMS scores (each 0-7) for shoulder internal rotation and external rotation.
4Calculated as the difference between the individual AMS scores (each 0-7) for shoulder internal rotation and external rotation.
5Physical exam measurement of passive shoulder external rotation with the arm in adduction.
6Physical exam measurement of passive shoulder external rotation with the arm in 90 degrees of abduction.
Figure 1. Receiver Operating Characteristic curves for ability of physical exam measurements to discriminate between dislocated and reduced shoulders on ultrasound. The curves show true positive and false positive rates of having a dislocation given physical exam findings, with select points labeled. For example, point 0.6 on the External Rotation in Adduction curve represents ≤60° vs >60°; point 2 on the IR-ER Difference curve represents IR-ER difference ≥2 vs ≤2 points on the AMS scale.

REFERENCES


PAPER 58

Clinical Paper Session 10: Congenital and Pediatrics
Saturday, October 1, 2016 • 10:47–10:52 AM
Treatment; Surgical Technique

Treatment of Infantile Glenohumeral Dislocation in Neonatal Brachial Plexus Palsy

Level 4 Evidence

Roger Cornwall, MD ▲
Thomas J. Sitzman, MD, MPH ▲
Kevin J. Little, MD ▲
Emily Louden, MPH ▲
Jenna Godfrey, MD ▲

COI: ▲ This presentation will discuss Allergan onobotulinum toxin A.

Hypothesis: Glenohumeral dysplasia following neonatal brachial plexus palsy (NBPP) can include glenohumeral dislocation in infancy, but treatment of this severe form of dysplasia in this age group has not been investigated. The present study tests the hypothesis that external rotation tendon transfers (ERTT) are frequently required to maintain shoulder alignment and improve function in this subset of NBPP patients.

Methods: We retrospectively reviewed interventions performed for glenohumeral dislocation in NBPP patients under 2 years of age, with at least 1 year follow-up after the index procedure. Dislocation was defined preoperatively as complete translation of the humeral head posterior to the scapula on ultrasonography or magnetic resonance imaging (MRI), or humeral head articulation in a pseudoglenoid with an empty anterior glenoid facet on MRI. Glenohumeral realignment was confirmed with postoperative ultrasonography and/or MRI.

Results: Twenty-six patients underwent intervention for reduction of glenohumeral dislocation at ages 4 months to 2 years with 34 month average follow-up. Twelve patients underwent internal rotator botulinum toxin (Botox) injection and casting, but all ultimately required surgery for redislocation, recurrent contracture, or persistent weakness. Among all 26 patients treated surgically, including those who failed Botox, 16 underwent internal rotation contracture release and ERTT, with 2 (13%) requiring revision surgery; 6 underwent release alone, with 4 (67%) requiring revision surgery; 3 underwent ERTT alone, with none requiring revision surgery; 1 underwent release and spinal accessory to suprascapular nerve transfer, requiring later ERTT for redislocation. Children whose initial surgery included ERTT were significantly less likely to undergo revision surgery than those without initial ERTT ($P < 0.005$). Ultimately, ERTT was required in 20/26 patients, regardless of Narakas grade or prior/concomitant nerve reconstruction. Across all groups, patients ultimately had improved passive and active external rotation (19 degrees to 69 degrees, -60 degrees to 17 degrees, respectively, $P < 0.001$) and global Mallet scores (12.5/30 to 17.6/30, $P < 0.001$) without worsened internal rotation function. Glenohumeral remodeling occurred in 12 of the 13 patients who had an MRI preoperatively and at least 1 year postoperatively.

Summary Points:
- External rotation tendon transfers are frequently required to maintain reduction of glenohumeral joints dislocated during infancy in NBPP.
- Such surgery can improve external rotation and global shoulder function without loss of internal rotation function, even when performed as early as 6 months of age.
- Botox injection is an unreliable adjunct to closed reduction of shoulders in this subset of NBPP patients.

PAPER 59

Clinical Paper Session 11: Hand/Wrist Trauma 3
Saturday, October 1, 2016 • 1:30–1:35 PM
Treatment

SLAC 2 Wrist: A Randomized Controlled Trial of Four-corner Fusion and Radioscapholunate Fusion

Level 2 Evidence

Stephen Tham, MBBS
Simon Chan, MD
Jason Harvey, MBBS, FRACS
Sheena Sikora, MD

COI: There is no financial information to disclose.

Hypothesis: To determine the differences in results of patients with a SLAC 2 wrist treated either by four-corner fusion (4CF) or radioscapholunate (RSL) fusion.

Methods: Institutional ethics approval was obtained for a prospective randomized patient and assessor blinded trial of patients with SLAC 2 wrists treated with either scaphoid excision and 4CF or RSL fusion with excision of distal scaphoid between March 2013 and September 2014. Pre-operative plain radiograph and computed tomography (CT) scans were performed in all patients. Wrist motion, grip strength, Mayo wrist score and PRWE were collected preoperatively and at 6 and 12 months. Decision for entry into the trial was made after visual inspection of the radiolunate and lunocapitate joints to confirm its status, and the procedure was selected from a numbered envelope. The procedures were performed by 2 fellowship trained surgeons. Plain radiograph was performed post-operatively at 6 weeks and CT at 16 weeks.
Results: Twelve patients with 13 wrists were treated. One patient had bilateral wrist involvement. There were 7 wrists in the RSL group and 6 wrists in the 4CF group. Mean age was 53.3 years in RSL and 62.3 years in 4CF. In the RSL group, 2 patients underwent further surgery for re-expansion of distal scaphoid, 1 for bone graft to radioscapophoid joint and 1 for total wrist fusion at 100 months. A widened SL interval and incongruous distal scaphophoid joint on CT scan was noted in all RSL wrists. There were no complications in 4CF. Preoperative mean range of motion, grip strength, Mayo wrist score and PRWE for the RSL group were (F-E) 41-43 degrees, (RD-UD) 14-24.3 degrees, (GS) 25.2 kg, Mayo 45, PRWE 65; in the 4CF group, they were (F-E) 34-44 degrees, (RD-UD) 7-29 degrees, (GS) 26.4 kg, (Mayo) 55, (PRWE) 61. At 12 months, the RSL group had (F-E) 22.1-27.9 degrees, (RD-UD) 5.6-17.1 degrees, (GS) 27.8 kg, Mayo 67, PRWE 49.8 and the 4CF group (F-E) 39-41 degrees, (RD-UD) 13-21 degrees, (GS) 32 kg, Mayo 74.2, PRWE 20.2.

Summary Points:
- Patients with a SLAC 2 degenerative wrist arthritis treated with RSL fusion to preserve midcarpal motion have a higher re-operation and conversion to total wrist fusion than those treated by 4CF.
- In these patients, the range of motion and PRWE is less than those treated by 4CF. RSL in the SLAC 2 wrist is technically challenging and does not give better results than 4CF.

REFERENCES

PAPER 60
Clinical Paper Session 11: Hand/Wrist Trauma 3
Saturday, October 1, 2016 • 1:37—1:42 PM
Treatment; Prognosis/Outcomes

Ultra Small Proximal Pole Scaphoid Nonunion Reconstruction with 1,2 Intercompartmental Supraretinacular Artery Vascularized Graft and Micro Screw Fixation
Level 4 Evidence

Mark S. Morris, MD
Andy Zhu, MD
Kagan Ozer, MD
Jeffrey N. Lawton, MD

COI: There is no financial information to disclose.

Hypothesis: Patients with proximal pole scaphoid fracture nonunions can be successfully treated using a 1,2 Intercompartmental Supraretinacular Artery (1,2 ICSRA) vascularized graft and a small compression screw. Although previous authors have shown unfavorable results with this surgery for waist fractures, we intend to show that this is a viable surgery for proximal pole scaphoid fractures.

Methods: This is a retrospective case series of 12 patients with ultra-small proximal pole scaphoid fracture nonunions that were treated at our institution with 1,2 ICSRA vascularized grafts and compression screws. Calculations of the size of the proximal pole fragment relative to the total scaphoid were performed using Posterior-Anterior Scaphoid view radiographs with the wrist in ulnar deviation and flat on the cassette. Analyses were repeated 3 times per subject, and the average ratio of proximal pole fragment relative to the entire scaphoid was calculated. We reviewed medical records, radiographs, and CT scans of these 12 patients. CT scans that were performed after an average of 12 weeks were ultimately used to confirm union of the scaphoid fractures.

Results: Twelve out of 12 (100%) scaphoid fractures healed at an average of 11.45 weeks as shown by CT scan. The mean proximal pole fragment size was 18% (range 7-27%) of the entire scaphoid.

