

AM E-POSTER 01: A Biomechanical Comparison Between Knotless Suture Anchor and Outside - In Peripheral Triangular Fibrocartilage Complex Repairs

Category: Arthroscopy

Keyword: Wrist

Not a clinical study

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Hypothesis: The traditional outside-in technique for Palmer 1B triangular fibrocartilage (TFCC) tears utilizes a soft-tissue capsular repair of only the superficial layer of the articular disk. However, the TFCC's origin from the fovea of the distal ulna lends itself to the use of suture anchors for repair of both the superficial and deep layers directly to bone. We hypothesize that an all-arthroscopic suture anchor repair is biomechanically stronger than an outside-in repair.

Methods: The distal ulna and TFCC were dissected from 12 matched cadaveric wrists and peripheral TFCC "tears" were made in each wrist. Six TFCC tears were randomized to receive the standard outside-in technique repair using two 2-0 PDS (Ethicon, Somerville, NJ) sutures placed in a vertical mattress fashion. The remaining six TFCC tears were repaired using mini-pushlock suture anchors (Arthrex, Naples, FL) to the fovea. The strength of the repairs was then determined using a MTS machine with the load placed across the repair site. The repairs were loaded until a gap of 2 mm formed across the repair site and then subsequently to failure. Load at 2 mm gap formation, maximum load, and mode of failure were recorded. Load at 2 mm gap formation and maximum load for each repair technique were compared using the Wilcoxon Signed Rank test and p-values less than or equal to 0.05 were considered significant.

Results: In withstanding 2 mm of diastasis, the all-arthroscopic repairs (10.0 +/- 3.0 N) were stronger than the outside-in repairs (1.8 +/-0.8 N, $p < .05$). For load to failure, the all-arthroscopic repairs (72.5 +/- 3.3 N) were stronger than the outside-in repairs (54.3 +/-6.4 N, $p < .05$). Catastrophic soft-tissue injury or suture pull-out accounted for all failures.

Summary:

- An all-arthroscopic suture anchor TFCC repair is biomechanically stronger than an outside-in repair.
- With a stronger repair, a patient may begin early range of motion and avoid the possible sequelae of lost time from work and deconditioning due to extended cast immobilization.

- The suture anchor technique allows for repair of both the superficial and deep layers of the articular disk directly down to bone, restoring the native TFCC anatomy.
- By being knotless, the suture anchor repair avoids irritation to the surrounding soft tissues by suture knots.

References:

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4. Yao J, Lee AT. All-Arthroscopic Repair of Palmer 1B Triangular Fibrocartilage Complex Tears Using the FasT-Fix Device. *J Hand Surg* 2011;36A:836-842.
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◆ Nothing of financial value to disclose

AM E-POSTER 02: Efficacy of Brachial Plexus Nerve Block in Elbow Arthroscopic Surgery: A Randomized Trial

Category: Arthroscopy

Keyword: Elbow

Level 2 Evidence

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- ◆ Gosuke Oki, MD
- ◆ Kosuke Iba, MD
- ◆ Kohei Kanaya, MD, PhD
- ◆ Sonoda Tomoko, DDS

Hypothesis: The purpose of this study is to evaluate early postoperative pain level after arthroscopic elbow surgery under general anesthesia and to determine whether an axillary nerve block provide additional pain management benefit as compared with local anesthetic injection at portals. We hypothesized that axillary nerve block with long-acting anesthetic might provide additional pain management benefits.

Methods: Thirty-six patients undergoing arthroscopic elbow surgery under general anesthesia were randomized to either a study group receiving axillary nerve block (Ax group; n=18) or a control group receiving local anesthetic injections at portals (Lo group; n=18) (TABLE 1). During the first 48 hours after surgery, pain visual analog scale (VAS) scores (0 to 100), total amount of oral analgesics requirement, and patient satisfaction were assessed. Prospective power analysis determined that a minimum of 17 subjects were required in each group. The Student's t-test and chi-square or Fischer's exact test were used for statistical analyses. $P < 0.05$ was considered to be statistically significant.

Results: Among all 36 patients, mean pain VAS scores (\pm SD) at rest were 37 ± 28 , 18 ± 19 , and 9 ± 14 at first 12 hour-period, 24, and 48 hours after surgery, respectively. The mean VAS scores during physiotherapy were 47 ± 29 and 33 ± 29 at 24 and 48 hours after surgery, respectively. No significant differences were found in the mean pain VAS scores at any time point after surgery between the Ax and Lo groups (FIGURE 1). Mean number of loxiprofen (20mg) tablets required during 48 hour study period was 5.1 ± 6.9 in the Ax group and 4.5 ± 9.1 in the Lo group. No significant difference was observed. Among all 36 patients, mean satisfaction VAS score (\pm SD) was 91 ± 15 . The Ax group and Lo group had overall patient satisfaction score of 91 ± 10 and 91 ± 11 , respectively. No significant difference was observed.

Summary:

- Postoperative mean pain VAS scores at rest after arthroscopic elbow surgery under general anesthesia were found to be 37 at first 12 hour-period and 18 at 24 hours.
- No intergroup differences were observed between the Ax and Lo groups in terms of VAS pain scores, oral analgesics requirement, and VAS satisfaction scores.
- An axillary nerve block was not found to provide any postoperative pain control benefit.

References:

1. Bowens C, Jr., et al. Regional blockade of the shoulder: approaches and outcomes. *Anesthesiol Res Pract* 2012;2012:971963.
2. Chung MS, et al. Evaluation of early postoperative pain and the effectiveness of perifracture site injections following volar plating for distal radius fractures. *J Hand Surg Am* 2010;35:1787-1794
3. Wada T, et al. Functional outcomes after arthroscopic treatment of lateral epicondylitis. *J. Orthop. Sci.* 2009;14:167-174.
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5. Krenzel BA, et al. Posterior capsular injections of ropivacaine during total knee arthroplasty: a randomized, double-blind, placebo-controlled study. *J. Arthroplasty* 2009;24:138-143.

TABLE 1. Patient Data

	Both Groups	Ax Group	Lo Group	P Value
Number	36	18	18	
Sex (M/F)	27/9	12/6	15/3	.59
Age (years)	51±9	50±10	53±8	.29
Surgery time (min)	97±36	105±38	90±33	.25
Disease				.24
Osteoarthritis	17	7	10	
Lateral epicondylitis	14	9	5	
Rheumatoid arthritis	3	1	2	
Plica	2	1	1	

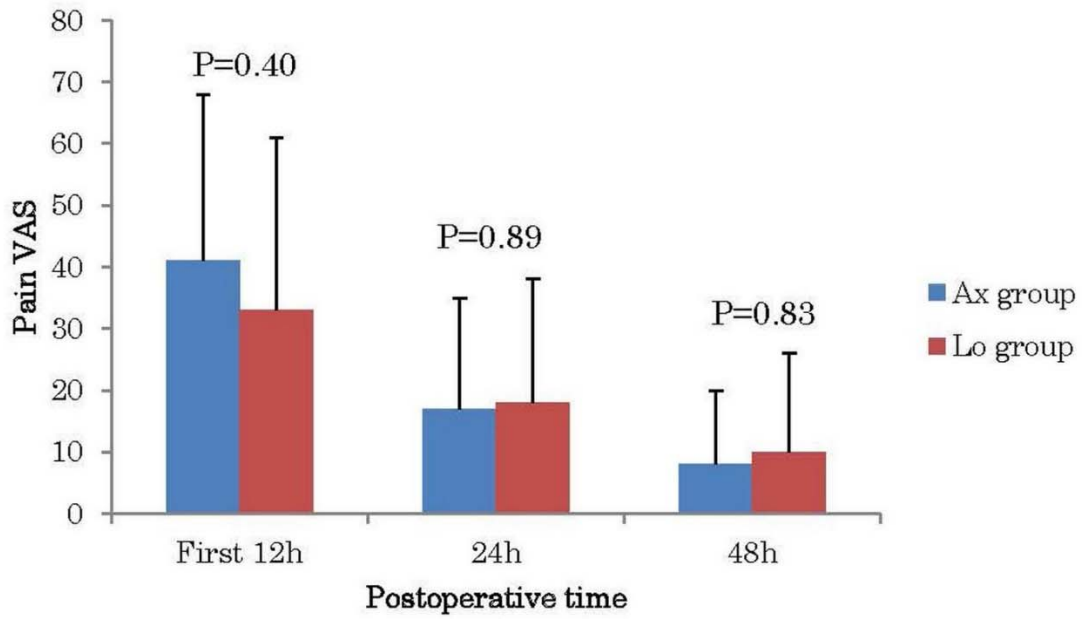


FIGURE 1: Postoperative VAS pain scores at rest after elbow arthroscopic surgery

◆ Nothing of financial value to disclose

AM E-POSTER 03: Locking of the DRUJ Due to TFCC Tear

Category: Arthroscopy

Keyword: Wrist

Level 4 Evidence

◆ Toshiyasu Nakamura, MD, PhD

◆ Yasuhiro Yoshikawa, MD, PhD

◆ Noboru Matsumura, MD, PhD

◆ Takuji Iwamoto, MD, PhD

◆ Kazuki Sato, MD, PhD

◆ Yoshiaki Toyama, MD, PhD

Hypothesis: Locking of the DRUJ indicates severe restriction of supination with normal range of pronation, maybe due to TFCC injury¹. We evaluated our consecutive 19 cases of DRUJ locking.

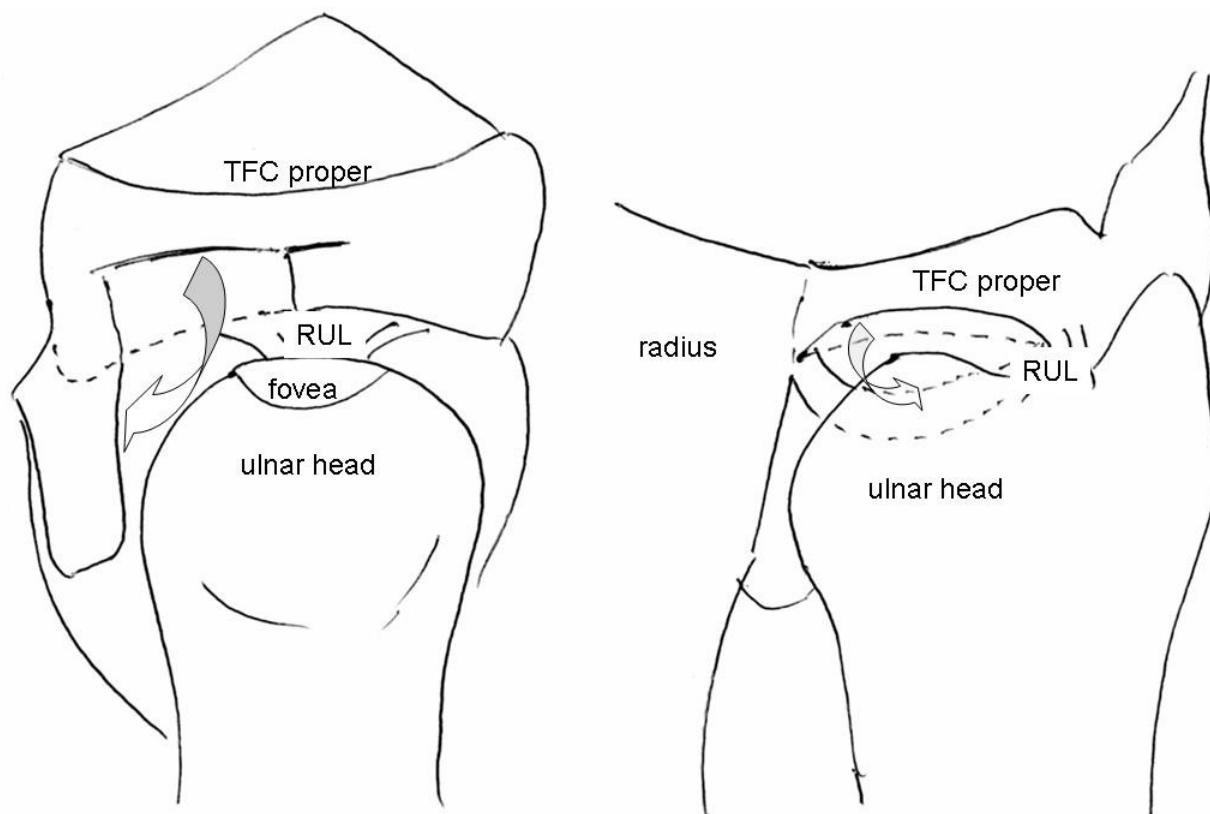
Methods: Nine male and 10 female indicated severe loss of supination without any restriction of pronation. Mean age was 30 (range 14-47). There were 10 right and 9 left wrists. Eight cases had lightly injured, 1 had fall, and however, 10 cases claimed unknown cause. Fourteen wrists indicated locked supination in 0 to 20 degrees, while 4 demonstrated 45 to 60 degrees of supination. One case indicated -70 degrees supination. Further supination could not be possible. Pronation range was normal in 17 wrists, while 2 wrists indicated 60 degrees of pronation. Ulnar variance demonstrated +5 mm in 1 wrist, +3 mm in 4, +2 mm in 1, and neutral in 13. All were underwent wrist arthrogram and arthroscopy. We evaluated arthrogram and arthroscopic findings, and treatments.