Summary Points:
- The 1,2 ICSRA vascularized graft and compression screw is an effective operation for patients with very small proximal pole scaphoid fractures.
- Previous studies have unsuccessfully used this surgery for waist fractures and have included a mix of patients treated with Kirschner wires and screws.
- The benefit of this study is that we included only patients with proximal pole fractures and included only patients treated with a compression screw and were able to show the success of the proposed operation.

REFERENCES

PAPER 61
Clinical Paper Session 11: Hand/Wrist Trauma 3
Saturday, October 1, 2016 • 1:44—1:49 PM
Treatment; Surgical Technique

Failed Bone Grafts in Scaphoid Non-unions: Is it Wise to Start All Over?
Level 3 Evidence

Colin De Cheveigne, MD
Pierre Crouzet, MD
Benjamin Ferreira, MD
Alexa Gaston-Nouvel, MD

COI: There is no financial information to disclose.

Hypothesis: Bone grafting can fail in scaphoid non-unions, generally due to unfavorable local conditions, perfectible surgery or poor patient compliance. With added devascularization, bone loss and demotivation, it may seem unsafe to repeat a similar procedure.

This series of 48 iterative scaphoid bone grafts shows it is possible to obtain an 82% healing rate, even in these difficult conditions.

Methods: The series is part of a prospective global single-operator series of 366 scaphoid non-unions grafted between 1991 and 2015. Twenty-four patients were operated elsewhere, 24 were personal failures. The series includes 45 male and 3 female patients, average age 29. The average delay from fracture to first graft was 5.6 years, between grafts was 8 months. Thirteen patients were smokers, 7 stopped during healing. Eight were on workers compensation. Pre-operative grip strength was 45% of contralateral, ROM 66%, pain was estimated 4,5/10. The initial fracture was situated in the proximal third 9 times, middle third 38
times, and distally in 1 patient. Thirty-two patients had no degenerative changes, 11 presented radio-scaphoid lesions at various stages, and 5 had radio-and intra-carpal involvement. The first graft was non-vascularized in all but one case. The second was an iliac graft in 11 cases, a microsurgical femoral condyle graft in 10 cases. (Two patients were grafted a third time.)

Results: All patients had clinical and x-ray follow-up (average 6.2 years, 4-260 months). Forty-one patients (82%) had healed, confirmed by CT scan when in doubt. There were no infections nor cases of RSD, 12 hardware removals and minor bone trimmings. None of the 7 failures required a salvage procedure.

In successful grafts, pain was down to 1.5/10, strength was 75% of contralateral, ROM unchanged. Average DISI measured 9 degrees. Bone fusion was shown to halt most degenerative changes.

Compared to our main cohort of bone grafts for scaphoid non-union, this series of 48 patients included more males, who were initially stiffer, more painful and smoked more frequently. These secondary grafts gave a lower success rate (82 instead of 93%) with less post-operative ROM, less strength but the same pain relief, when union was achieved.

Summary Points:
- The study illustrates some of the causes for failure in scaphoid healing and shows the importance of vascularized bone grafts, free if necessary, when re-operating failed scaphoid non-unions.
- Faced with persistsant scaphoid non-union, repeated bone grafting seems a good alternative to salvage procedures in most patients.

References:

PAPER 62
Clinical Paper Session 11: Hand/Wrist Trauma 3
Saturday, October 1, 2016 ● 1:51—1:56 PM
Treatment; Prognosis/Outcomes

Effect of Policy Change on the Use of Long-distance Transport and Follow-up Care for Patients with Traumatic Finger Amputations
Level 3 Evidence
Michael T. Nolte, MD
Aviram M. Giladi, MD
Melissa J. Shauver, MPH
Kevin C. Chung, MD, MS

COI:
There is no financial information to disclose.

Hypothesis: Emergency air transport has been cited as overused and unnecessary for patients with traumatic finger amputations.1 In January 2006, the American College of Emergency Physicians (ACEP) changed official guidelines for air transfer such that a digit amputation or near-amputation is no longer an indication for this costly service.2 We analyze the effect of this change on the use of the service and associated care outcomes, and examine factors involved in providing follow-up care for these patients.

Methods: A retrospective chart review identified all patients treated for traumatic finger amputation between 1995 and 2012 at a major hand trauma referral center. Analysis of available factors and outcomes measures was conducted using multiple logistic and linear regression models, in addition to Fisher’s exact test. Analysis of factors affecting frequency of return visits was performed via negative binomial regression.

Results: Of the 724 total patients identified, 267 (36.9%) were transferred from an outside hospital. In 11 years prior to the 2006 protocol change, 49 of 166 patients (29.5%) were transferred via air, 12 of which (24.5%) underwent replantation attempt with 8 successful (75%). In 7 years following this change, 15 of 101 patients (14.9%) were transferred via air transport, 2 of which (13.3%) underwent replantation attempt with 1 successful (50%). Of note, the total number of replantation attempts before and after 2006 did not significantly differ (n = 76 and 86, respectively). The likelihood of transfer via emergency air transport was significantly lower after the 2006 change (OR = 0.235, P = 0.002)(Table 1). There were no significant differences in replantation success rate, length of hospital stay, or number of return visits for both helicopter transfers and all transferred patients pre- versus post-2006. Work-relatedness was associated with a higher number of return visits across all finger amputation injury patients (IRR = 1.375, P = 0.001), whereas increasing age (IRR = 0.977, P = 0.022) and transfer from >100 miles away (IRR = 0.597, P = 0.009) were associated with fewer return visits (Table 2).

Summary Points:
- In accordance with ACEP policy change, a major hand trauma referral center was successful in decreasing the use of emergency air transport for patients with traumatic finger amputations. This occurred without adversely affecting care delivery and outcomes.
- These findings suggest that the ACEP guideline may be successfully implemented on a center-by-center basis to reduce costs without resulting in worse patient care.
- Work-related and increased transfer distance significantly impacted the number of return visits, suggesting that funding status and travel distance play an integral role in follow-up care after transfer to regional referral centers.

Table 1: Factors affecting the likelihood of transfer for a patient with traumatic finger amputation via helicopter.* Indicates statistical significance of p<0.05

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>p-value</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt;70 years</td>
<td>1.722</td>
<td>0.371</td>
<td>4.357</td>
</tr>
<tr>
<td>70-90 years</td>
<td>0.262</td>
<td>0.056</td>
<td>1.222</td>
</tr>
<tr>
<td>91-100 years</td>
<td>1.013</td>
<td>0.348</td>
<td>2.945</td>
</tr>
<tr>
<td>&gt;100 years</td>
<td>0.578</td>
<td>0.163</td>
<td>2.943</td>
</tr>
<tr>
<td>Transfer Distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;25 miles</td>
<td>0.451</td>
<td>0.046</td>
<td>1.693</td>
</tr>
<tr>
<td>25-100 miles</td>
<td>12.723</td>
<td>1.307</td>
<td>155.222</td>
</tr>
<tr>
<td>101-200 miles</td>
<td>13.358</td>
<td>1.401</td>
<td>127.369</td>
</tr>
<tr>
<td>&gt;200 miles</td>
<td>181.657</td>
<td>10.357</td>
<td>3296.818</td>
</tr>
<tr>
<td>Injury Type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avulsion</td>
<td>0.753</td>
<td>0.234</td>
<td>2.422</td>
</tr>
<tr>
<td>Blunt</td>
<td>3.318</td>
<td>0.346</td>
<td>20.170</td>
</tr>
<tr>
<td>Sharp</td>
<td>2.033</td>
<td>0.818</td>
<td>5.053</td>
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<td>Season of Year</td>
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<tr>
<td>Summer</td>
<td>0.280</td>
<td>0.078</td>
<td>1.012</td>
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<tr>
<td>Winter</td>
<td>1.995</td>
<td>0.612</td>
<td>3.178</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Related</td>
<td>1.288</td>
<td>0.478</td>
<td>3.471</td>
</tr>
<tr>
<td>Smoker</td>
<td>0.749</td>
<td>0.338</td>
<td>1.658</td>
</tr>
<tr>
<td>Post-2006 Revision</td>
<td>0.235</td>
<td>0.005</td>
<td>0.713</td>
</tr>
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</table>

Table 2: Factors affecting the number of return visits following traumatic finger amputation. * Indicates statistical significance of p<0.05

<table>
<thead>
<tr>
<th>Variable</th>
<th>IRR</th>
<th>p-value</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 0-977</td>
<td>0.022*</td>
<td>0.959</td>
<td>0.997</td>
</tr>
<tr>
<td>Work Related 1.375</td>
<td>0.001*</td>
<td>1.123</td>
<td>1.608</td>
</tr>
<tr>
<td>Complication 1.107</td>
<td>0.313</td>
<td>0.912</td>
<td>3.143</td>
</tr>
<tr>
<td>Transfer &lt;50 miles 1.353</td>
<td>0.103</td>
<td>0.940</td>
<td>1.945</td>
</tr>
<tr>
<td>Transfer &gt;100 miles 0.597</td>
<td>0.009</td>
<td>0.406</td>
<td>0.879</td>
</tr>
</tbody>
</table>
Innervation of the Interphalangeal Joint of the Fingers

N/A - Not a clinical study

Martin Jose Pastrana, MD
Carlos Rodolfo Zaidenberg, MD
Ezequiel Ernesto Zaidenberg, MD

COI:
There is no financial information to disclose.