Results: In arthrogram, 13 wrists demonstrated overlapping of the TFCC shadow on the ulnar head. Manual reduction of the DRUJ was achieved in the first 3 cases with dorsal peripheral rupture of the TFCC. Open reduction of the overlapped TFCC on the ulna was done in next 10 cases. When the proximal side of the TFCC was raised up from the ulnar head, supination could be possible. Ulnar shortening was done in 5 cases. Arthroscopic reduction was possible in 6 wrists, among them 1 wrist needed ulnar shortening for positive ulnar variance. Pathomechanics of the DRUJ locking were entrapping of the dorsal RUL in 10, palmar RUL in 8, and flap tear of the TFC into the DRUJ in 1. Arthroscopic reduction was possible in entrapped palmar RUL or TFC flap. After reduction of the DRUJ locking, supination range indicated average 83 degrees with 90 degrees of pronation. There was no re-locked case.

Summary: DRUJ locking is mainly due to entrapping of the ulnar head into the dorsal or palmar RUL (Fig. 1). Manual reduction introduces dorsal peripheral rupture of the TFCC, so we recommend release of the locking in arthroscopic or open fashion.

References:

1. Takahashi S, Nakamura T, Sato K, Toyama Y: J Wrist Surg 2013;2:83–86.



◆ Nothing of financial value to disclose

AM E-POSTER 04: Long-Term, Hardware-Related Complications Following Radiocarpal Arthrodesis Using a Dorsal Plate

Category: Arthritis

Keyword: Wrist

Level 4 Evidence

◆ Stephen E. Berling, BS

◆ Peter J. Stern, MD

◆ Thomas R. Kiefhaber, MD

Hypothesis: Complications more than six months after wrist arthrodesis using dorsal plate fixation are rarely reported. A retrospective chart review was designed under the hypothesis that long-term complications are both frequent and often involve screw or plate failure when the middle finger carpometacarpal joint (CMCJ) is not fused.

Methods: Between 1988 and 2012, we identified 205 wrists in 199 patients who underwent wrist arthrodesis with a dorsal plate. One hundred and twenty-two patients with a minimum follow up of six months were reviewed. Long-term complications were defined as any occurring or persisting more than six months following arthrodesis. Patients with inflammatory arthropathies, and patients who had arthrodesis following tumor resection of the distal radius and failed total wrist arthroplasty were excluded. Hardware-related complications were identified, and all operative notes and postoperative radiographs were reviewed to investigate completeness of fusion and whether failure to fuse the middle finger CMCJ contributed to the complications.

Results: Twenty long-term, hardware-related complications occurred following arthrodesis of 122 wrists (16%). These twenty complications included screw fracture (n=12), plate loosening (n=5), and plate fracture (n=3) and occurred at a median of 2.5 years following arthrodesis. (range, 6 months – 19 years) Thirteen (65%) of the hardware complications occurred when the middle finger CMCJ was not included in the arthrodesis. The middle finger CMCJ did not fuse after attempted arthrodesis in an additional six wrists. We believe that persistent CMCJ motion was likely present in 19 of the 20 wrists (95%) that experienced hardware fracture or loosening. There was one radiocarpal nonunion following wrist arthrodesis and it was accompanied by a plate fracture over the nonunion site. Additional procedures to address the hardware complications were completed in seventeen of the twenty wrists. The additional procedures required included plate removal (n=16), repeat fusion and plating (n=5), and screw removal (n=1).

Summary:

- Wrist arthrodesis is an excellent salvage procedure; however long term complications frequently occur.

- Due to the severity of these hardware-related complications, secondary procedures are required.
- Long term, plate or screws can fail if the middle finger CMCJ is not fused.
- Given the occurrence of hardware failures centering on this joint, we recommend that, unless the plates are routinely removed within a given timeframe, the middle finger CMCJ must be formally fused.

◆ Nothing of financial value to disclose

AM E-POSTER 05: Prosthetic Arthroplasty versus Arthrodesis for Osteoarthritis and Post-Traumatic Arthritis of the Index Finger Proximal Interphalangeal Joint

Category: Arthritis

Keyword: Hand

Level 3 Evidence

- ◆ Mark A. Vitale, MD, MPH
- ◆ Kristin M. Fruth, BS
- Marco Rizzo, MD
- ◆ Steven L. Moran, MD
- Sanjeev Kakar, MD, MBA

Hypothesis: In the surgical treatment of osteoarthritis (OA) or post-traumatic arthritis (PTA) of the index finger proximal interphalangeal joint (PIPJ) the decision to perform prosthetic arthroplasty versus joint arthrodesis remains controversial. The hypothesis was that arthrodesis would result in superior pinch strength and a lower risk of complications and reoperations compared to prosthetic arthroplasty in these patients.

Methods: A retrospective review was conducted comparing the outcomes of patients with primary OA or PTA of the index finger PIPJ treated with prosthetic arthroplasty or arthrodesis from 1999 to 2011. Preoperative and postoperative assessments included digit range of motion (ROM), grip and pinch strength, patient-rated pain and satisfaction scores and the Michigan Hand Questionnaire (MHQ).

Results: Seventy-three patients (79 index finger PIPJs – 68 with OA and 11 with PTA) were followed for an average of 62 months (SD=42 months). Sixty-five patients were treated with prosthetic arthroplasty and 14 with arthrodesis. There was no significant change in ROM in patients undergoing arthroplasty (mean=4.9°, SD=31.6°, p=0.3). There was a significant loss of ROM in patients undergoing arthrodesis (mean=-28.8°, SD=21.8°, p<0.001). Patients undergoing arthroplasty experienced improvement in only opposition pinch (mean=1.8, SD=1.1, p<0.01). There was a significant improvement in both opposition pinch (mean=1.5 kg, SD=0.9 kg, p<0.01) and apposition pinch (mean=3.1, SD=1.4, p<0.01) in those undergoing arthrodesis. There were no differences between arthroplasty and arthrodesis groups with regards to pain, satisfaction and MHQ scores. Patients undergoing arthroplasty compared to those undergoing arthrodesis had a significantly higher mean number of complications per year (mean=0.4, SD=1.1 versus mean=0.3, SD=0.7 respectively, p=0.02) and mean number of complications in the first year postoperatively (mean=1.0, SD=1.3 versus mean=0.3, SD=0.7 respectively,

p=0.02). There was a 4.3 times increased risk of complication in those undergoing arthroplasty versus arthrodesis (CI=1.4 – 13.8, p=0.01).

Summary: Index finger PIPJ arthroplasty provided preservation of ROM, while arthrodesis provided greater improvement pinch strength. The decision for prosthetic arthroplasty versus arthrodesis in the index finger of young, active patients with OA or PTA must be made with patient goals in mind and in light of higher risk of complications associated with prosthetic arthroplasty.

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1. Pellegrini, V.D. and R.I. Burton, Osteoarthritis of the proximal interphalangeal joint of the hand: Arthroplasty or fusion. *J Hand Surg*, 1990. 1990(15A): p. 194-209.
2. Jennings, C.D. and D.P. Livingstone, Surface replacement arthroplasty of the proximal interphalangeal joint using the PIP-SRA implant: results, complications, and revisions. *J Hand Surg Am*, 2008. 33(9): p. 1565 e1-11.
3. Johnstone, B.R., Proximal interphalangeal joint surface replacement arthroplasty. *Hand Surg*, 2001. 6(1): p. 1-11.
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5. Bravo, C.J., et al., Pyrolytic carbon proximal interphalangeal joint arthroplasty: results with minimum two-year follow-up evaluation. *J Hand Surg Am*, 2007. 32(1): p. 1-11.
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8. Wijk, U., et al., Outcomes of proximal interphalangeal joint pyrocarbon implants. *J Hand Surg Am*, 2010. 35(1): p. 38-43.
9. Adams, J., et al., Proximal interphalangeal joint replacement in patients with arthritis of the hand. *J Bone Joint Surg Br*, 2012. 94B: p. 1305-12.
10. Watts, A.C., et al., Pyrocarbon proximal interphalangeal joint arthroplasty: minimum two-year follow-up. *J Hand Surg Am*, 2012. 37(5): p. 882-8.

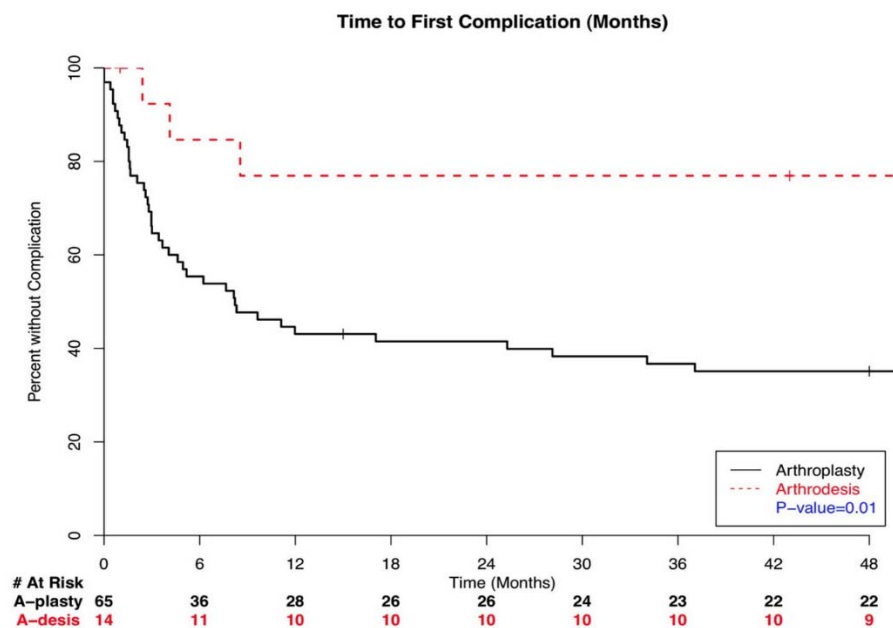
TABLE 1. Differences in Preoperative versus Final Postoperative Values for ROM and Grip and Pinch Strengths within Groups

	Arthroplasty (N=65)			Arthrodesis (N=14)			**p-value
	N	Mean(SD)	*p-value	N	Mean(SD)	*p-value	
Change in PIP Arc (degrees)	49	4.9 (31.6)	0.29	12	-28.8 (21.8)	<0.001	<0.001
Change in Grip Strength (kg)	17	0.1 (8.7)	0.96	6	1.2 (1.9)	0.18	0.67
Change in Opposition Pinch Strength (kg)	8	1.8 (1.0)	<0.01	6	1.5 (0.9)	0.01	0.74
Change in Apposition Pinch Strength (kg)	14	0.9 (2.8)	0.22	6	3.1 (1.4)	<0.01	0.10

* Significance assessed using Wilcoxon signed rank test, assessment that the change within a treatment group is not equal to zero (no change)

** Significance assessed using Wilcoxon rank sum test, assessing for a difference in the change between the two groups, Arthroplasty versus Arthrodesis.

Figure 1. Kaplan-Meier survival curve in which first complication was considered the end point.



- Contracted Research with: SBI, Inc. (Rizzo)
- Other Financial/Material Support received from: Arthrex (Kakar)
- ◆ Nothing of financial value to disclose

AM E-POSTER 06: Ideal Fusion Angle for Thumb Interphalangeal Joint Arthrodesis

Category: Arthritis

Keyword: Hand

Level 3 Evidence

◆ Danielle M. Cross, MD

● Kristofer Matullo, MD

Hypothesis: While a thumb IP joint arthrodesis is typically performed in 0-10 degrees of flexion, most daily activities are completed with increased angles of flexion at the IP joint to facilitate pinch and grip. This study evaluated the preferred thumb IP joint position with certain tasks of daily living in an effort to determine if increased IP angles are more satisfactory

Methods: 28 healthy volunteers (11 males, 17 females, average age of 33.5yrs) were splinted at various degrees (0°, 15°, 30°, 45° bilaterally) with thumb orthotics, leaving the tip free, to mimic various degrees of IP fusion angles. Subjects then underwent a series of power tasks (pouring from a gallon jug, opening/closing a tight jar, lifting a heavy glass, and opening a door), timed precision tasks (writing, buttoning/unbuttoning a shirt, translating coins, zippering/unzippering a jacket, and opening/closing Velcro), as well as pinch and grip strength testing, both at baseline (without any splinting to their thumb), and with the thumb splinted in each of the various angles. Subjects used a 10-point visual analogue scale (VAS) to rate the ease of completing each task, as well as their overall satisfaction with the splint, at baseline and at each of the various angles for their dominant and nondominant hand. Separate Wilcoxon signed rank tests were conducted for selected outcomes, with $p < 0.05$). Across all categories and tasks, VAS ratings were most similar to baseline (thus, the most preferred splint) at a fusion angle of 15° for the dominant thumb, and at 30° for the nondominant thumb. The second most preferred angle of fusion for the dominant thumb was 30°, and for the nondominant thumb was 15°. The lowest scoring splint overall was at 45°, while a splint of 0° ranked third. Overall, the most difficult tasks to perform were precision tasks, such as translating coins or buttoning buttons, while the easiest tasks to perform were power tasks.

Summary: Our current study suggests that a thumb IP fusion angle of 15°- 30° is a functional and preferred angle of thumb IP joint positioning for various activities and should be considered when performing an IP joint arthrodesis.

Table 1:

Angle of Thumb Fusion	VAS (ease)
Baseline	10.0
0°	7.85
15°	8.83
30°	8.35
45°	7.38

Note: Values are averages of Right and Left thumb values

Measurements	OVERALL (across all categories and timed tasks)
Baseline L	10 (7.4-10)
Baseline R	10 (9-10)
0° L	7.55 (2.3-10)
0° R	8.15 (3.2-10)
15° L	9 (3.3-10)
15° R	8.65 (2.8-10)
30° L	7.9 (2.2-10)
30° R	8.8 (2.7-10)
45° L	7.15 (.8-9.8)
45° R	7.6 (1-10)

- Consulting Fees (e.g. advisory boards) received from: Synthes
- ◆ Nothing of financial value to disclose

AM E-POSTER 07: Longevity of Swanson Silicone Arthroplasty in Proximal Interphalangeal Joint Osteoarthritis

Category: Arthritis

Keyword: Hand

Level 4 Evidence

◆ Joshua G. Bales, MD

◆ Lindley B. Wall, MD

◆ Peter J. Stern, MD

Hypothesis: A variety of treatment options exist for degenerative joint disease at the proximal interphalangeal (PIP) joint. Long-term outcomes have rarely been reported. We hypothesize that the Swanson silicone arthroplasty for the PIP joint provides durable, long-term pain relief in osteoarthritis.

Methods: Thirty-eight joints (22 patients) underwent PIP joint Swanson silicone arthroplasty for osteoarthritis. All patients returned for follow-up evaluation at an average of ten years following arthroplasty. Subjective outcomes were assessed utilizing the Quick DASH, Visual Analog Pain Scale, and Likert questionnaire scores. Clinical and radiographic objective data was collected, by measuring range of motion, coronal plane deformation and assessing final radiographs.

Results: Silicone arthroplasty at the PIP joint provided consistent pain relief. The average Quick DASH score was 17 and the average pain VAS score was 0.4. The Likert questionnaire revealed that on average patients either agreed or strongly agreed that they would have surgery again, recommend surgery to another patient, and were satisfied at an average of 10 years postoperative. Furthermore, patients had neutral responses when they rated appearance, functional improvement, and range of motion. Objectively, range of motion (flexion arc of 50°) did not significantly change from the preoperative flexion arc (55°) ($p>0.05$). Radiographically, 31 implants had implant deformation on radiographs and 21 implants had an implant fracture. There were 3 revisions for symptomatic implant fractures and one implant removal for infection.

Summary: Despite unchanged range of motion and considerable radiographic implant deformation or fracture, patients obtained consistent pain relief and satisfaction. Furthermore, there was no correlation between radiographs and satisfaction. With an implant survivorship of 90% at average of 10 years postoperatively, silicone implant arthroplasty remains our treatment of choice for the symptomatic osteoarthritic PIP joint.

References:

1. Pellegrini VD Jr, Burton RI. Osteoarthritis of the proximal interphalangeal joint of the hand: arthroplasty or fusion? *J Hand Surg* 1990;15A:194–209.

2. Swanson AB. Implant resection arthroplasty of the proximal interphalangeal joint. *Orthop Clin North Am* 1973;4:1007–1029.
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◆ Nothing of financial value to disclose

AM E-POSTER 08: Long-term Outcome of the Achilles allograft Interposition for Failed Darrach Distal Ulna Resections

Category: Arthritis

Keyword: Wrist

Level 4 Evidence

- Dean G. Sotereanos, MD
- ◆ Loukia K. Papatheodorou, MD
- ◆ Benjamin G. Williams, MD

Hypothesis: Despite modifications, the reported failure rate of the Darrach's procedure, distal ulnar resection, remains high. To mitigate the symptoms associated with painful convergence and impingement after distal ulna resections, a variety of alternative procedures have been developed with varying success to prevent painful impingement. The aim of this study was to evaluate the long-term outcome of Achilles tendon allograft interposition as a salvage procedure for failed distal ulna resection.

Methods: Twenty-nine patients with painful impingement and instability of the distal ulna following resection of the ulnar head were treated with Achilles tendon allograft interposition. There were 21 women and 8 men with a mean age of 44 years (range, 37-68 years) at the time of the surgery. The Achilles allograft is placed between the distal radius and the resected distal ulna and is secured by sutures through suture anchors to the radius and drill holes to the ulna. All patients were evaluated radiographically and clinically. Functional outcome was assessed with VAS score, measurement of grip strength and forearm rotation and subjective satisfaction parameters.

Results: All patients were followed for at least 12 months. The mean follow-up was 72 months (range, 12 -174 months). At the final follow-up, patient pain levels (on a visual analog scale) were significantly reduced, from 8.1 to 1.3. Comparisons between preoperative and postoperative forearm rotation and grip strength measurements showed an average 28 degrees increase in pronation, 41 degrees in supination and 72% in grip strength. Patients' satisfaction was improved an average of 6.7 points. Postoperative radiographic evaluation demonstrated maintenance of an adequate space between the distal ulna and radius. No graft-related complications or infections were encountered.

Summary: Interpositional arthroplasty with an Achilles allograft is a highly effective procedure for the treatment of failed distal ulna resections preventing impingement and painful convergence of the radius on the ulna. This procedure provides a safe and reliable alternative especially for young, active patients in which a metallic implant or alternative procedure may not be appropriate.

References:

1. Sotereanos DG, Gobel F, Vardakas DG, Sarris I. An allograft salvage technique for failure of the Darrach procedure: a report of four cases. *J Hand Surg* 2002;27Br:317-321.
2. Bieber EJ, Linscheid RL, Dobyms JH, Beckenbaugh RD. Failed distal ulna resections. *J Hand Surg* 1988;13A:193-200.
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4. Greenberg JA, Sotereanos D. Achilles allograft interposition for failed Darrach distal ulna resections. *Tech Hand Up Extrem Surg* 2008;12:121-125.

- Royalties/Honoraria received from: Wright Medical
- Consulting Fees (e.g. advisory boards) received from: Arthrex, Integra, Zimmer, AxoGen
- ◆ Nothing of financial value to disclose

AM E-POSTER 09: Long Term Outcomes of Patients with Bilateral Total Wrist Arthrodesis

Category: Arthritis

Keyword: Wrist

Level 4 Evidence

◆ Eric R. Wagner, MD

◆ Bassem T. Elhassan, MD

● Sanjeev Kakar, MD, MBA

Hypothesis: To date, there is a paucity of information within the published literature on the outcomes of patients with bilateral total wrist arthrodesis. The purpose of this study is to try to report the long-term outcomes of bilateral total wrist arthrodesis.

Methods: A medical record review and prospective follow-up questionnaire study of all patients with bilateral wrist arthrodesis from 1980-2010 within a single institution. Outcome measures included pain levels, Disability of the Arm Shoulder and Hand (DASH), Patient Rated Wrist Evaluations (PRWE), Michigan Hand Questionnaires (MHQs) satisfaction scores, complications and revision surgeries.

Results: Thirteen patients were identified with an average follow up of 14.2 years (3.7-28). The average time between surgeries was 15.8 months (3-55). Eleven (85%) patients had rheumatoid arthritis. Eleven (42%) wrists had undergone prior surgeries. Wrists were fused from 50 of flexion to 300 of extension, with all but two wrists fused within 5 degrees of the contralateral wrist. There was no significant difference between preoperative and postoperative grip strength ($p < 0.9$). Postoperative pain levels significantly improved from preoperative levels ($p < 0.001$), with worse scores seen in on steroids in the perioperative period ($p < 0.03$). The postoperative DASH, PRWE, and MHQ scores were 21.4 (+/-18), 28.6 (+/- 22) and 73.2 (+/- 20), respectively. Increasing age ($p < 0.014$) and perioperative steroid usage ($p < 0.01$) were associated with worse DASH scores. Twelve (93%) of patients were satisfied with their functional outcomes and stated they would do the surgery again. Nine (69%) were able to return to work full time. Patients' most significant functional limitations were opening a doorknob or tight jar. Thirty two percent of patients underwent secondary surgery including 5 revision fusions, 2 plate removals and 2 screw removals. Revision surgeries were increased when the total fusion was not the patient's first wrist procedure ($p < 0.001$), perioperative steroid usage ($p < 0.001$), females ($p < 0.02$), smokers ($p < 0.036$), and fixation with a dorsal locking plate ($p < 0.01$). Of note, the position the wrists were fused in did not have any significant impact on the outcome.

Summary: Bilateral total wrist arthrodesis improves pain, function, and quality of life in patients with severe carpal arthrosis. Although limitations are present, patients adapt and are very satisfied with their functional capabilities.

- Other Financial/Material Support received from: Arthrex
- ◆ Nothing of financial value to disclose

AM E-POSTER 10: Death, Taxes, and Trapeziometacarpal Arthrosis

Category: Arthritis

Keyword: Hand

Not a clinical study

◆ Stéphanie J.E. Becker, MD

◆ Jan Paul Briet, MD

◆ Michiel G.J.S. Hageman, MD

● David C. Ring, MD, PhD

Hypothesis: Evidence suggests that trapeziometacarpal (TMC) arthrosis is a normal part of human aging, but that's not how it's routinely considered. Our primary study question addressed the radiographic prevalence of TMC arthrosis at ten-year age groups in patients who presented with a distal radius fracture aged 31 years and older. We also tested for differences by sex.

Methods: A total of 2321 patients who were 31 years or older with radiographs obtained during treatment of a distal radius fracture between 2002 and 2012 were analyzed. Trapeziometacarpal arthrosis was graded using the 3-point scale of Sodha et al. (no, definite, severe).

Results: Three patients (0.1%) had radiographic evidence of prior surgery for TMC arthrosis and were not included in the analysis. Radiographic TMC arthrosis was noted from 31 years onwards. Its prevalence vastly increased from 17% to 45% between the ages of 41 to 50 years and 51 to 60 years, respectively. The prevalence steadily increased to 85% between the ages of 71 and 80 years, and reached 100% in women (50% severe) aged 91 years or older and 93% in men of 81 years or older (there were only 6 men older than 90 years in our cohort so the 67% prevalence in that age group is not reliable). Severe arthrosis was more prevalent at earlier ages amongst women and reached 35% in women and 34% in men who were 81 years or older. Logistic regression identified age (odds ratio = 2.6 per 10 year interval, 95% confidence interval = 2.4–2.8; $P < 0.0001$) as the strongest factor associated with TMC arthrosis, but sex (women; odds ratio = 1.3, 95% confidence interval = 1.0–1.5; $P = 0.025$) was also a factor.

Summary:

- Age was the most important predictor for radiographic evidence of TMC arthrosis and more severe disease. TMC arthrosis is like grey hair: if you live long enough, you get it.
- This combined with the fact that only three patients had evidence of prior surgery suggests that most people adapt to TMC arthrosis.
- Treatments that optimize adaptation in patients that present with symptoms and disability related to TMC arthrosis merit additional study.

- Contracted Research with: Skeletal Dynamics
- Royalties/Honoraria received from: AO North America, AO International, Wright Medical, Medartis
- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Illuminos
- Consulting Fees (e.g. advisory boards) received from: Wright Medical, Skeletal Dynamics
- Other Financial/Material Support received from: Editor - Journal of Hand Surgery, Journal of Orthopaedic Trauma, Journal of Shoulder and Elbow Surgery
- ◆ Nothing of financial value to disclose

AM E-POSTER 11: Complications and Risk Factors Associated with Arthrodesis of the Thumb Interphalangeal Joint

Category: Arthritis

Keyword: Hand

Level 4 Evidence

◆ Imran K. Choudhry, MD

◆ Steve Hoover, MD

◆ Peter J. Stern, MD

Hypothesis: Arthrodesis of the thumb Interphalangeal joint (IPJ) is performed to alleviate pain and dysfunction. Several techniques are used to perform the fusion such as K-wire fixation, intramedullary screw, and tension band. The purpose of our study was to determine radiographic and patient parameters that determine the risk of complications amongst patients undergoing thumb IPJ arthrodesis.

Methods: A retrospective chart and radiographic review was performed to identify thumb IPJ arthrodeses performed between 1997 and 2010 with a minimum of 10 weeks of follow-up. Patient factors including age, co-morbidities, smoking status, and indications for fusion were recorded along with fusion technique and postoperative complications. Preoperative radiographs were analyzed and the joint was classified as having MINIMAL (congruent joint, none to small osteophytes, minimal loss of articular height), MODERATE (mild joint incongruity, significant bony changes on one articular surface, moderate loss of articular height) or SEVERE (incongruent joint, destruction of both articular surfaces, moderate to severe loss of articular height) pathology. Univariate, Multivariate, and logistical regression analysis were performed.

Results: 74 thumbs met inclusion criteria, of which 68 had complete radiographic data available for analysis. We found 29 complications in 21/74(28%) thumbs. There were 13(18%) nonunions but only one required revision arthrodesis. 37(50%) thumbs were fused using K-wires, 26(35%) using an intramedullary screw, 8(11%) using a tension band, and the remaining 3(4%) with other methods. There was no significant difference between fusion technique and complication rate including nonunion. Age, gender, presence of co-morbidities, smoking status, and joint involvement showed no statistically significant difference with regards to complication rate at the $p=.05$ level. However, the odds of complication among smokers were 4 times that of non-smokers. There was a significant trend ($p=.05$) towards increased complications as joint involvement became more severe. The odds of complication compared to thumbs with mild joint involvement were 3.5 times increased for moderate involvement and 3.8 times increased for severe involvement.

Summary:

- 28% of patients undergoing thumb IPJ arthrodesis will have at least one complication.
- Nonunion is common and can usually be managed without revision surgery and provide a satisfactory outcome.
- Fixation technique has no influence on the nonunion or complication rate.
- The pre operative pathology necessitating fusion did not correlate with complications.
- Smokers are 4 times as likely to develop complications compared to non-smokers.
- Preoperative severity of joint involvement is proportional to the rate of associated complications

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 12: Which is More Debilitating for Upper Extremity Function: Limited Wrist Prono-supination or Limited Wrist Flexion-Extension?

Category: Arthritis

Keyword: Wrist

Level 3 Evidence

◆ Elkin J. Galvis, MD

◆ Sara Sanders, MD

◆ Rodrigo Moreno, MD

Hypothesis: Combined arthritis of the radio carpal joint (RCJ) and the distal radio ulnar joint (DRUJ) is a surgical challenge. In order to decide and plan a reconstruction procedure; one of the most important questions is whether the RCJ versus the DRUJ has a greater impact on function. This study was undertaken to determine whether limited wrist prono-supination or limited wrist flexion-extension is more debilitating for overall upper extremity function.