Hypothesis: The knowledge of the proximal interphalangeal (PIP) joint anatomy is known in detail, while the understanding of its innervation is still controversial. The purpose of this study was to describe the innervation of the PIP joint of the fingers, as well as the anatomical relations of the articular branches.

Methods: In the anatomical study, 27 fresh frozen not formolized cadaveric fingers (including the second to the fifth finger) were dissected after injection of coloured latex composite.

In all specimens, a palmar longitudinal incision with a “V” distal shape was performed, allowing to expose the neurovascular pedicle of the finger. The anatomical dissections were performed under magnification of 3.5 X and 6.0 X, proceeding through the Grayson ligament and preserving the Cleland ligament.

The number of articular nerve branches that penetrate the PIP joint on both sides of the fingers were quantified, trying to establish the patterns of presentation. We also measured the origin of the branches regarding PIP articular line, the angle of emergence and the nerves diameter.

Results: The PIP joint was innervated in 23 fingers by 1 constant articular branch on each side of the PIP. Only in 4 fingers, the joint was supplied by two branches on each side. We could distinguish 2 distinct patterns of innervation. The more frequent pattern (type 1) had a unique articular sensory branch emerging to each side of the finger at an average of 17mm proximal to the PIP joint (range 9 to 25mm), with a lower angle of 15 degrees. The second pattern (type 2) had an additional distal branch at an average of 8mm proximal to the PIP joint (range 6 to 10mm) with an average angle of 45 degrees. Those articular branches penetrate the capsule in the palmar aspect of the PIP joint. The mean diameter of the palmar digital nerve was 1.1mm (range 0.9 to 1.3mm), while the average articular sensory branch was 0.3mm (range 0.4 to 0.2mm).

Summary Points:
- PIP joint is innervated at least 1 constant articular branch of the palmar digital nerve at each side of the finger.
- A second distal articular branch can be identified in some cases reaching the palmar aspect of the PIP joint capsule.

REFERENCES


PAPER 64

Clinical Paper Session 11: Hand/Wrist Trauma 3
Saturday, October 1, 2016 • 2:05–2:10 PM
Treatment; Surgical Technique; Basic Science

Near Normothermic Ex Situ Perfusion of Human Limbs for 24 Hours

N/A - Not a clinical study

Nicole Werner, MD, MS
Fares Alghanem, BS
Stephanie Rakestraw
Dylan C. Sarver, ATC
Alvaro Roja Pena, MD
Kagan Ozer, MD

COI:
There is no financial information to disclose.

Hypothesis: Currently vascularized composite allografts (VCA) are cold preserved (4°C) until transplantation. This process is time limited, as the tissue has to be revascularized within 4-6 hours to minimize ischemia reperfusion (IR) injury. Normothermic perfusion was proposed as an alternative method of preservation in solid organ.
transplantation. This method helps to avoid complications associated with cold preservation and maintains tissue viability without inducing IR injury. Using this method, previous investigators demonstrated its potential to prolong swine forelimb allograft survival up to 24 hours. In this study, we aimed to test this system on human limb allografts.

Methods: Four human forearms were procured from brain-dead adult donors under tourniquet control. Following elbow disarticulation, the brachial artery was cannulated. The limb was flushed with heparinized saline and connected to a temperature controlled (30-33°C) ex situ perfusion system (Figure) for 24 hours. The perfusate consisted of plasma and red blood cells with a target hemoglobin (Hb) concentration of 4-6 g/dL. Muscle biopsies (flexor carpi radialis) were obtained at 0, 12, and 24 hours.

Results: Average warm ischemia time was 76 minutes. Average arterial systolic pressure was 98±2 mmHg, perfusion flow 319±18 mL/min (~6-8% of the donor’s estimated cardiac output), and vascular resistance 156±18 mmHg/mL/min. Perfusion had an average pH of 7.43±0.04, pCO2 32±1 mmHg, pO2 317±18 mmHg, and Hb 4.8±0.4 g/dL. Electrolytes (sodium, potassium, chloride) remained within a physiologic range. Lactate started to increase steadily throughout the experiment; however, neuromuscular electrical stimulation revealed ongoing contraction throughout the experiment and H&E staining showed mild to moderate fatty infiltration on some myocytes at 24 hours.

Summary Points:
- All limbs appeared viable after 24 hours of near-normothermic ex situ perfusion as evidenced by ongoing neuromuscular stimulation.
- While no conclusions can be drawn about the long-term function of the extremity, this approach could help extend VCA transplantation to a wider geographic area.
- It also has the potential to circumvent complications associated with cold preservation.

REFERENCES


PAPER 65
Clinical Paper Session 12: Nerve 2
Saturday, October 1, 2016 • 1:30–1:35 PM
Evaluation/Diagnosis; Prognosis/Outcomes; Education; Anatomy
Correlating Median Nerve Cross-sectional Area with Distal Sensory and Distal Motor Nerve Latencies
Level 2 Evidence
John Fowler, MD
COI: There is no financial information to disclose.
Hypothesis: There is a direct measurable correlation between ultrasonographic median nerve cross-sectional area (CSA) and both distal motor latency and distal sensory latency in patients referred for nerve conduction studies (NCS) due to carpal tunnel syndrome (CTS) symptoms.
Methods: A prospective study was carried out on 41 wrists/25 patients referred by an orthopedic surgeon for nerve conduction studies due to clinical manifestations of CTS. Demographic information including age, gender, race, height and weight was recorded. Ultrasound examinations were performed using a 15-6 MHz linear array transducer. Median nerve CSA was measured at the carpal tunnel inlet 3 times, and the results averaged. Accuracy of CSA measurements is to 0.1mm. All NCS were performed according to the guidelines of the American Association of Electrodiagnostic Medicine, and no treatment was administered between the ultrasound test and the NCS. Median nerve CSA was compared to both distal sensory and distal motor latency using Pearson correlations. Pearson correlations were run again controlling for BMI. CSA and latency were compared by means of a linear regression to determine odds ratio. Sensitivity and specificity were calculated for CSA compared to both latencies.

Results: Of the 41 wrists included in the study, all were used in the analysis of distal motor latency, while 2 were excluded in the analysis of distal sensory latency due to missing data. Correlation was significant between CSA and distal motor latency (R = .431, P = .005), as well as between CSA and distal sensory latency (R = .385, P = .015). When controlling for BMI the correlations were also significant for CSA and distal motor latency (R = .415, P = .008), and CSA with distal sensory latency (R = .361, P = .026). Using logistic regression to determine association of a correct diagnosis, association between CSA and distal motor latency was significant (OR = 5.786, P = 0.028, CI [1.208, 27.716]), while association between CSA and distal sensory latency was not (OR = 3.306, P = 0.129, CI [0.706, 15.489]). CSA compared to distal motor latency had a sensitivity 88% of and a specificity of 44%. CSA compared to distal sensory latency had a sensitivity 85% of and a specificity of 37%.

Summary Points:
- The significant correlation and high specificity between CSA and NCS indicate that diagnosis of CTS using ultrasonographic median nerve cross-sectional area is a promising complimentary and alternative diagnostic tool to the costly and uncomfortable nerve conduction studies; however, the low sensitivity may preclude it from being a confirmatory test.

REFERENCES
were also no differences in muscle net weight (1.36g versus 1.33g, density, and diameter were no different between the autograft groups. There were no differences in behavioral outcomes (SFI, FF) at any tested time point.

Summary Points:
- Reversing nerve autograft polarity does not influence functional or regenerative outcomes.
- Since polarity does not alter outcomes, autograft repair should be oriented in the direction that allows the best fascicular alignment.
- Diffusion tensor imaging (DTI) is a reliable assessment tool for peripheral nerve regeneration.

Hypothesis: Diffusion tensor imaging (DTI) is a magnetic resonance technology that is widely used in the study of the central nervous system and is emerging as a tool to non-invasively image peripheral nerves and assess the extent of nerve fiber regeneration. Given no definitive consensus on the accepted autograft orientation during peripheral nerve injury repair, we compare outcomes between reverse and normally oriented (forward) autografts utilizing DTI.