Methods: We enrolled 25 healthy subjects; 14 females and 11 males; 21 subjects right handed; mean age 35 years. Each subject was tested using seven tasks from the Jebsen Hand Function Test (JHFT). They repeated the JHFT three times. The initial with their dominant hand free to be used as baseline; the second, placed in a regular wrist brace limiting wrist flexion-extension; the third one, placed in a modified sugar tongue splint to limit prono-supination but leaving the wrist free. For each task, a self-reported difficulty scale 1 (easy) to 10 (difficult) was used. A Computerized Baltimore Therapeutic Equipment (BTE) for simulated activities was used to measure ROM; Initially static maximal ROM; and later active as an average of ten repeated and continuous motions.

Results: The restriction of both joints resulted in a consistent increase in the time used. Comparing the results between the wrist brace and the modified sugar tongue, all 7 tasks showed significant increase in time used with the modified sugar tongue ($p>0.05$). The difficulty reported with the wrist brace was 2.37 and 2.89 respectively ($p=0.007$). In flexo-extension the active ROM used was 78.4% of the passive ROM (Table 1). Meanwhile in prono-supination, the active ROM used 99.5 % of total passive ROM (table 2). Using the wrist brace, the active ROM is wider than passive ROM. This demonstrates the other joints in the upper extremity are compensating for lack of wrist movement; instead in prono-supination active ROM was nearly identical to the total passive ROM .

Summary:

- Limiting subjects prono-supination consistently shows the worst performance in terms of time and self-reported difficulty with JHFT.
- The lack of motion in flexion extension is better compensated by other joints in the upper extremity, than prono-supination.
- These results suggest that in combined RC joint and DRUJ Arthritis; focusing on the DRUJ, with preference given to surgical restoration of this joint may result in superior functional outcomes for the patient.

Table 1. ROM flexion and extension in degrees

	Free hand	Wrist brace
Passive		
Flexion	87.5	9.7
Extension	83.6	10
Total ROM	171.1	19.7
Active		
Total 10 motions	1341	706
Each motion	134.1	70.6
Total used active from passive	78.4%	358%

Table 2. ROM pronation and supination in degrees

	Free hand	Modified sugar tongue
Passive		
Pronation	80.7	39.1
Supination	100.3	58.5
Total ROM	181	96.6
Active		
Total 10 motions	1802	942
Each motion	180.2	94.2
Total used active from passive	99.5%	97.51%

◆ Nothing of financial value to disclose

AM E-POSTER 13: Surgical Treatment for Boutonniere Deformity of the Thumb in Rheumatoid Arthritis by Modified EPL Rerouting Procedure

Category: Arthritis

Keyword: Hand

Level 4 Evidence

- ◆ Takuji Iwamoto, MD, PhD
- ◆ Noboru Matsumura, MD, PhD
- ◆ Kazuki Sato, MD, PhD
- ◆ Toshiyasu Nakamura, MD, PhD
- ◆ Yoshiaki Toyama, MD, PhD

Hypothesis: Nalebuff described the surgical technique by reconstruction of the extensor mechanism, called “EPL rerouting technique”, for the treatment of the early stage of the thumb boutonniere deformity in rheumatoid arthritis (RA)¹. However, the unsatisfactory results associated with the recurrence of the deformity or inability of active extension of the IP joint was also reported². We hypothesize that our modified EPL rerouting procedure is effective for the treatment of boutonniere deformity of the thumb.

Methods: Fifteen fingers in 13 RA patients were included in this study. The mean age at the time of the procedure was 55 years (range 22-66 years), and the mean follow-up was 22 months (range 10-42 months). The preoperative deformities were classified into early 6 fingers and moderate 9 fingers according to the system described by Nalebuff. After MP joint synovectomy or arthroplasty, the EPL tendon dislocated ulnarward was reduced dorsally and sutured firmly to the dorsal base of the proximal phalanx. The EPB tendon was dissected from the insertion and transferred to the distal portion of the EPL tendon in order to extend the IP joint (Figure 1). The thumb was held in full extension for 3 weeks by the splint. Clinical examination included an evaluation of the ROM of the thumb, recurrence of the deformity, and the patients’ satisfaction using visual analog scale (VAS: score 0 indicated dissatisfaction, and 100 indicated completely satisfaction).

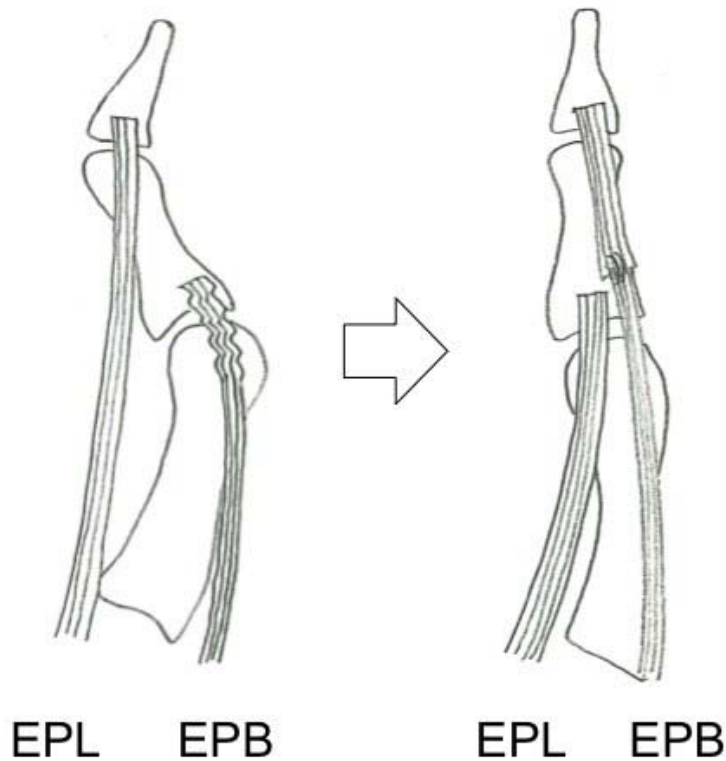
Results: The mean MP joint range of motion significantly increased from 23° to 42°. Above all, the MP joint extension remarkably improved from -58° to -19°. Five IP joints had an active extension deficit of 5, 15, 17, 28, and 37°, whereas only one of these patients complained of the lack of active IP extension. The recurrence of the deformity occurred in 2 finger. Thumb appearance improved in 13 cases, and mean VAS for the satisfaction was 84.

Summary:

- Our modified EPL rerouting procedure reinforced MP joint extension while at the same time preserving the extension of IP joint.
- The technique was effective not only for the early stage, also for the moderate stage in combination with MP joint arthroplasty.

References:

1. Nalebuff EA. The rheumatoid thumb. Clin Rheum Dis, 1984;10:589-607
2. Salgeback S, Eiken O, Haga T. Surgical treatment of the rheumatoid thumb. Special reference to the metacarpophalangeal joint. Scand J Plast Reconstr Surg, 1976; 10: 153-6



◆ Nothing of financial value to disclose

AM E-POSTER 14: Natural History of SLAC Wrist

Category: Arthritis

Keyword: Wrist

Level 4 Evidence

● Richard A. Bernstein, MD

Introduction: Scapholunate advanced collapse (SLAC) is the most common arthritic condition affecting the wrist. Proximal row carpectomy, radial styloidectomy, and various intracarpal fusions have been described to treat SLAC wrist. In 1993 Fassler et. al reported on 25 patients with “Asymptomatic SLAC wrist.” In the ensuing 18 years various open and arthroscopic procedures have been advocated to treat this condition. The purpose of this study was to evaluate the natural history of patients with SLAC wrist to investigate the course of patient symptoms.

Materials and Methods: From 2007 to 2012, 115 wrists in 105 consecutive patients presenting to a single fellowship hand surgeon were identified with SLAC wrist findings. Demographics are shown in Table 1. The radiographs were graded according to Watson (Table 2) and the patient’s clinical findings and course were recorded. 48 were found completely incidentally on films taken for other hand conditions. Sixty-seven, 58.2% presented with wrist pain that was attributable to SLAC degeneration. All patients were fit with wrist splints and offered a cortisone injection and 33 were injected.

Results: At final followup 88.7% were pleased with their progress, had no ongoing or disabling symptoms and were functioning to their fullest capacity. 13 however failed to respond to nonoperative treatment and underwent surgical treatment. Finally in the subgroup of patients who required surgical treatment, 61.5% of these patients were under worker's compensation.

Conclusion: In summary, 88.7 % of patients with radiographic SLAC respond to nonoperative measures with high patient satisfaction. To our knowledge, this is the largest reported series on the natural history of SLAC wrist demonstrating most patients respond to nonoperative measures and treatment.

References:

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2. Watson HK, Ballet FL. The SLAC wrist: scapholunate advanced collapse pattern of degenerative arthritis. *J Hand Surg* 1984;9A: 358–365.

Table 1:

Demographics		
Age	65.5 (33 - 91)	
Gender	Males: 78	Females: 27
Dominant 66	Nondominant 29	Bilateral 20
Handedness	Right 86	Left 29
Hand involved:		
Right 54	Left 41	Bilateral 20

Table 2:

Radiographic Stage	
Stage 1	30
Stage 2	31
Stage 3	44
Stage 4	10

- Consulting Fees (e.g. advisory boards) received from: Biomet, Tornier

AM E-POSTER 15: Longitudinal Radiographic Analysis of Rheumatoid Wrist: Minimum 7 Year Follow-up

Category: Arthritis

Keyword: Wrist

Level 4 Evidence

◆ Kwang-Hyun Lee, MD

◆ Chang-Hun Lee, MD

◆ Hyun-Soo Park, MD

◆ Il-Hoon Sung, MD

◆ Wan-Sun Choi, MD

Hypothesis: Only a few studies had reported the natural course of rheumatoid wrist. Furthermore, there was no concern about spontaneous joint fusion in those studies. The purpose of this study was to address the natural course and spontaneous joint fusion in rheumatoid wrist through minimum 7 year follow up.

Methods: We retrospectively studied 164 patients (213 wrists) who met inclusion criteria; unequivocal diagnosis of rheumatoid arthritis by a rheumatologist, serial x-ray of the hand and wrist at least 7-year interval, age >18 years and 0.05). Ulnar carpal translation was not increased significantly between initial visit (4.6 mm (SD 2.9)) and last follow up (5.7 mm (SD 2.8)).

Summary:

- Radiologic deterioration was more severe in rheumatoid distal radioulnar joint than other wrist joints through minimum 7 year follow up.
- Spontaneous fusion was developed more frequently in midcarpal joint than radiocarpal joint.
- Carpal height ratio and ulnar carpal translation were not differed significantly with appropriate medical treatment.

References:

1. Leak RS, Rayan GM, Arthur RE. Longitudinal radiographic analysis of rheumatoid arthritis in the hand and wrist. *J Hand Surg Am.* 2003 May;28(3):427-34.
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3. Hindley CJ, Stanley JK. The rheumatoid wrist: patterns of disease progression. A review of 50 wrists. *J Hand Surg Br.* 1991 Aug;16(3):275-9.

◆ Nothing of financial value to disclose

AM E-POSTER 16: Clinical Investigation of Total Semi-Constained DRUJ Arthroplasty

Category: Arthroplasty

Keyword: Wrist

Level 4 Evidence

◆ Seth Dodds, MD

◆ Remy Bizimungu

Hypothesis: The distal radioulnar joint (DRUJ) is critical for pronation, supination, weight bearing and gripping. Post-traumatic, degenerative or rheumatoid arthritis of the DRUJ can significantly compromise an individual's ability to perform these essential aforementioned actions. The Scheker total distal radioulnar joint arthroplasty (APTIS Medical, Louisville, KY, USA) replaces all the components of the DRUJ. We hypothesized that this prosthesis would improve forearm range of motion and grip strength while reducing pain in our cohort.

Methods: The goal of this study was to assess wrist functionality over an average of 5 ± 1.1 years follow up of 10 patients who have received the Scheker total distal radioulnar joint prosthesis. The degree of pronation, supination, flexion, extension, radial deviation and ulnar deviation were used to evaluate the change in range of motion of the wrist preoperatively to postoperatively. Change in grip strength was measured with a dynamometer. These measurements were compared to the contralateral unaffected hand. The QuickDASH (Disabilities of the Arm, Shoulder and Hand) outcome measure, the PRWE (Patient-Rated Wrist Evaluations (PRWE) and the Mayo Wrist score questionnaire was administered to the patients to evaluate their upper extremity and wrist function. VAS Pain scores (scale 1-10) were used to determine preoperative to postoperative change in level of pain.

Results: Mean final wrist flexion and extension were $32.1\pm 22.8^\circ$ and $44.8\pm 13.9^\circ$, respectively. Mean final supination and pronation were $72.5\pm 14.4^\circ$ and $69.5\pm 14.6^\circ$, respectively. Average grip strength was 54.9 ± 23.7 lbs. The mean pain score was 3.6 ± 3.1 . Wrist extension, supination, pronation and pain scores all improved but were not statistically significant. Grip strength decreased by less than 1lb while wrist flexion decreased mainly due to a patient who developed an extension contracture. Supination, pronation and grip strength were more than 80% of the contralateral wrist. The QuickDASH, PRWE and Mayo wrist scores were 25 ± 21.9 , 28.9 ± 26.1 and 58.5 ± 22.3 respectively.

Summary: The Scheker total DRUJ implant improved range of motion of the wrist with the exception of wrist flexion while decreasing pain. Supination, pronation, and grip strength were strongly conserved compared to the contralateral wrist. Due to the self-stabilizing nature of this prosthesis and the satisfactory functional outcomes from this study and other studies, the Scheker

prosthesis is a viable option for DRUJ pathology affecting both distal radius and distal ulna that is refractory to more traditional hemiarthroplasties.

References:

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2. Scheker LR. Implant arthroplasty for the distal radioulnar joint. *J Hand Surg.* 2008; 33A:1639–44.
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◆ Nothing of financial value to disclose

AM E-POSTER 17: Limited Wrist Arthrodesis for SLAC Wrist -Triangle Fixation for Four-Corner Fusion

Category: Arthroplasty

Keyword: Wrist

Level 4 Evidence

- ◆ Kosuke Shintani, MD
- ◆ Kiyohito Takamatsu, MD
- ◆ Takuya Uemura, MD
- ◆ Masahiro Yoneda, MD
- ◆ Kenichi Kazuki, MD

Hypothesis: Limited wrist arthrodesis is a commonly performed surgical procedure for the treatment of scapholunate advanced collapse wrist (SLAC wrist) because of its ability to provide pain relief with preserving wrist motion. Kirschner-wires originally have been used for internal fixation. However the long-term cast immobilization, pin tract infection or necessity of hardware removal was remained as problem. We report a new internal fixation technique for ‘Triangle fixation for four-corner fusion’ (Fig.1) as a treatment for SLAC wrist, and evaluate its biomechanical strength and clinical outcomes compared with those of Kirschner wires fixation. Hypothesis of this study is ‘Triangle fixation for four-corner fusion’ would be superior compared with Kirschner wires fixation clinically as well as biomechanically.

Methods:

1. Biomechanical analysis

We prepared plastic carpal bone models which had four-corner fusion with four Kirschner-wires (group A, n=3), or three double threaded screws (group B, n=3) (Fig.2). The biomechanical strength was evaluated for the maximum compressive force generated by each bone models until capitate-hamate failure.

2. Clinical evaluations

We evaluated 14 SLAC wrists (12 males, 2 females; mean age: 55 years) treated by four-corner fusion with four Kirschner-wires (group A, n=9) or three double threaded screws (group B, n=5). Arm splint was removed and wrist exercises started on 7-8 postoperative weeks in the group A, or 3-4 postoperative weeks in the group B. Wrist pain, grip strength, range of wrist motion were evaluated compared with the contralateral wrist as controls in the both groups.

Results:

1. Biomechanical analysis

The average maximum compressive force was 72.4 ± 13.0 N in the group A, and 596.0 ± 130.7 N in the group B. The data of the group B was significantly higher than that of the group A (Mann-Whitney U test, $P < 0.05$)

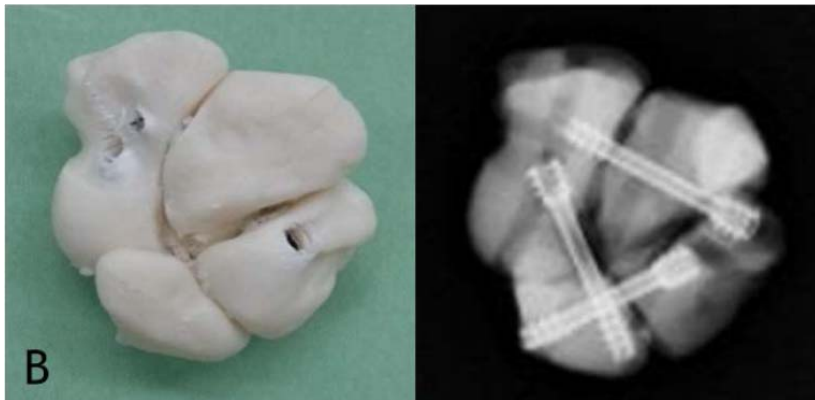
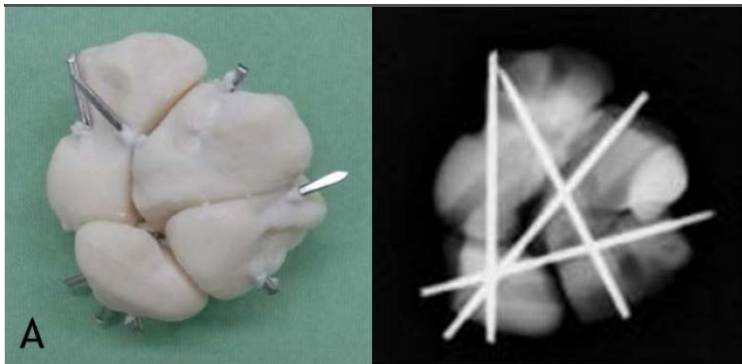
2. Clinical outcomes

Bone union was obtained in all patients. Wrist pain remained in one patient of each group, but all the other patients returned to their jobs without wrist pain. Postoperative grip strength and range of wrist motion were 83% and 55% respectively compared with the contralateral side in the group A, and 75% and 56% respectively in the group B. There was no significant difference between two groups.

Summary: Triangle fixation for four-corner fusion using three screws for SLAC wrist possesses the theoretical advantages of stronger compression force between carpal bones, and enable to shorten splint immobilization term than conventional technique without the need for pin removal while it obtains the similar clinical outcomes.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 18: Anatomic Relationships and Branching Patterns of the Ulnar Dorsal Cutaneous Nerve(s)

Category: Basic Science - Anatomy

Keyword: Hand

Not a clinical study

◆ Daniel London, BA

◆ Cassie Root, MD

◆ Nicole Strauss, MD

◆ Ryan Patrick Calfee, MD

Hypothesis: This study was conducted to detail the branching patterns of the dorsal cutaneous ulnar nerve (DCUN) in relation to identifiable anatomic landmarks. The rationale behind this study was that despite prior investigation into the DCUN branch diameters and its point of origin, surgeons would benefit from additional investigation designed to quantify the expected number and location of branches from the DCUN.

Methods: Branches of the DCUN were dissected in 28 unmatched fresh-frozen cadavers. The ulnar nerve was identified in the forearm and dissected distally to identify the DCUN and its branches from their origins to the level of the metacarpophalangeal (MCP) joints. The number and location of branches of the DCUN were recorded relative to the distal ulnar articular surface. Relationships to the subcutaneous border of the ulna (SBU), the pisotriquetral joint (PTJ), and the extensor carpi ulnaris (ECU) tendon were defined in the pronated wrist. Branching patterns of the DCUN were diagrammed from the origin of the DCUN to the level of the MCP joints in 23 specimens. Descriptive statistics were produced to describe the mean number, range, and location (\pm SD) of branches present.

Results: An average of 2 (range, 1-4) branches of the DCUN were present at the level of the distal ulnar articular surface (Table 1). An average of 2.2 (range, 1-3) branches were present 2cm distal to the ulnar articular surface. At least one longitudinal branch crossed dorsal to the ECU tendon (prior to its insertion on the 5th metacarpal) in 23/28 specimens (82%) at an average of 1.43cm distal (range 0.00-2.81cm) to the distal ulnar articular surface. In 27/28 specimens (96%), all longitudinal branches of the DCUN coursed between the dorsal-volar midpoint of the SBU and the PTJ. In 20/28 (71%) specimens, a transverse branch of the DCUN to the distal radial-ulnar joint was present. Together, the 3 most common branching patterns accounted for findings in 87% (20/23) of specimens (Figure 1).

Summary:

- During exposure of the dorsal or ulnar wrist, identification and protection of a single branch of the DCUN is unlikely to ensure safe dissection as multiple branches are expected at the level of the ulnocarpal joint.
- 6-U, 6-R, and ulnar mid-carpal arthroscopy portals may place branches of the DCUN at risk.
- In the pronated forearm, the area between the dorsal SBU and the PTJ contained all branches of the DCUN in 96% of specimens.

References:

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Table 1. Number of dorsal cutaneous nerve branches present relative to the distance from the distal ulna articular surface.

	Number of Branches Present				
	2cm Proximal	1cm Proximal	Distal Ulna Articular Surface	1cm Distal	2cm Distal
Mean	1.2	1.6	2.0	2.3	2.2
Range	1-2	1-4	1-4	1-3	1-3
Specimens with multiple branches (%)	6 (21%)	13 (46%)	20 (71%)	27 (96%)	26* (93%)

*Fewer specimens with multiple branches compared to 1cm distal to the distal ulnar articular surface as at least one transverse branch to the DRUJ did not reach this location.

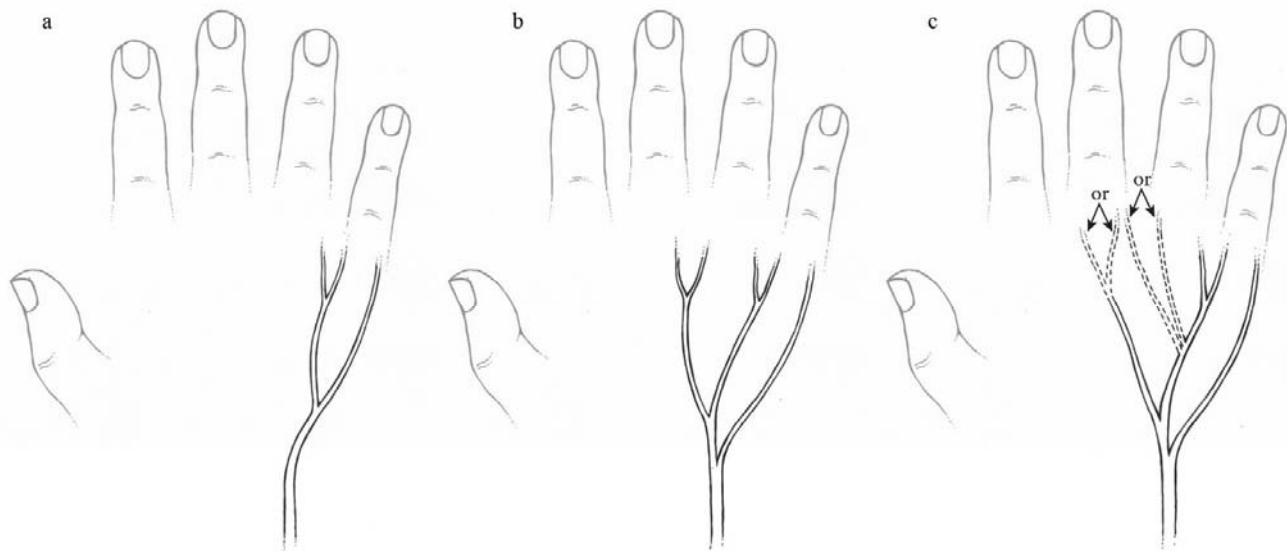


Figure 1. a) Diagram of the most common longitudinal branching pattern (52% (12) of specimens).
b and c) Diagrams of the next most common longitudinal branching patterns (17% (4) of specimens, each)

◆ Nothing of financial value to disclose

AM E-POSTER 19: The Effect of Flexor Digitorum Profundus Tendon Advancement on the Development of Quadriga Syndrome in the Treatment of Jersey Finger: A Biomechanical Study

Category: Basic Science - Anatomy

Keyword: Hand

Not a clinical study

◆ Michael D. Smith, MD

◆ Claudius D. Jarrett, MD

Hypothesis: Current recommendations discourage advancing the flexor digitorum profundus (FDP) tendon more than 1 cm during primary repair of a jersey finger in order to prevent the development of quadriga. However, this commonly believed recommendation has not been validated. We hypothesize that advancing the FDP tendon greater than 1 cm will significantly increase the force required to form a fist but advancing the tendon less than 1 cm will not.

Methods: Six fresh frozen cadaver forearms were harvested. The FDP muscle belly was dissected and isolated at its musculo-tendinous junction. The force required to pull the fingertips of the index, middle, ring, and small digits to the palm was recorded for each specimen. Next, iatrogenic jersey finger injuries to the ring finger were then created and repaired. The force required to pull the fingertips back to the palm following 0.5, 1.0, and 1.5 cm of tendon advancement were measured. Each force measurement cycle was repeated ten times. The resultant force measurements required to form a fist amongst all the forearms were then analyzed using the Kruskal-Wallis test, a non-parametric method. The average force required at the resultant levels of advancement were then compared against each other level of advancement within individual forearms and across the cohort of forearms using the Wilcoxon Two-Sample test.

Results: The average force required to form a fist prior to the creation of a jersey finger was 92.7 N. At 0.5 cm, 1.0 cm, and 1.5 cm the average force was 119.6 N, 144.6 N, and 146.7 N respectively. Significantly more force was required to form a fist when the FDP was advanced by 0.5 cm in comparison to no advancement ($p < 0.0001$) and by 1.0 cm in comparison to 0.5 cm of advancement ($p < 0.0001$). However, there was not a significant difference in force required to make a fist between 1.0 cm and 1.5 cm of tendon advancement ($p = 0.4376$).

Summary:

- Significantly more force is required to form a fist with advancement of the FDP tendon up to 1.0 cm.
- There is not a significant increase in force between 1.0 and 1.5 cm of tendon advancement.

- This suggests that if advancement of the FDP tendon more than 1 cm is required for primary repair of a jersey finger, there may not necessarily be an elevated risk of developing quadriga.

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◆ Nothing of financial value to disclose

AM E-POSTER 20: Anatomical Study of Anterior Interosseous Nerve Transfer for Proximal Ulnar Nerve Injury

Category: Basic Science - Anatomy

Keyword: Forearm

Not a clinical study

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- ◆ Takane Suzuki, MD
- ◆ Ken Hashimoto, MD
- ◆ Yasufumi Ogawa, MD
- ◆ Kazuhisa Takahashi, MD, PhD

Hypothesis: Anterior interosseous nerve (AIN) transfer for proximal ulnar nerve injury yields excellent results and is now considered to be the best choice for motor recovery. However, there have been few reports discussing the procedure in detail — for example, which muscle layers provide the shortest distance through which to pass the terminal branch of the AIN, what point on the ulnar nerve the transferred nerve reaches, and how the motor and sensory branches of the ulnar nerve should be divided. The purpose of this study was to investigate the most efficient technique using cadaveric arm simulation.