Methods: Thirty-six female Sprague Dawley rats were divided into 3 groups: (1) Control - left sciatic nerve isolation without injury, (2) Reverse Autograft - 10mm cut left sciatic nerve segment reoriented 180 degrees and used to coapt the proximal and distal stumps, or (3) Forward Autograft - 10mm cut left sciatic nerve segment kept in its normal orientation for coaptation. Animals underwent Sciatic Function Index (SFI) and Foot Fault (FF) behavior studies at 72 hours, and then weekly. At 6 weeks, axons proximal, within, and distal to the autograft were evaluated using DTI and choline acetyltransferase motor staining for immunohistochemistry (IHC). Toluidine blue staining of one-micron sections was also performed to assess total axon count, axon density and diameter. Bilateral gastrocnemius/soleus muscle weights were compared to obtain a net wet weight to assess the degree of muscle atrophy. Statistical significance was determined using Mann-Whitney U test.

Results: DTI findings - including fractional anisotropy (FA), radial diffusivity, and axial diffusivity - were similar between reverse and forward autografts. DTI tractography demonstrated proximo-distal regeneration in both autograft groups. Median motor axon counts proximal/within/distal to the autograft were 1519/561/362 in the reverse group and 1516/490/338 in the forward group, which were not statistically significant. Similarly, total axon count, density, and diameter were not different between the autograft groups. There were also no differences in muscle net weight (1.36g versus 1.33g, \( P = 0.68 \)) at 6 weeks or behavioral outcomes (SFI, FF) at any tested time point.

Summary Points:
- Reversing nerve autograft polarity does not influence functional or regenerative outcomes.
- Since polarity does not alter outcomes, autograft repair should be oriented in the direction that allows the best fascicular alignment.
- DTI is a reliable assessment tool for peripheral nerve regeneration.

Hypothesis: There is no financial information to disclose.

COI: No financial information to disclose.

References:

PAPER 66
Clinical Paper Session 12: Nerve 2
Saturday, October 1, 2016 1:37–1:42 PM
Surgical Technique; Basic Science
Assessment of the Effect of Autograft Orientation on Peripheral Nerve Regeneration Utilizing Diffusion Tensor Imaging

N/A - Not a clinical study

Ashkan Afshari, MD
Lyl Vu Nguyen, MD
Nathaniel D. Kelm, MS
Justine S. Kim, BS
Ravinder Bamba, MD
Nancy L. Cardwell, BS
Alonda C. Pollins, MS
Bruce Shack, MD
Wesley P. Thayer, MD, PhD

COI: There is no financial information to disclose.

Hypothesis: Diffusion tensor imaging (DTI) is a magnetic resonance technology that is widely used in the study of the central nervous system and is emerging as a tool to non-invasively image peripheral nerves and assess the extent of nerve fiber regeneration. Given no definitive consensus on the accepted autograft orientation during peripheral nerve injury repair, we compare outcomes between reverse and normally oriented (forward) autografts utilizing DTI.

Methods: Thirty-six female Sprague Dawley rats were divided into 3 groups: (1) Control - left sciatic nerve isolation without injury, (2) Reverse Autograft - 10mm cut left sciatic nerve segment reoriented 180 degrees and used to coapt the proximal and distal stumps, or (3) Forward Autograft - 10mm cut left sciatic nerve segment kept in its normal orientation for coaptation. Animals underwent Sciatic Function Index (SFI) and Foot Fault (FF) behavior studies at 72 hours, and then weekly. At 6 weeks, axons proximal, within, and distal to the autograft were evaluated using DTI and choline acetyl-transferase motor staining for immunohistochemistry (IHC). Toluidine blue staining of one-micron sections was also performed to assess total axon count, axon density and diameter. Bilateral gastrocnemius/soleus muscle weights were compared to obtain a net wet weight to assess the degree of muscle atrophy. Statistical significance was determined using Mann-Whitney U test.

Results: DTI findings - including fractional anisotropy (FA), radial diffusivity, and axial diffusivity - were similar between reverse and forward autografts. DTI tractography demonstrated proximo-distal regeneration in both autograft groups. Median motor axon counts proximal/within/distal to the autograft were 1519/561/362 in the reverse group and 1516/490/338 in the forward group, which were not statistically significant. Similarly, total axon count, density, and diameter were not different between the autograft groups. There were also no differences in muscle net weight (1.36g versus 1.33g, \( P = 0.68 \)) at 6 weeks or behavioral outcomes (SFI, FF) at any tested time point.

Summary Points:
- Reversing nerve autograft polarity does not influence functional or regenerative outcomes.
- Since polarity does not alter outcomes, autograft repair should be oriented in the direction that allows the best fascicular alignment.
- DTI is a reliable assessment tool for peripheral nerve regeneration.

COI: There is no financial information to disclose.

Hypothesis: There is no financial information to disclose.

COI: There is no financial information to disclose.

References:

PAPER 67
Clinical Paper Session 12: Nerve 2
Saturday, October 1, 2016 1:44–1:49 PM
Evaluation/Diagnosis; Treatment
National Practice and Impact of Preoperative Electrodiagnostic Studies for Carpal Tunnel Syndrome

Level 2 Evidence
Erika Davis Sears, MD, MS
Peter R. Swiatek, BA
Kevin C. Chung, MD, MS

COI: There is no financial information to disclose.

Hypothesis: We aimed to conduct a population-level analysis of patients undergoing carpal tunnel release (CTR) to (1) characterize overall utilization of preoperative electrodiagnostic studies (EDS) and (2) determine the impact of EDS use on timeliness of treatment and cost of care. We hypothesize that providers do
not uniformly perform EDS for all patients having CTR and that use of EDS is associated with prolonged time to surgery and increased cost of care. Methods: The 2009 to 2013 Truven MarketScan Databases were used to identify a national cohort of adult patients undergoing CTR. Preoperative EDS use was recorded. Three multivariable regression models were designed to evaluate the relationship between preoperative EDS use and time to surgical release, number of preoperative physician visits, and total cost for carpal tunnel syndrome (CTS)-related visits, while controlling for socio-demographic variables, insurance type, comorbid conditions, and treatment characteristics. Results: The final study cohort included 62,894 patients who underwent CTR, of which 58% had preoperative EDS. Patients undergoing EDS had an estimated 36% longer wait for surgical release than patients without EDS in the adjusted analysis. The mean predicted time between diagnosis and surgery was 183 days and 135 days for patients with and without preoperative EDS, respectively (P < 0.001). Patients who underwent EDS had an average of 2.9 preoperative physician visits between diagnosis and surgical release, whereas patients who did not undergo EDS had an average of 1.9 preoperative physician visits. EDS was associated with $996 greater total costs and $112 additional out-of-pocket expense for patients (Figure). In the controlled analysis, EDS use was associated with 25% greater costs (P < 0.001). Anesthesia type was the only treatment factor that influenced total cost at a similar magnitude as seen with EDS use. Summary Points: • Patients having preoperative EDS experienced 2 month longer wait to surgical release, 1 additional visit, and greater total cost and out-of-pocket expense on average. • Based on national practice trends, providers do not uniformly perform EDS prior to carpal tunnel release for all patients. • Given the increased time to surgery and added costs, providers should understand the impact of routine EDS use for all patients considered for surgical release, especially if the test results will not alter the treatment plan. Hypothesis: Isolated axillary nerve injuries can occur subsequent to trauma or as a direct complication from shoulder procedures. While partial radial to axillary nerve transfers have previously been described, there has been a lack of information related to patient selection, surgical methodology, and outcomes. We hypothesize that partial radial to axillary nerve transfers is an under-utilized, promising treatment option for patients with this devastating injury. Methods: We performed a retrospective analysis of all partial radial nerve transfers for isolated axillary nerve injuries (n = 7) performed by a single surgeon at 1 institution over the past 4 years. All patients had nerve conduction studies verifying a complete axillary nerve lesion with no reinnervation as detailed by fibrillation potentials without evidence of nascent potentials. The surgery consisted of (1) using a direct posterior approach to the arm, (2) isolating one fascicle of the radial nerve responsible for only elbow flexion as confirmed by intra-operative monitoring, and (3) coapting this branch to the proximal portion of the axillary nerve in the quadrilateral space. All patients were protected in a shoulder sling for 3 weeks until the nerve repair healed. Results: There was no donor nerve deficit for any patient. Four of the 7 patients had undergone previous shoulder surgery and had received a pre-operative nerve block. One patient had the nerve transfer performed within 4 months of injury and regained functional motion with forward elevation to 160 degrees and M4 strength. The other patients had surgery after the initial 7 months after the injury and did not have any meaningful improvement in function after the nerve transfer. The other 3 patients had an axillary nerve injury related to a traumatic injury and had nerve transfer performed within the initial 6 month time period. One patient has subsequent restoration of his deltoid muscle; however, his range of motion was limited due to an underlying proximal humerus nonunion. The other 2 patients have forward elevation to 160 degrees with M4 strength. Summary Points: • For patients with axillary nerve injuries, a partial radial to axillary nerve transfer is a safe procedure without donor deficit that can provide functional recovery with early intervention. • While the expanded use of regional anesthesia may cloud the initial post operative exam for patients undergoing shoulder surgery, the surgeon should be suspicious of patients who do not demonstrate recovery and refer patients early for intervention rather than prolonged observation in order to maximize the chances of recovery.
Animal study: 4cm sciatic nerve defects were created in Lewis rats and bridged with autograft + allograft with epineurotomies (group 1); autograft + allograft without epineurotomies (group 2); or allograft alone (group 3) (N = 2 per group). At 2 weeks, mid-graft cross-sections were stained for S100 to assess for the presence of Schwann cells by immunofluorescence microscopy.