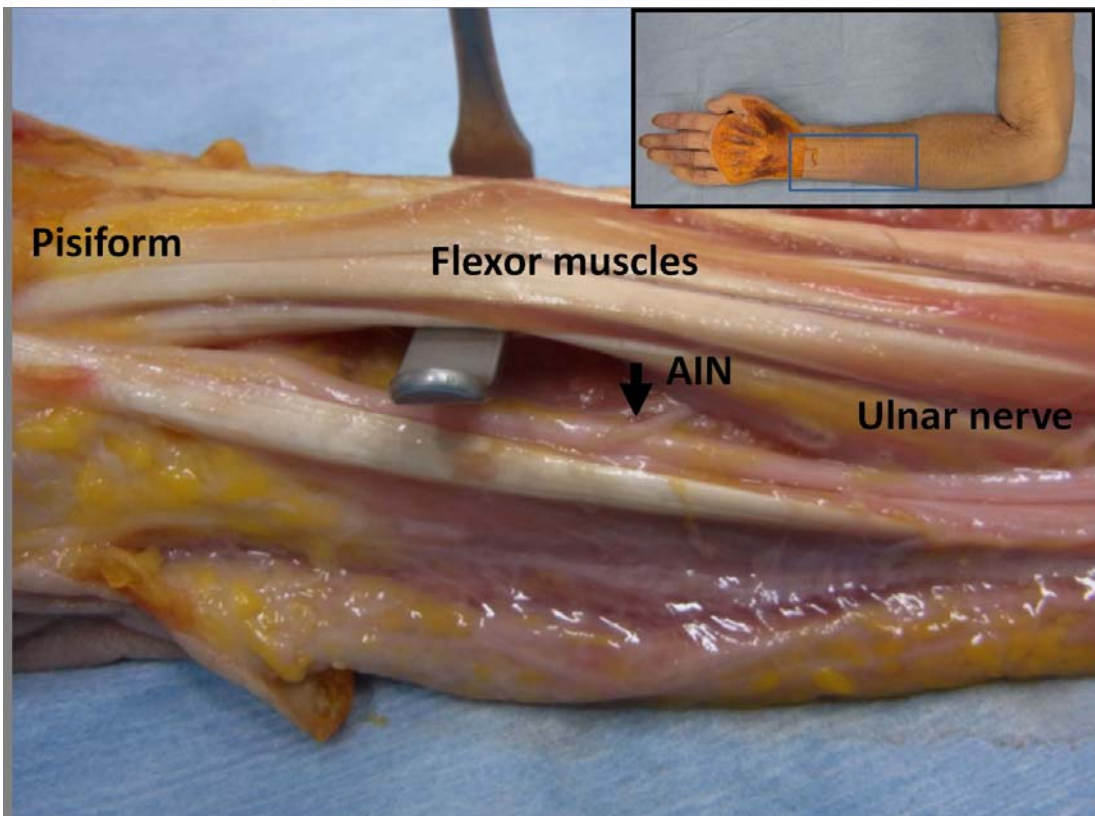
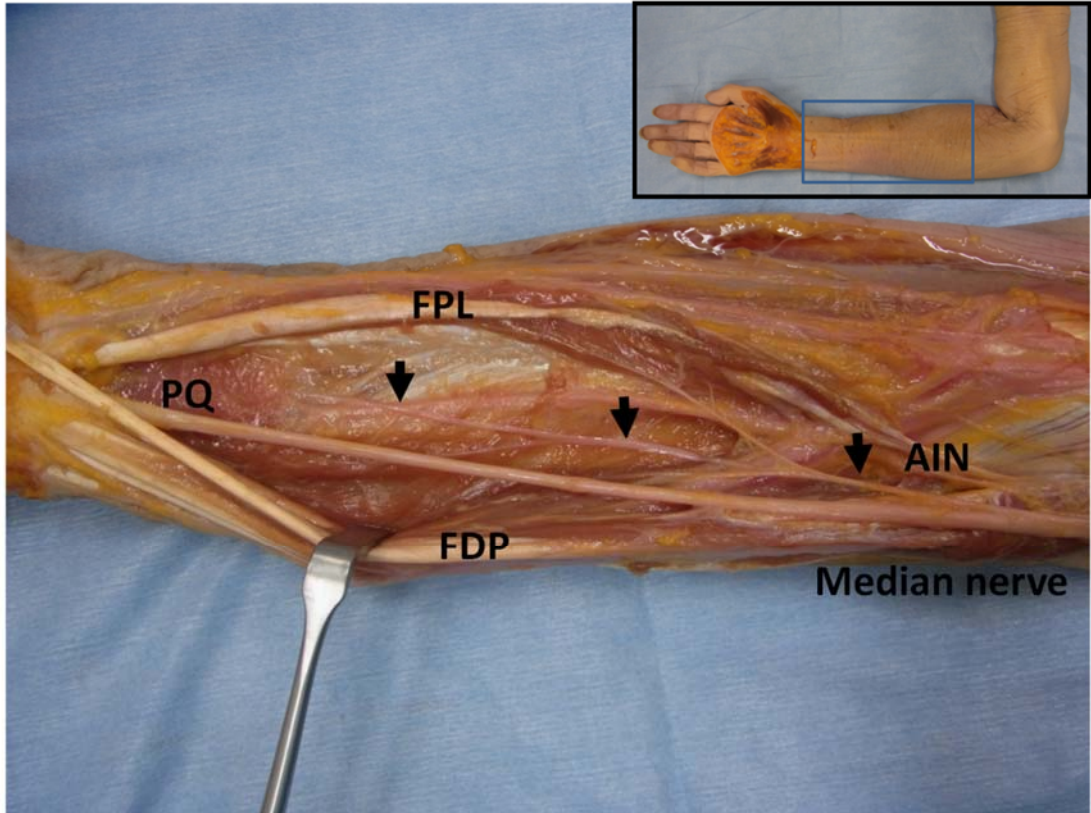
Methods: The ulnar nerve and the AIN with its branches were dissected in 14 fresh cadaveric arms and the number of AIN branches was counted. The length available for transfer was measured, consisting of the distance between the last branch supplying the flexor pollicis longus (FPL) or the flexor digitorum profundus (FDP)? and the branch supplying the pronator quadratus (PQ). The AIN was cut just proximal to the PQ branch and transferred to the ulnar nerve through 1 of 3 courses: dorsal to the FDP, between the FDP and the flexor digitorum superficialis (FDS), and volar to the FDS. The distance between the suture site on the ulnar nerve and the pisiform bone was measured. The distance between the suture site and the divergence of the motor and the sensory branches of the ulnar nerve was also measured, and it was determined whether blunt dissection alone was sufficient to separate the branches from the divergence to the suture site, or whether sharp dissection was needed as well.

Results: The mean number of AIN branches was 4.2 ± 1.1 ; the mean length available for transfer was 76 ± 16 mm. The transferred nerve reached the ulnar nerve most distally when placed dorsal to the FDP. This point was 55 ± 8 mm proximal to the pisiform bone and was proximal to the divergence in all specimens; 37 ± 9 mm of blunt dissection and 19 ± 9 mm of sharp dissection were required to separate the branches from the divergence to the suture site.

Summary: The AIN should be transferred dorsal to the FDP. The motor and sensory branches of the ulnar nerve require about 40 mm of blunt dissection and 20 mm of sharp dissection between their divergence and the AIN suture site.

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◆ Nothing of financial value to disclose

AM E-POSTER 21: The Posterior Interosseous Nerve Revisited: Anatomic Study in Fresh Cadaveric Arms

Category: Basic Science - Anatomy

Keyword: Forearm

Not a clinical study

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- ◆ Takane Suzuki, MD
- ◆ Ken Hashimoto, MD
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Hypothesis: Posterior interosseous nerve (PIN) palsy is one of the most frequent peripheral neuropathies encountered in routine medical care. An understanding of the branching pattern of the PIN is required for diagnostic purposes; however, there have been few reports involving the anatomy of the PIN in fresh cadaveric specimens. The aim of this study was to determine the number and pattern of branching of the PIN in fresh cadaveric arms.

Methods: This study was conducted on both forearms of 10 fresh frozen cadavers. Eight of the cadavers were male and two cadavers were female. The radial nerve was identified between the brachioradialis and brachialis muscles in the proximal forearm. The supinator muscle was exposed, the superficial layer of the supinator was incised to its distal margin, and the nerve was followed distally. The course and branches of the PIN were identified by cleaning the surrounding fatty tissue. The anatomic patterns of the PIN were documented.

Results: The PIN bifurcated into a short branch, which was distributed to the superficial extensor muscles, and a long branch, which was distributed to the deep muscles. The division point was proximal to the distal edge of the supinator in 4 forearms (20%), at the level of the distal edge of the supinator in 7 forearms (35%), and distal to the distal edge of the supinator in 9 forearms (45%). The short branch innervated the ED, ECU, and EDM. The average number of branches was 3.4 in the ED, 2.8 in the ECU, and 2 in the EDM. In all cases, the first branch of the deep long trunk was the common branch of the APL and EPB, which arose an average of 17.9 mm distal to the supinator edge. The average number of branches was 1.7 and 1.4 in the APL and EPB, respectively. The branching patterns were the EPL-EI in 16 forearms (80%), the EI-EPL in 3 forearms (15%), and the EI&EPL-EPL in 1 forearm (5%). The average number of branches was 2.2 and 1.2 in the EPL and EI, respectively.

Summary: The innervating territory of the short and long branches of the PIN almost accorded in most specimens with previous reports. The branching patterns of the EI&EPL-EPL were much less frequent (5%) than previous studies. Knowledge of these variations is useful for diagnosing PIN palsy presenting as an uncommon pattern of paralysis.

◆ Nothing of financial value to disclose

AM E-POSTER 22: Superficial Dorsal Foot Vein Valves: Consideration in Use for Palmar Arch Reconstruction

Category: Basic Science - Anatomy

Keyword: Hand

Not a clinical study

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◆ John R. Lien, MD

◆ David J. Ruta, MD

◆ Alexander Brunfeldt, MS

◆ Kagan Ozer, MD

Hypothesis: Superficial dorsal foot veins arising from the saphenous venous system is a graft option in arterial reconstruction of the palmar arch of the hand.

Methods: Eight fresh frozen cadaveric feet from five patients were dissected, exposing the dorsal superficial veins. The location of valves and the flat diameters of the veins were determined at three zones defined by the first tarsometatarsal joint and one centimeter proximal to the venous branch on the lesser saphenous side extending to the 4/5 webspace (Figure 1). India ink was injected retrograde into the vein starting proximally at the greater saphenous vein then repositioned just distal to a valve and iteratively repeated, recording the location of the valves. This was repeated from the side of the lesser saphenous vein.

Results: Of the five patients, three were female and two were male. Mean age was 49.8 (± 11.4 SD) years, average weight 173.4 (± 24.1 SD) pounds and average height 67.2 (± 5.1 SD) inches. The venous structure was mapped out for each foot (Figure 1). The venous structure was grossly different from side to side in the three patients with bilateral foot dissection. Valves were commonly found near branch bifurcations on the branch and occasionally through the arch and proximal to the arch on the greater saphenous vein side. In the arch alone, there were a mean of 1.5 (± 1.1 SD) valves in ZONE1, 1.5 (± 1.3 SD) valves in ZONE2 and 0 valves in ZONE3. However, valves were found near the branch bifurcation on the branches off the arch in ZONE3. Valve diameters were 4.9 (± 0.7 SD, 4.1-5.9) mm in ZONE1, 3.0 (± 0.6 SD, 2.0-4.0) mm in ZONE2 and 2.3 (± 0.6 SD, 1.5-3.0) mm in ZONE3. The mean diameter of the branches coming off the arch was 2.2 (± 0.6 SD, 1.4-3.9). There was an average of 3.4 (± 0.9 SD, 2-5) branches off the dorsal arch extending to the toes with 81% (22/27) of these branches having valves.