Results: Case series: Defects were reconstructed in ulnar, median and sciatic nerves. All defects were greater than 4cm in length. All patients demonstrated favorable recovery of motor and sensory function.

Animal study: In 1 of 2 animals in Group 1, S100-positive Schwann cells were found within allograft fascicles (Figure 2). In the second animal of Group 1, Schwann cells were seen crossing the perineurium of the allograft, but none were found within the allograft fascicles. In Groups 2 and 3, there were no S100-positive cells observed within the allograft fascicles or crossing the perineurium in any animals.

Summary Points:
- Case series demonstrates the feasibility of combining autograft and decellularized allograft cable grafts with epineurotomies to reconstruct large mixed-motor nerve defects.
- Epineurotomies allow for trans-perineurial side-to-side Schwann cell migration from autograft to decellularized allograft cables.
- Further studies are needed to delineate the degree and timing of Schwann cell migration, as well as the impact this has on axonal regeneration and functional outcomes.

OUTCOMES OF LATE MICROSURGICAL RECONSTRUCTION FOR BRACHIAL PLEXUS BIRTH PALSY

Michael C. Daly, MD, MSc
Hayley M. Lynch, BA
Donald S. Bae, MD
Peter M. Waters, MD
Andrea S. Bauer, MD

COI: There is no financial information to disclose.

Hypothesis: Microsurgical nerve reconstruction is advocated in select patients with brachial plexus birth palsy (BPBP) between 3 and 9 months of life, yet some patients undergo indicated surgery after this time frame. Microsurgical outcomes in BPBP patients older than 9 months remain poorly characterized. This study has 2 aims: (1) to critically analyze outcomes of microsurgical reconstruction in BPBP patients after 9 months of age, and (2) to test the null hypothesis that there is no difference in Active Movement Scale (AMS) scores in BPBP patients who undergo nerve transfer versus nerve graft after 9 months of age.

Methods: We retrospectively analyzed prospectively collected data from a large multicenter database of BPBP patients (TOBI). We included all patients who had microsurgery after 9 months of age with minimum 12 month follow-up. Patients were evaluated using the AMS and Toronto scores. To focus on the outcomes of microsurgery only, we only included outcomes prior to secondary surgery in our analysis. We analyzed baseline variables using bivariate statistics and changes in AMS scores using the nonparametric Wilcoxon signed rank test.

Results: We identified 34 patients (59% female, 52% birth weight >4000g) treated with microsurgical reconstruction at or after 9 months of age with mean follow-up 26.2 months. Mean age at presentation was 3.9 months. Mean age at microsurgery was 12.3 months. No patient underwent revision microsurgery; no other complications were noted. Twenty-six patients (76%) had upper trunk palsy (Narakas groups 1 and 2); the remaining 8 (24%) had total palsy (Narakas groups 3 and 4). Total AMS scores were significantly improved from preoperative values at 1-year, 2-year, and 3-year follow-up (Table 1). Among 30 patients with 1-year follow-up, AMS scores significantly improved for multiple upper extremity movements, including shoulder reanimation (abduction, flexion, external rotation) and elbow flexion (Table 1; P < 0.05). When compared with nerve grafting, nerve transfers resulted in significantly improved results for shoulder reanimation (abduction, flexion, external rotation) and elbow flexion (Table 2; P < 0.05).

Summary Points:
- BPBP patients treated with microsurgery after 9 months of age demonstrate encouraging results with improved total AMS scores at 1-year, 2-year, and 3-year follow-up.
- When compared with nerve grafting, nerve transfers resulted in significantly improved results for shoulder reanimation (abduction, flexion, external rotation) and elbow flexion in this select group of older patients.

Table 1. Toronto and Active Movement Scale (AMS) Scores Before and After Microsurgery in Brachial Plexus Birth Palsy

<table>
<thead>
<tr>
<th>Variable</th>
<th>Preop 1 yr postop</th>
<th>Preop 2 yr postop</th>
<th>Preop 3 yr postop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Toronto</td>
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<td></td>
<td></td>
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<tr>
<td>Total AMS score</td>
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<td></td>
<td></td>
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<tr>
<td>Shoulder</td>
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<td>Elbow</td>
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<td>Abduction</td>
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<td>Flexion</td>
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<td></td>
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<td>External rotation</td>
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<td>Wrist</td>
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<td>Forearm</td>
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<td>Foot</td>
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<tr>
<td>Total AMS score</td>
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<tr>
<td>Shoulder</td>
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<td>Elbow</td>
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<tr>
<td>Abduction</td>
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<td>External rotation</td>
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<td>Foot</td>
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</tbody>
</table>

PAPER 70

Clinical Paper Session 12: Nerve 2
Saturday, October 1, 2016 • 2:05–2:10 PM
Treatment, Prognosis/Outcomes

Outcomes of Late Microsurgical Reconstruction for Brachial Plexus Birth Palsy

Level 3 Evidence
REFERENCES

PAPER 71
Clinical Paper Session 13: Trauma
Saturday, October 1, 2016 • 2:57–3:02 PM
Treatment; Surgical Technique; Prognosis/Outcomes
Proximal Interphalangeal Arthroplasty in Young Patients: An Analysis of 305 Consecutive Primary Arthroplasties
Level 4 Evidence
Eric R. Wagner, MD
William Robinson, MD
Matthew Houdek, MD
Steven L. Moran, MD
Marco Rizzo, MD

COI:
There is no financial information to disclose.

Hypothesis: Increased demand in younger patients has the potential to impact proximal interphalangeal (PIP) arthroplasty outcomes. The purpose of this investigation was to assess the correlation between a young age and outcomes after PIP arthroplasty.

Methods: 305 consecutive primary PIP arthroplasties were performed in over a 14-year period, with an average age of 60 years (16-88). There were 129 arthroplasties performed in patients <60 years of age. In these younger patients (compared to patients over 60), surgical diagnoses included inflammatory arthritis (36% versus 30%), osteoarthritis (35% versus 53%), and post-traumatic arthritis (23% versus 17%). Implant utilized in younger patients (versus older patients) were pyrocarbon (64% versus 63%), silicone (7% versus 8%), and surface replacing arthroplasty (SRA, 29% versus 30%). Both the younger and older group have 3% laborers.

Results: Overall, there were 55 (18%) PIP arthroplasties that required revision surgery, including 33 (26%) in young patients (<60 years) at a mean 1.4 years. Risk of revision surgery was associated with younger ages (P = 0.002). The 2,
5, and 10-year implant survival rates for the patients <60 years were 80%, 71%, and 71%, respectively, which was worse than the older patients (HR 2.10, P = 0.006, Figure 1). Patients younger than 50 years had an increased risk of revision surgery (HR 1.88, P = 0.04). Amongst these younger patients (<60 years), a diagnosis of post-traumatic arthritis increased the risk for revision surgery (Table 1). The use of silicone implants decreased the risk of revision surgery (Figure 1). Complications in the younger patients included dislocation (n = 13), infection (n = 6), intraoperative fracture (n = 9), and postoperative fracture (n = 1). The risk of dislocation was increased in younger patients (P = 0.02). Amongst the young patients, use of a silicone implant decreased the risk of dislocation (P < 0.001). In unrevised patients at a mean 5.3 years follow-up (1-12), preoperative to postoperative pain levels significantly improved in patients <60 years (P < 0.001). PIP total arc of motion did not significantly improve from 38 degrees preoperatively to 37 degrees postoperatively (P = 0.71), and there was no significant change in grip or pinch strength. Older patients had improved PIP motion compared to patients younger than 60 years (P = 0.045), but no differences in pain or pinch strength.

Summary Points:
- Younger age leads to worse outcomes after PIP arthroplasty, particularly in the setting of post-traumatic arthritis.
- Silicone implants have improved rates of revision and complications in patients <60 years.
- However, PIP arthroplasty predictably relieves pain and preserves motion with low complications in these younger patients.

Table 1: Hazard Ratios for Implant Failure in PIP Arthroplasty in Patients Younger than 60 Years of Age

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Hazard Ratio</th>
<th>95% Confidence Interval</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicone</td>
<td>&lt;0.01</td>
<td>------</td>
<td>*p = 0.01</td>
</tr>
<tr>
<td>Pyrocarbon</td>
<td>1.21</td>
<td>0.60 – 2.59</td>
<td>p = 0.60</td>
</tr>
<tr>
<td>SRA</td>
<td>1.22</td>
<td>0.57 – 2.47</td>
<td>p = 0.59</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>0.88</td>
<td>0.40 – 1.80</td>
<td>p = 0.73</td>
</tr>
<tr>
<td>Post-Traumatic Arthritis</td>
<td>2.63</td>
<td>1.30 – 5.25</td>
<td>*p = 0.008</td>
</tr>
<tr>
<td>Inflammatory Arthritis</td>
<td>0.73</td>
<td>0.35 – 1.46</td>
<td>p = 0.38</td>
</tr>
<tr>
<td>Preoperative Instability</td>
<td>1.07</td>
<td>0.43 – 2.33</td>
<td>p = 0.88</td>
</tr>
<tr>
<td>Female</td>
<td>0.72</td>
<td>0.36 – 1.51</td>
<td>p = 0.37</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>0.32</td>
<td>0.02 – 1.49</td>
<td>p = 0.18</td>
</tr>
<tr>
<td>Bone Graft</td>
<td>0.94</td>
<td>0.15 – 3.11</td>
<td>p = 0.93</td>
</tr>
<tr>
<td>Laborer</td>
<td>1.32</td>
<td>0.07 – 6.18</td>
<td>p = 0.79</td>
</tr>
<tr>
<td>Index Finger</td>
<td>0.92</td>
<td>0.37 – 1.99</td>
<td>p = 0.83</td>
</tr>
<tr>
<td>Dominant Hand</td>
<td>0.72</td>
<td>0.36 – 1.44</td>
<td>p = 0.35</td>
</tr>
<tr>
<td>BMI</td>
<td>1.05</td>
<td>0.99 – 1.11</td>
<td>p = 0.11</td>
</tr>
</tbody>
</table>

S43
**PAPER 72**

Clinical Paper Session 13: Trauma  
Saturday, October 1, 2016 • 3:04–3:09 PM  
Treatment; Surgical Technique; Prognosis/Outcomes

**Total Wrist Arthroplasty in Patients Younger than 60 Years of Age: An Analysis of 261 Consecutive Primary Arthroplasties**  
Level 4 Evidence

Eric R. Wagner, MD  
Casey M. DeDeugd, MD  
Marco Rizzo, MD

**COI:**  
There is no financial information to disclose.

**Hypothesis:** The outcomes of upper extremity small joint arthroplasty in young patients has yet to be examined. The purpose of this investigation was to define the association between a young age and outcomes after TWA.

**Methods:** Using our institution’s total joint registry, 445 consecutive primary TWA arthroplasties were performed at our institution from 1974 to 2013. The average age was 57 years (16-83). There were 261 arthroplasties performed in patients <60 years of age. In these younger patients, the surgical diagnoses included osteoarthritis (3%), inflammatory arthritis (91%), and post-traumatic arthritis (PTA, 7%). The implants in this study included Remotions (n = 19), Biax (n = 99), Volz (n = 10), Meuli (n = 91), Universal (n = 4), and Swanson (n = 38). Cement was used in 215 (82%), while 27 (10%) required augmentation with bone graft.

**Results:** Overall, there were 110 (25%) TWA arthroplasties that required revision surgery at a mean of 5.4 years postoperatively. In the young patients (<60 years), 81 (31%) required revision surgery at a mean 5.6 years postoperatively for loosening (n = 36), component fracture (n = 6), infection (n = 7), wrist instability (n = 20), and other (n = 12). Risk of revision surgery was not associated with age taken as a continuous variable (P = 0.44), but there was an increased risk of revision surgery when comparing those younger than 60 to those older than 60 years (HR 1.61, P = 0.02). The 5, 10, and 20-year implant survival rates for the patients <60 years were 80%, 70%, and 60%, respectively, which was significantly lower the older patients (Figure 1). Amongst the younger patients, the risk for revision surgery was increased in osteoarthritis, but this was not significant (Figure 1). Swanson implants had improved implant survival (Table 1). In the younger patients, there were 4 intraoperative complications involving fracture in the younger patients. Postoperative complications in the younger patients included dislocation (n = 24), infection (n = 13), postoperative fractures (n = 11), implant loosening (n = 41), recurrent subluxation (n = 17) heterotopic ossification (n = 5), tendon/ligament injury (n = 12), and wear (n = 6). The risk of carpal component loosening was increased in patients younger than 60 years, while dislocation and fractures were not.

**Summary Points:**
- Younger age lead to slightly higher rate of revision surgery and complications, particularly implant loosening after total wrist arthroplasty.
- Swanson implants performed better in this younger population.
- These findings help when counseling patients, estimating risk, and potentially evaluating risk in health policy.

**Table 1:** Hazard Ratios for TWA Implant Failure in Patients Younger than 60 years

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Hazard Ratio</th>
<th>Confidence Interval</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>1.03</td>
<td>0.95 – 1.12</td>
<td>0.44</td>
</tr>
<tr>
<td>Female</td>
<td>1.09</td>
<td>0.86 – 1.89</td>
<td>0.76</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>2.03</td>
<td>0.50 – 5.48</td>
<td>0.28</td>
</tr>
<tr>
<td>Inflammatory Arthritis</td>
<td>0.93</td>
<td>0.48 – 2.10</td>
<td>0.85</td>
</tr>
<tr>
<td>Post-traumatic Arthritis</td>
<td>0.82</td>
<td>0.29 – 1.84</td>
<td>0.66</td>
</tr>
<tr>
<td>Tourniquet Time</td>
<td>1.00</td>
<td>0.99 – 1.01</td>
<td>0.84</td>
</tr>
<tr>
<td>Operative Time</td>
<td>1.01</td>
<td>1.00 – 1.01</td>
<td>0.17</td>
</tr>
<tr>
<td>Preop Instability</td>
<td>1.83</td>
<td>0.50 – 5.88</td>
<td>0.44</td>
</tr>
<tr>
<td>Remotion</td>
<td>2.23</td>
<td>0.77 – 5.11</td>
<td>0.13</td>
</tr>
<tr>
<td>Biax</td>
<td>0.81</td>
<td>0.51 – 1.28</td>
<td>0.37</td>
</tr>
<tr>
<td>Volz</td>
<td>0.61</td>
<td>0.10 – 1.92</td>
<td>0.45</td>
</tr>
<tr>
<td>Meuli</td>
<td>1.47</td>
<td>0.95 – 2.28</td>
<td>0.09</td>
</tr>
<tr>
<td>Universal</td>
<td>3.73</td>
<td>0.61 – 12.07</td>
<td>0.13</td>
</tr>
<tr>
<td>Swanson</td>
<td>0.50</td>
<td>0.22 – 0.98</td>
<td>0.04</td>
</tr>
<tr>
<td>Bone Graft</td>
<td>1.50</td>
<td>0.70 – 2.85</td>
<td>0.27</td>
</tr>
<tr>
<td>Cemented Implant</td>
<td>0.90</td>
<td>0.51 – 1.75</td>
<td>0.74</td>
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**PAPER 73**

Clinical Paper Session 13: Trauma  
Saturday, October 1, 2016 • 3:11–3:16 PM  
Treatment; Therapy/Rehabilitation; Prognosis/Outcomes

**Perioperative Glucocorticoid Administration Improves Elbow Motion in Terrible Triad Injuries**  
Level 3 Evidence

Mihir J. Desai, MD  
Andrew P. Matson, MD  
David S. Ruch, MD  
Fraser J. Leversedge, MD  
J. Mack Aldridge, MD  
Marc J. Richard, MD

**COI:**  
There is no financial information to disclose.

**Hypothesis:** Among patients who undergo surgical treatment of terrible triad elbow injuries (TTEI), we hypothesized that those who received perioperative glucocorticoid (GC) therapy would have improved postoperative pain and range of motion (ROM), and a similar complication rate compared to those patients who did not receive GC therapy.

**Methods:** After obtaining approval from an institutional review board, 26 consecutive patients who underwent surgical treatment of TTEI from 2009-2015 were retrospectively identified. Thirteen patients received a single intraoperative dose of 10mg intravenous dexamethasone followed with an outpatient 6-day Medrol dose pack (GC group), and 13 did not (control group). All patients were placed in a postoperative splint at 90 degrees of flexion with the forearm in pronation. Range of motion was initiated at 2 weeks. Patients were seen in clinic at 2, 6, 12, and 24 weeks postoperatively, at which time visual analog scale (VAS) pain scores and ROM data was collected and any complications were noted.