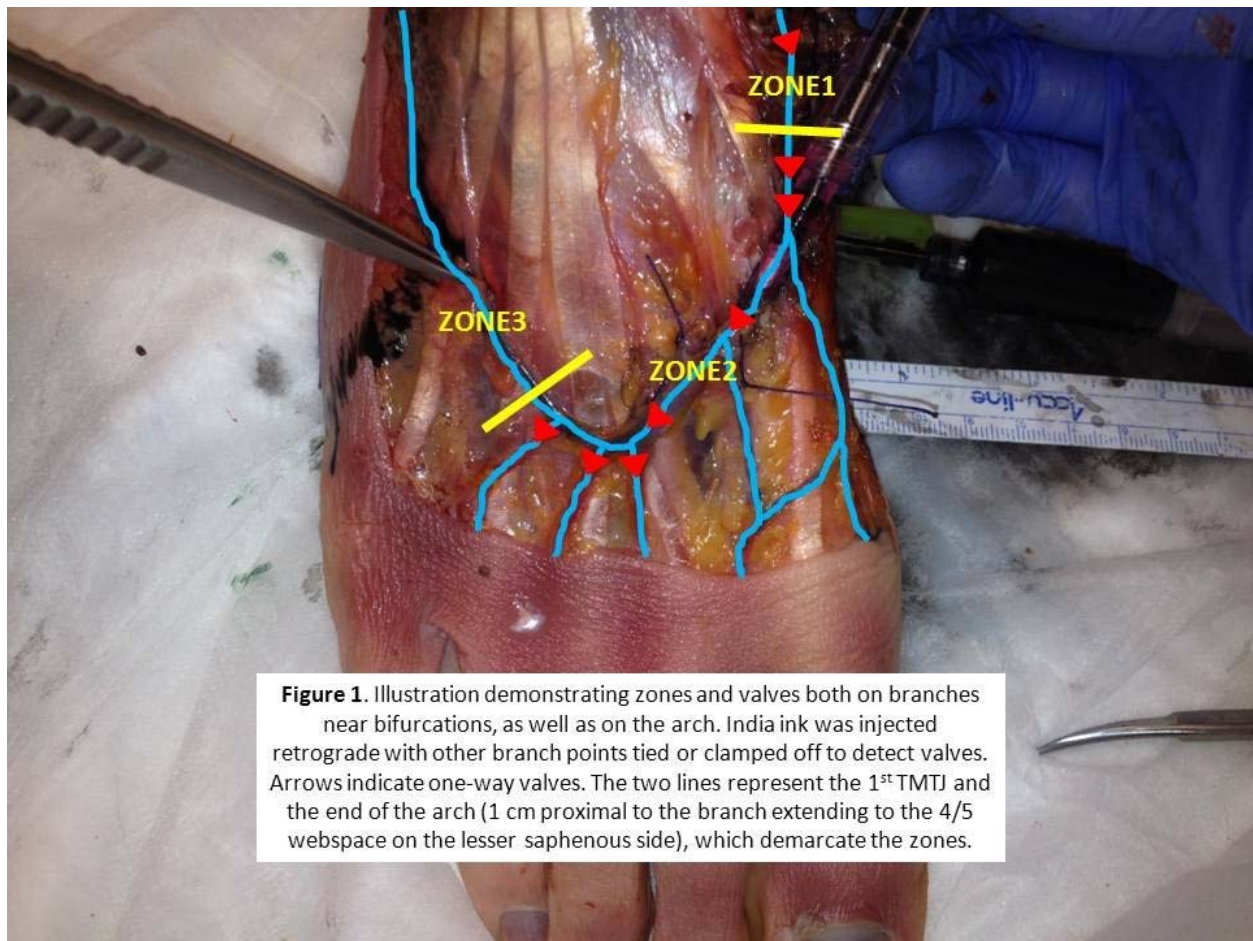
Summary:

- Valves are commonly located distal to bifurcations but may occur along the arch and within long segments on the greater saphenous side.

- The diameter of common digital arteries in the hand is approximately 1.6 (1.5 to 2.0) mm, which compares favorably with our measured branch flat diameters.1
- When reconstructing the palmar arch and its digital branches using a dorsal foot vein arch graft, the surgeon should be aware of these valves.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 23: Redefining the Supraclavicular Anatomy of the Brachial Plexus

Category: Basic Science - Anatomy

Keyword: Other

Not a clinical study

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◆ Dan A. Zlotolow, MD

◆ Scott H. Kozin, MD

◆ Joshua Abzug, MD

Hypothesis: Traditional drawings of the brachial plexus demonstrate the suprascapular nerve as a branch off the midportion of the upper trunk, with the lateral division of the upper trunk being the anterior division. We have not found these descriptions to be accurate in the infant brachial plexus when encountered surgically, particularly in the area of the upper trunk. More often, the suprascapular nerve takes off as a trifurcation at the level of the upper trunk, with the posterior division of the upper trunk being the more lateral structure, and the anterior division being the most medial structure. We suspect that this relationship can also be observed in the adult plexus.

Methods: Brachial plexus dissections were performed on eight age-matched adult cadavers bilaterally, for a total of sixteen specimens. Once the upper trunk and surrounding structures were identified, the following measurements were taken three times with the use of a digital caliper: length of the upper trunk and distance of the takeoff of the suprascapular nerve from the divisions. Mean values were calculated for all measurements. Native positions of the divisions and suprascapular nerve from lateral to medial were recorded.

Results: In all sixteen specimens, a trifurcation was found at the level of the upper trunk, with the structures from lateral to medial being the suprascapular nerve, the posterior division, and the anterior division. The mean distance of the takeoff of the suprascapular nerve was 3.57 mm proximal to the anterior and posterior divisions, however in some instances the nerve was found to take off from the posterior division proper. The mean length of the upper trunk was 28.88 mm. In all 16 specimens, the posterior divisions were the more lateral structure, and the anterior divisions more medial at the level of the upper and lower trunks. This was also true for 14 of 16 specimens at the level of the middle trunk.

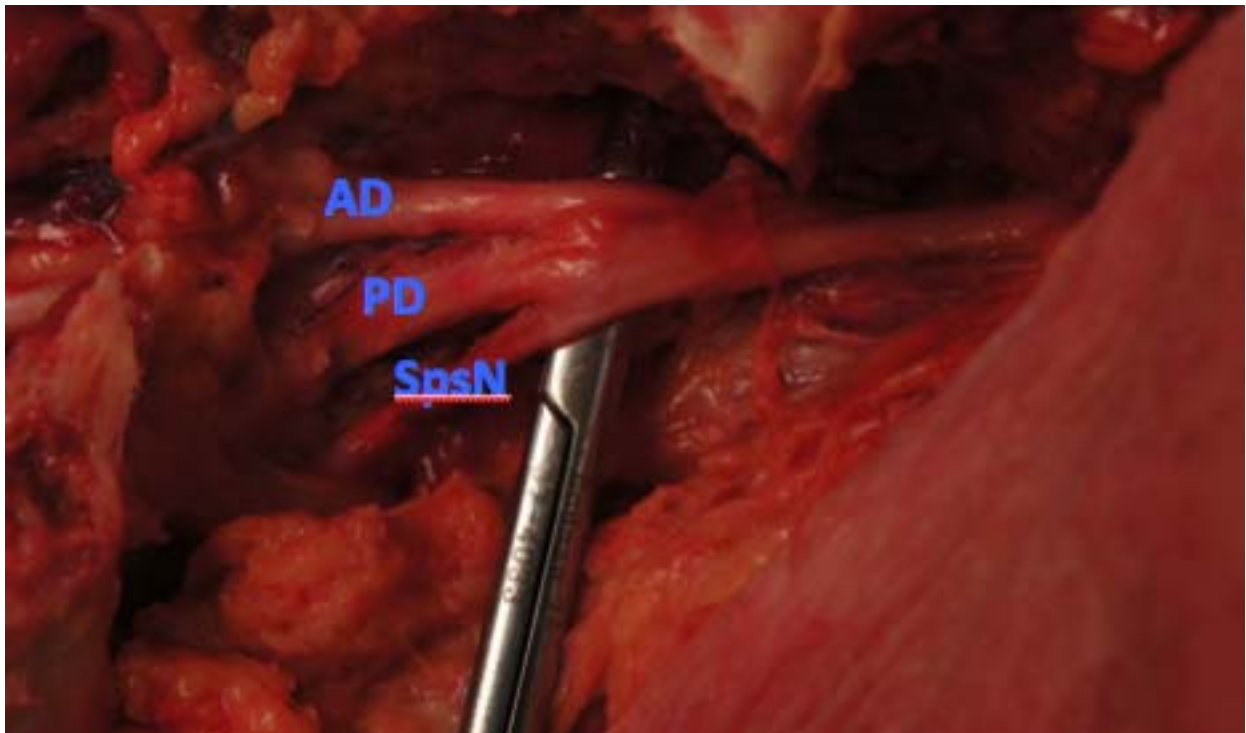
Summary:

- These findings question the standard illustrations and depictions of the brachial plexus anatomy.
- The suprascapular nerve, posterior division, and anterior division should be depicted as a trifurcation in this order from lateral to medial.

- At the level of the upper, middle and lower trunks, the posterior division is most often the more lateral structure, and the anterior division the more medial.
- This understanding of these anatomic relationships will facilitate dissection and grafting across the upper trunk as well as aid in nerve transfer surgeries.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 24: Does the Location of Cubital Tunnel Release Incision Predispose Iatrogenic Ulnar Nerve Subluxation? A Cadaveric Study.

Category: Basic Science - Anatomy

Keyword: Elbow

Not a clinical study

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◆ Tobias Mann, MD, MSc

◆ Daniel J. Lee, BA

◆ Theron Fussell, BS

◆ Taylor Buckley, MD

◆ John C. Elfar, MD

Hypothesis: Release of the fascia over the cubital tunnel can cause iatrogenic ulnar nerve subluxation. Little is known about the relationship between ulnar nerve subluxation after cubital tunnel release and the position of incision within the roof of the cubital tunnel. The present study aims to characterize the dynamic behavior and subluxation of the ulnar nerve at the elbow when the cubital tunnel is release from either an anterior or posterior side of the ligament. We hypothesized that both releases would yield a similar predilection towards subluxation.

Methods: Sixteen fresh-frozen cadaveric upper extremities (8 matched pairs) were used in this study. For each pair, one arm was randomly assigned the anterior approach and the other assigned the posterior approach. In situ cubital tunnel releases with dissections 8 cm proximal and 8 cm distal to the medial epicondyle were performed in each arm with the only difference being the position of the incision in Osbornes ligament. The degree of medial excursion of the ulnar nerve was then assessed with a digital caliper at 0, 45, 90, and 135 degrees of elbow flexion. Any gross nerve subluxation was noted and classified as perched or dislocated. The angle at which nerve excursion first occurred was also recorded.

Results: Statistics were reviewed with a statistician and significant differences between anterior and posterior releases were evaluated (Student's t test). There was one perched ulnar nerve in the posterior-based group, and 3 perched ulnar nerves in the anterior-based group. No gross subluxations occurred in either group. The average medial excursion of the ulnar nerve was 4.89 mm (range -1.12 to 8.99) for the the anterior and 2.72 mm (range -0.60 to 5.23 mm) for the posterior groups ($p = 0.11$). The average angle at which nerve excursion first occurred was 100.3 degrees (range 53 - 136 degrees) in the posterior group and 82.6 (range 66 - 112) degrees in the anterior group ($p = 0.174$).

Summary:

- There was no significant difference in ulnar nerve excursion, or flexion angle at which excursion first occurred between the anterior- and posterior-based release groups
- Although there were more perched ulnar nerves with elbow flexion in the anterior release group (3 of 8 vs. 1 of 8), this finding did not reach a significant difference.
- In this cadaveric study, the location of the fascial cubital tunnel release did not significantly affect the development of iatrogenic ulnar nerve subluxation.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 25: Computed Tomography-Based Three-Dimensional Kinematic Comparison of Dart-Throwing Motion Between Wrists with Malunited Distal Radius and Contralateral Normal Wrists

Category: Basic Science - Anatomy

Keyword: Wrist

Not a clinical study

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- ◆ Young Ho Lee, MD
- ◆ Jin Young Kim, MD, PhD
- ◆ Ji Yeong Kim, MD, PhD
- ◆ Suk Ha Jeon, MD
- Goo Hyun Baek, MD, PhD

Hypothesis: The purpose of this study was to compare motion of the capitate, scaphoid, and lunate in wrists with a malunited distal radius and contralateral normal wrists during dart-throwing motion (DTM) by three-dimensional kinematic studies using computed tomography (CT) images.

Methods: CT was performed simultaneously on both wrists in 6 patients with a unilateral distal radius malunion at 3 stepwise positions simulating DTM. Using volume registration technique, the kinematic variables of helical axis motion of the capitate, scaphoid, and lunate were calculated and compared between both wrists. The helical motion of the capitate was also evaluated in a scaphoid- and lunate-based coordinate system.

Results: Among the average rotation, translation, and lengths of the moment arms of the scaphoid, lunate, and capitates during DTM, only the average rotation of the capitate was significantly different between the uninjured (88.9°) and the injured (70.0°) wrist ($p = .0075$). Rotation of the capitate relative to the scaphoid (26.3° vs. 37.8° , $p = 0.029$) or lunate (39.2° vs. 59.3 , $p=0.028$) was smaller in the malunited wrist. The centers of helical axis motion of the 3 carpal bones were located more dorsally and radially in the injured wrist.

Summary: This 3D in vivo kinematic study of the capitate, scaphoid, and lunate in wrists with distal radius malunion might be the first to present a 3D kinematic analysis of the effect of distal radius malunion on the carpal bones. This study showed that decreased DTM in wrists with a distal radius malunion resulted from decreased midcarpal motion. DTM is a crucial motion of the wrist joint in activities of daily living and occupational tasks, and the present result indicates that anatomical reduction of distal radius fractures should be performed to maintain the function of

the wrist. DTM and capitate motion should be parameters to evaluate the function of a wrist with a distal radius fracture or malunion.

References:

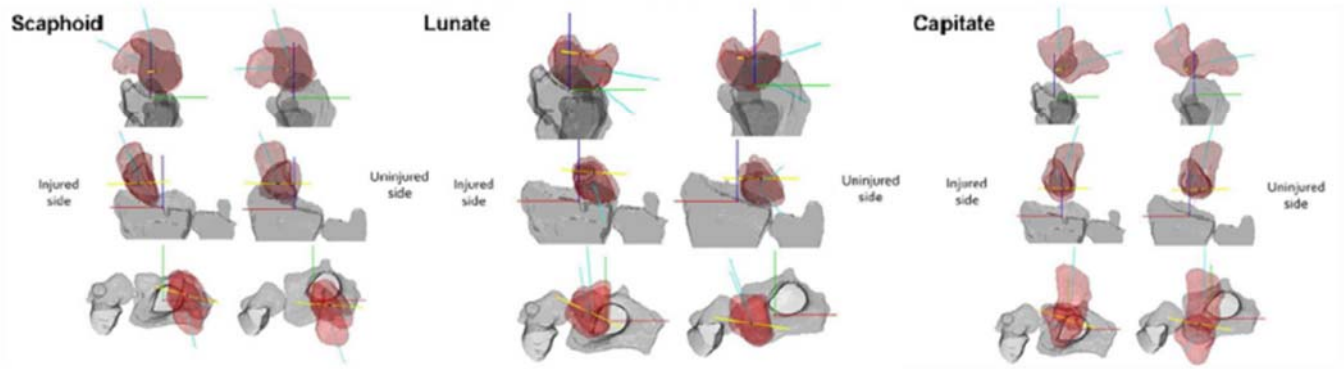
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Figure 1. Radiocarpal and midcarpal rotation during DTM (*p < 0.05).