**Results:** Average follow-up was 50.3 weeks (range, 21.1-77.0). Compared to the control group, the GC group had greater flexion-extension arc of motion ROM at 24 weeks (132.5 versus 105.5 degrees, P = 0.026). At all other time points, the flexion-extension arc ROM comparison favored the GC group but did not reach statistical significance. Supination measurements were significantly greater for the GC group at every time point with a difference at final follow-up of 23.2 degrees (61.0 versus 84.2 degrees, P = 0.039). Pronation measurements and VAS pain scores did not differ
between groups. There were 5 complications in the control group (35.8%) of which 3 required additional surgery, 3 in the GC group (23.1%) of which 1 required another surgery ($P = 0.667$). There were no postoperative infections in either group.

**Summary Points:**
- Perioperative glucocorticoid administration is associated with improved ROM following surgical treatment of TTEI.
- The flexion-extension arc and supination were significantly improved. As patients are initially splinted and rehabilitated in a pronated position, there was no difference in final pronation measurements between the groups.
- Postoperative pain scores and complication rates are similar between GC and control groups.

### References

### PAPER 74
Clinical Paper Session 13: Trauma
Saturday, October 1, 2016 3:18–3:23 PM
Evaluation/Diagnosis; Anatomy; Basic Science

Distal Ulnar Hounsfield Units Accurately Predict Bone Mineral Density and Future Fragility Fracture Risk
Level 3 Evidence

Scott Wagner, MD
Theodora Catherine Dworkor, MD
Patrick Grimm, MD
George C. Balazs, MD
Scott M. Tintle, MD

**COI:**
There is no financial information to disclose.

**Hypothesis:**
Hounsfld unit (HU) measurement from wrist computed tomography (CT) may provide an effective screening tool for low bone mineral density (BMD). We hypothesized that HU measurements from wrist CT scans would accurately evaluate forearm BMD, and low HU values would effectively predict the occurrence of fragility fractures.

**Methods:**
An electronic database of radiographs was queried for all wrist CT scans obtained at a single institution, and a database of all active duty and military dependents was cross-referenced with the CT scan population to identify all patients with both wrist CT and DXA. Hounsfld unit measurements were performed by one author blinded to DXA results on sequential coronal CT slices of the distal ulnar head. Average HU values were compared to forearm and femoral neck T-score determined by DXA scan. Medical records were then manually reviewed for the occurrence of any fragility fracture.

**Results:**
There were 161 CTs in 159 patients included; 74 patients also had available DXA scans. For the population with both CT and DXA, average HU were significantly lower in the DXA-confrmed osteoporotic and osteopenic groups when compared to the normal BMD group (98.1 and 126.9HU versus 198.6HU, respectively, $P < 0.0001$). The upper limit 95% confidence interval for forearm osteopenia patients was 145.8HU. Overall, the prevalence of fragility fractures was 15.7%. Average HU in the fragility fracture group was significantly lower (126.2 versus 200.5HU, $P < 0.0001$). The percentage of patients with HU below 145.8HU who subsequently sustained fragility fractures was significantly higher (29.5% versus 2.5%, $P < 0.0001$). The odds ratio for fragility fracture in the low HU group was 16.9 (range: 3.8 to 74.6). The sensitivity of forearm HU for fragility fracture risk was 92.3%, with a negative predictive value of 97.5%.

**Summary Points:**
- Patients with low BMD of the forearm and femoral neck had significantly lower HU measurements in the distal ulna on CT when compared to patients with normal BMD, and measurements below 145.8HU were strongly associated with low BMD.
- Patients with HU below 145.8HU were 16 times more likely to sustain a subsequent fragility fracture. Using this cutoff, we were able to predict 92% of fragility fractures.
Methods: We hypothesized that young patients with proximal radial fractures (PRF) would have lower levels of 25-hydroxyvitamin D (25(OH)D) and increased levels of bone turnover markers (BTMs) compared to controls without fracture.

Elevated Bone Turnover Markers are Associated with Distal Radius Fractures in Pre-menopausal Women

Level 3 Evidence

Beverlie Ting, MD
Kempland C. Walley, BSc
Thomas G. Travison, PhD
Tamara D. Rozental, MD

Grant received from: OREF Resident Research Project Grant

COI: There is no financial information to disclose.

Hypothesis: Vitamin D deficiency and increased bone turnover markers (BTM) are associated with an increased risk of fragility fractures. We hypothesized that young patients with distal radius fractures (DRF) would have lower levels of 25-hydroxyvitamin D (25(OH)D) and increased levels of BTM compared to controls without fracture.

Methods: Premenopausal women with DRF (n = 20) were prospectively enrolled and compared to age-matched individuals without a fracture (n = 20). Outcome measures included serum levels of 25(OH)D, parathyroid hormone (PTH), markers of bone formation (osteocalcin [OC], N-terminal extension propeptide of type I collagen [P1NP], and bone-specific alkaline phosphatase [BSAP], and markers of bone resorption (C-terminal telopeptide of type-I collagen [CTX-1]). Associations between BTM and DRF were assessed with conditional logistic regression and the utility of markers for fracture prediction was assessed with a receiver operator characteristic (ROC) analysis.

Results: The fracture group and control group were comparable in terms of age, body mass index, and age at menarche. Fracture patients had higher levels of OC (23.09 ± 6.86 versus 17.23 ± 4.19 ng/mL, mean difference = 6.01 ng/mL, 95% CI = 1.32 - 10.70) and P1NP (72.15 ± 25.80 versus 51.99 ± 24.18 ng/mL, mean difference = 20.44 ng/mL, 95% CI = 4.53 - 36.34) and trended toward higher levels of CTX (0.43 ± 0.21 versus 0.32 ± 0.21 ng/mL, mean difference = 0.10, 95% CI = -0.01 - 0.22). The levels of 25(OH)D, PTH, and BSAP were similar between groups. Conditional logistic regression revealed independent associations between DRF and CTX (OR = 7.4 per SD increase, 95% CI = 1.3 - 43.6, P = 0.026) and OC (OR = 2.4 per SD increase, 95% CI = 1.0 - 5.8, P = 0.043). Associations between DRF and P1NP (OR = 4.78 per SD increase, 95% CI = 0.97 - 23.66, P = 0.055) and BSAP (OR = 3.16 per SD increase, 95% CI = 0.96 - 10.37, P = 0.058) trended towards significance (Table 1).

Summary Points:
- 25(OH)D levels were not associated with DRF in pre-menopausal women.
- Patients with DRF had increased levels of BTMs of formation and resorption.
- Women with increased levels of OC and CTX were at higher risk of fracture.
- BTMs may be helpful in predicting fractures in pre-menopausal women.

REFERENCE


PAPER 75

Clinical Paper Session 13: Trauma
Saturday, October 1, 2016  3:25–3:30 PM
Evaluation/Diagnosis; Prognosis/Outcomes

PAPER 76

Clinical Paper Session 14: General
Saturday, October 1, 2016  2:57–3:02 PM
Treatment; Prognosis/Outcomes

Randomized Controlled Trial of Local Steroid Injection in Carpal Tunnel Syndrome: 5 Years Follow-up

Level 1 Evidence

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COI: There is no financial information to disclose.

REFERENCES

**Hypothesis:** Patients with carpal tunnel syndrome (CTS) are commonly treated with local steroid injections. A randomized placebo-controlled trial has shown that injection of 80mg methylprednisolone into the carpal tunnel reduces the need for surgery up to 1 year after injection. No placebo-controlled randomized studies have assessed outcomes of local steroid injection beyond 1 year. We hypothesized that the beneficial effect of methylprednisolone injection in CTS is not durable.

**Methods:** Between November 2008 and March 2012, we conducted a randomized double-blind placebo-controlled trial to assess the efficacy of local injection of 2 different doses of methylprednisolone (80mg and 40mg) in patients with idiopathic CTS, aged 18 to 70 years, not previously treated with steroid injection, and with no thenar atrophy or sensory deficit. Of the 111 patients randomized, 37 patients were assigned to 80mg methylprednisolone, 37 patients to 40mg methylprednisolone, and 37 patients to placebo (saline); each was combined with 1ml lidocaine for a total injected volume of 3ml. No repeat injections were given during the trial. Patients who did not improve or who experienced recurrent symptoms after injection were offered carpal tunnel release surgery. The trial found that during 1 year after injection, carpal tunnel release was done on the study hand in 73% in the 80mg methylprednisolone group, 81% in the 40mg methylprednisolone group, and 92% in the placebo group. Patients who received 80mg methylprednisolone were significantly less likely than those who received placebo to undergo surgery during 1 year (odds ratio 0.24; 95% CI, 0.06-0.95). An extended follow-up of the randomized trial has been conducted; the primary outcome was the difference between the methylprednisolone groups and the placebo group in the proportion of patients who have had carpal tunnel release surgery on the study hand within 5 years after injection.

**Results:** At 5 years after injection, 10 of the 111 patients have not undergone carpal tunnel release surgery on the study hand: 6 in the 80mg methylprednisolone group, 3 in the 40mg methylprednisolone group and 1 in the placebo group ($P = 0.04$).

**Summary Points:**
- In patients with CTS, a first-time local injection of 80mg methylprednisolone had a modest, statistically significant, beneficial effect compared to placebo injection up to 5 years.
- The higher dose of methylprednisolone had better efficacy, compared with placebo, than the dose commonly used in clinical practice.

**REFERENCE**

**PAPER 77**
Clinical Paper Session 14: General Saturday, October 1, 2016 • 3:04–3:09 PM Treatment; Prognosis/Outcomes

A Comparison of Fixation Methods in Adolescent Patients with Diaphyseal Forearm Fractures
Level 2 Evidence

Sarah Elizabeth Sibbel, MD

**COI:** There is no financial information to disclose.

**Hypothesis:** Congenital proximal radioulnar synostosis is a rare congenital anomaly characterized by a fixed forearm rotation. It has the high tendency toward re-ankylosis after separation without interposition between separated radius and ulna. Can the congenital radioulnar synostosis be mobilized? If so, what is the safe and simple procedure for mobilization?

**Methods:** We performed mobilization procedures for 104 forearms in 87 patients. Through a posterior incision, the synostosis was exposed and separated with a high-speed burr. After separation, osteotomy of the radius was performed to reduce the dislocated radius head. After that, a vascularized fascio-fat graft was interposed between separated radius and ulna. Four different procedures were used to interpose the vascularized fat. A free vascularized fascio-fat graft (FVFG) was used in 26 forearms, a pedicle forearm fascio-fat graft with one incision (PVFG-1) in 25, a pedicle forearm fascio-fat graft with both anterior and posterior incisions (PVFG-2) in 26, and a pedicle upperarm fascio-fat graft in two incisions (PVFG-3) in 27.

The mean age at the surgery was 8.1 years (range, 5.1 to 13 years), 7.4 years...
(range, 4.3 to 10.9 years), 7.8 years (range, 4 to 14 years) and 6.0 years (range 4.5 to 6.0) respectively. Preoperative forearm ankylosis was 34.8 degrees of pronation in FVFG, 39.3 degrees in PVFG-1, 40.2 degrees in PVFG-2, and 37.4 degrees in PVFG-3. They were followed-up more than 2 years after surgery.

Results: All patients reported improvements in performing some activities, such as catching a ball, accepting objects such as coins, holding a bowl of soup, and performing gymnastics. Four re-ankyloses were observed among 104 mobilizations. The mean range of active forearm rotation (mean ± SD) after mobilization was 81.6 ± 15.8 degrees in FVFG, 75.4 ± 23 degrees in PVFG-1 excluding 3 re-ankyloses, 71.1 ± 27.4 degrees in PVFG-2, and 70.2 ± 25.4 degrees in PVFG-3 excluding 1 re-ankylose. The average surgery time was 9.8 ± 0.79 hours in FVFG, 4.3 ± 2.0 hours in PVFG-1, 3.9 ± 1.3 hours in PVFG-2, and 4.2 ± 1.7 hours in PVFG-3.

Summary Points:

- This mobilization procedure prevented re-ankylosis after separation of the synostosis and provided some forearm rotation that improved a child’s daily activities.
- Mobilization with a pedicle fascio-fat graft shortened the surgery time than those with free vascularized fascia-fat graft.
- Two-incision technique could securely fasten PVFG to the space between separated radius and ulna and may prevent re-ankylosis.

REFERENCE


PAPER 79

Clinical Paper Session 14: General Saturday, October 1, 2016 • 3:18–3:23 PM Treatment; Therapy/Rehabilitation

Erythropoietin is Neuroprotective During Ongoing Compression and Speeds Recovery Following Surgical Decompression in a Murine Model of Chronic Compression Neuropathy

N/A - Not a clinical study
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Grant received from: American Foundation for Surgery of the Hand (Hand Surgeon Scientist Award), National Institute of Health grant (# 1 K08 AR060164-01A), Clinical and Translational Science Award (CTSA) grant (# UL1 TR000042), through the University of Rochester School of Medicine & Dentistry, University of Rochester CTSA award (# TL1 TR000096) from the National Center for Advancing Translational Sciences of the National Institutes of Health, University of Rochester Center Goldstein Grant, University of Rochester Laboratory Startup Fund, ART/CTSI Student Research Fellowship Award- salary support for Co-Investigator and medical student, Leigh Sundem

COI: There is no financial information to disclose.

Hypothesis: We previously described erythropoietin’s (EPO) effectiveness in ameliorating the effects of acute peripheral nerve crush. Pilot studies indicate that EPO therapy is an effective neuromodulatory agent for the treatment of chronic nerve compression (CNC) when used as an adjuvant to surgical decompression. This left open the question as to whether pre-treatment with EPO during compression would be relevant in reducing the effect of ongoing compression.

Methods: CNC injury was created in wild-type mice by placing an inert silastic sleeve around the sciatic nerve as in previous work. Decompression surgery was performed at 6 weeks with alternative mice receiving pre-decompression treatment. Nerve conduction studies were performed weekly before decompression and every 48-hours thereafter until full recovery. Sixty mice were randomized into either a sham-surgery group, saline-treatment control (saline/saline), or 1 of 2 EPO-treatment groups with initiation of EPO at day 0 (EPO/EPO), or week 6 (saline/EPO) in conjunction with surgical decompression. Comparison of NCV was tested with one-way ANOVA followed by Student’s t-test in this dataset, which was normally distributed.

Results: During compression, there was a progressive decline in nerve conduction velocity (NCV) as compared to sham-injured animals where NCV remained normal (~ 55 m/s) throughout the experiment (Figure 1A). NCV in saline-treated animals progressively decreased from normal (55.153.42 m/s) to a plateau (35.680.72 m/s) over 6 weeks of compression. This expected decline was strikingly attenuated in randomly-selected animals treated with EPO (NCV decreased from 54.091.67 to 45.771.08 m/s, P < 0.01) so that EPO-treated animals fared significantly better than saline-treated counterparts (P < 0.01). Following decompression, all animals recovered to a normal baseline NCV by day 15 (P = 0.74); however, the improvement in NCV observed was markedly accelerated within the first week post-decompression in the EPO-treated groups, and not in saline-treated counterparts (P < 0.01). Animals treated with EPO during both phases fully recovered in half the time as those treated only after decompression (day 5 versus day 9 P < 0.05).

Summary Points:

- This study supports the possibility of EPO as a neuroprotective agent during CNC injury in rodents and may support adjuvant use during active compression.
- Improvement in electrophysiologic parameters is observed with EPO treatment during compression and decompression phases.
- EPO may accelerate the natural recovery of decompressed nerves and protect against ongoing injury through the same mechanism, which suggests translational relevance.

REFERENCES

Congenital Syndactyly Reconstruction of 391 Webspaces: An 18 Year Experience

David L. Colen, MD

COI: There is no financial information to disclose.

Hypothesis: Congenital syndactyly occurs in isolated and syndromic forms; method of reconstruction must be tailored to the type of syndactyly, and postoperative function will depend on the pre-operative state of the hand in addition to the method of reconstruction selected.

Methods: All patients who underwent webspace reconstruction for congenital syndactyly by the senior author over an 18 year period were included in this study. Data included demographics, medical history, anatomy and severity of syndactyly, surgical technique, follow-up and need for revision. Patients who underwent hand surgery prior to their first clinic visit were excluded from outcomes analysis. Logistic regression was performed to identify factors that were associated with postoperative wound complications and revision.

Results: Reconstruction was performed for 182 patients with 391 webspaces; 21 patients were referred from outside surgeons and excluded from analysis. Twenty-six patients had complications (16%), of which 13 (8%) required revision. The most common complications were web creep (n = 10), scar contracture (n = 6), and flexion contracture (n = 5). Dorsal VY advancement flap was the most common method for reconstructing simple incomplete syndactyly and was associated with decreased risk of complication in the 3rd webspace (OR = 0.427, P = 0.006), while triangular flaps and skin graft were associated with increased complications (OR = 2.75, P < 0.001). Presence of a complicated hand anomaly did not significantly increase the likelihood of complications (P = 0.21).

Summary Points:
- Syndactyly is a common congenital hand condition that occurs as both an isolated anomaly and as part of several syndromic diagnoses.
- We describe the largest retrospective cohort of congenital syndactyly reconstruction to date and discuss important technical and clinical considerations to minimize postoperative complications and revisional surgery.

This research was supported by a 2013 Hand Surgeon Scientist Award from the American Foundation for Surgery of the Hand.