Rotation (°)	R-C (p = 0.0075)*		R-S (p = 0.27)		R-L (p = 0.66)		S-C (p = 0.029)*		L-C (p = 0.028)*	
	Inj	Uninj	Inj	Uninj	Inj	Uninj	Inj	Uninj	Inj	Uninj
Average	70.0	88.9	46.5	54.0	34.7	33.2	26.3	37.8	39.2	59.3
S.D.	15.4	23.0	16.1	25.1	10.3	13.7	6.8	6.4	4.4	13.6

(R-C: radiocarpitate; R-S: radioscapoid; R-L: radiolunate; S-C: scaphocarpitate; L-C: lunocarpitate)

Figure 2. Lateral, volar, and proximal view of rotation of the scaphoid, lunate, and capitate during dart-throwing motion.



- Other Financial Relationship: Seoul R&D Program (ST090809) (Lee, Baek); 2011 Inje University research grant. (Lee)
- ◆ Nothing of financial value to disclose

AM E-POSTER 26: The Vascular Basis of the Hemi-Hamate Osteochondral Free Flap: Surgical Anatomy and Clinical Application

Category: Basic Science - Anatomy

Keyword: Hand

Not a clinical study

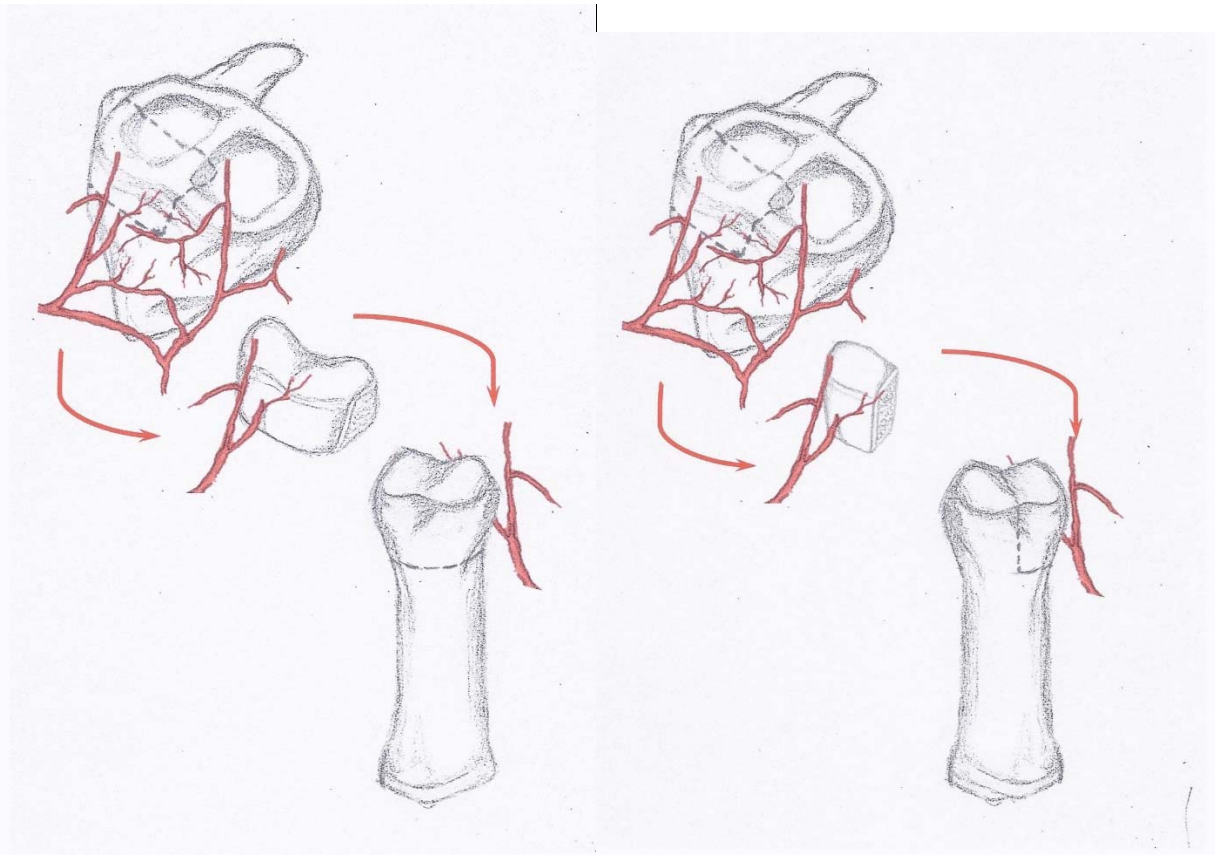
- ◆ Vachara Niumsawatt, MBBS
- ◆ Warren M. Rozen, MBBS, BMedSc, MD, PhD
- ◆ Richard Ross, MBBS
- ◆ James C. Leong, MBBS, MS, FRACS
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Hypothesis: The free vascularised hemi-hamate flap combines the utility of providing a small osteochondral portion of hamate for reconstruction, while providing a means of vascularisation to preserve articular cartilage after transfer. In part 1 of this series, we highlighted the vascular approaches to such a technique. The current study investigates the bony architecture of the hamate, with particular emphasis on its utility for a range of osteochondral defects in the hand.

Methods: A morphometric assessment of the hamate as a potential osteochondral flap donor site for resurfacing digital phalangeal heads (either total or unicondylar) and/or bases was thus undertaken. This anatomic study was undertaken using in-vivo imaging performed for a range of clinical indications, with computed tomographic angiography (CTA) and digital subtraction angiography (DSA) of the upper limb included. Bony and vascular measurements and relationships were recorded and assessed both quantitatively and qualitatively. A clinical case is presented, highlighting the application of these measurements.

Results: The mean digital artery diameter was 0.7mm, with a mean distance between digital artery and interphalangeal joint surface (i.e. pedicle length) of 1.18mm. Mean hamate dimensions comprised a transverse width 16.62mm, lateral width of 14.29mm, and ridge height of 1.43mm. Measurements of the phalangeal bases, condyles and total phalangeal heads were recorded, and the optimal hamate harvest approaches demonstrated. Despite perceived differences, in all cases there was statistical similarity demonstrated between the fragments.

Summary: From the current anatomical analysis, we believe that the geometry of the hamate can be designed to match the contour of the phalangeal base and head. Use of a hemi-hamate osteochondral graft to replace an unstable middle phalangeal base fracture has been used with success. We have since shown that using the hemi-hamate as a vascularised bone flap may confer additional benefits to cartilage survival in the long term. The application of this approach to a range of osteochondral defects in the hand may offer new options to the hand surgeon, and is an appropriate technique from anatomical bony and vascular standpoints.



◆ Nothing of financial value to disclose

AM E-POSTER 27: Local Injection Around the Ulnar Nerve at the Elbow: A Cadaveric Study

Category: Basic Science - Anatomy

Keyword: Elbow

Not a clinical study

◆ Dustin L. Larson, MD

◆ Matthew McElvany, MD

◆ Adam Mirarchi, MD, MS

◆ Robert Orfaly, MD, FRCS

Hypothesis: Injection of the cubital tunnel at the level of the medial epicondyle does not lead to effective delivery of drug concentrations at all potential sites of compression of the ulnar nerve near the elbow.

Methods: A local injection of radio-opaque contrast and methylene blue dye was delivered directed at the cubital tunnel of 6 fresh frozen cadaveric upper extremity specimens based on anatomic landmarks. Fluoroscopy was used to assess the distribution of the injectate. The specimens were dissected to determine the distance from the arcuate ligament to other potential sites of entrapment and the staining pattern of the ulnar nerve at these locations.

Results: Injection of radio-opaque contrast resulted in a highly variable distribution of injectate. Fluoroscopic measurements indicated the injectate was unlikely to be delivered to all potential sites of entrapment. Anatomic dissection revealed poor staining of the ulnar nerve distal to the arcuate ligament. No nerves were stained distal to the junction of the ulnar and humeral heads of the flexor carpi ulnaris. No nerves were stained more than 3-cm proximal to the arcuate ligament, and no nerves were stained at the Arcade of Struthers nor the majority of the medial intermuscular septum.

Summary:

- Injections for cubital tunnel syndrome using anatomic landmarks show poor delivery of the injectate to all potential sites of nerve entrapment.
- The accuracy of the injection of the cubital tunnel is poor. Associated risks include intraarticular, intraneural, and intradermal delivery.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 28: Volar Percutaneous Approach for Treatment of Scaphoid Fractures: Anatomical Study Investigating Structures at Risk

Category: Basic Science - Anatomy

Keyword: Wrist

Not a clinical study

◆ Deana Mercer, MD

◆ Christina Brady, BS

◆ Justin Brantley, BS

◆ Scott Evans, MD

◆ Christina Salas, MS

Hypothesis: The objective of this study was to evaluate, in a cadaveric model, anatomical structures at risk when utilizing the volar percutaneous approach for fixation of scaphoid fractures.

Methods: Fifteen fresh frozen cadaveric hands were utilized. Under fluoroscopic guidance, a 0.062 K-wire was percutaneously placed into the center-center position of the scaphoid, from the volar side of the hand, in the distal to proximal trajectory. We then carefully dissected around the scaphoid pin to determine which structures were at potential risk with this approach. We measured the distance from the volar pin to adjacent anatomical structures at risk including the main radial artery, recurrent motor branch of the median nerve, first dorsal extensor compartment, superficial radial nerve, superficial branch of the radial artery and the flexor carpi radialis.

Results: We found that the structure most at risk is the flexor carpi radialis and the superficial branch of the radial artery. The average distances from the pin to anatomical the structures included 16.6 (± 4.7) mm to the main radial artery, 15.9 (± 4.6) mm to the recurrent branch of the median nerve, 13.6 (± 4.1) mm to the first dorsal extensor compartment, 11.5 (± 3.9) mm to the superficial radial nerve, 7.2 (± 3.3) mm to the superficial branch of the radial artery, and 2.5 (± 3.3) mm to the flexor carpi radialis. The guide pin passed through the flexor carpi radialis in 4 of the 13 specimens (31%) and was adjacent but did not pierce the tendon in 4 of the 13 specimens. It also passed through the superficial branch of the radial artery in one of the specimens (8%).

Summary:

- Volar percutaneous approach for fixation of scaphoid fractures is a commonly utilized technique.

- The flexor carpi radialis is the structure most at risk with this approach followed by the superficial branch of the radial artery.

◆ Nothing of financial value to disclose

AM E-POSTER 29: Median Nerve Deformation and Displacement in the Carpal Tunnel During Finger Motion

Category: Basic Science - Clinical Research

Keyword: Wrist

Level 3 Evidence

- ◆ Yuichi Yoshii, MD
- ◆ Wen Lin Tung, OTR
- ◆ Tomoo Ishii, MD
- ◆ Shinsuke Sakai, MD
- ◆ Peter C. Amadio, MD

Hypothesis: Ultrasound indices of median nerve deformation are useful to assess carpal tunnel syndrome (CTS), and there is a different motion pattern of the median nerve during finger motion in CTS patients. In this study, we hypothesized that there were correlations between deformation indices of median nerve and tendon-nerve displacement during finger motion in the carpal tunnel.

Methods: Sixty-two wrists of 31 asymptomatic volunteers and fifty-one wrists of 28 idiopathic CTS patients were evaluated by ultrasound. CTS was diagnosed with clinical findings and nerve conduction study. An ultrasound scanner and a linear array transducer were used. Cross-sectional images of carpal tunnel during motion from full finger extension to flexion were recorded. The displacement of median nerve and middle finger flexor digitorum superficialis (FDS) tendon, as well as the area, perimeter, aspect ratio of a minimum enclosing rectangle, and circularity of the median nerve were measured in finger extension and flexion positions. A deformation index, which was determined by the flexion-extension ratio for each parameter, was calculated. The displacement of median nerve and middle finger FDS tendon were compared between patients and controls. The correlations between displacement and deformation indices were evaluated.

Results: During finger flexion in the normal controls, the median nerve moved 2.3mm and 0.38mm in the ulnar and palmar directions, respectively. In the CTS patients, the median nerve moved 1.98mm and 0.06mm in the ulnar and palmar directions, respectively. The displacement of the tendon ulnarly was relatively smaller in CTS patients, but it did not reach significance ($P=0.06$). The median nerve displacement toward the palmar side was smaller in the patients ($P<0.01$). The tendon displacement toward the palmar side was larger in the patients ($P<0.05$). The results of correlation coefficients between deformation indices and the displacements are shown in Table 1. There were significant correlations for all deformation indices with palmar-dorsal displacement. The perimeter and circularity deformation indices showed positive correlations. The deformation indices of area and aspect ratio showed negative correlations. It

showed the highest correlation coefficient between the deformation index of aspect ratio and the nerve displacement for palmar-dorsal direction (-0.572, P<0.01).

Summary: This study showed that there is a relationship between median nerve deformation indices and nerve palmar-dorsal displacement in the carpal tunnel. Since the highest correlation was between palmar-dorsal direction nerve displacement and aspect ratio, it may be possible to assess the risk of carpal tunnel syndrome by measuring these parameters clinically.

Table 1 The results of correlation coefficients.

		Area	Perimeter	Aspect ratio	Circularity
<i>Displacement</i>					
Ulna-Radial direction					
	Nerve	-0.130	-0.014	-0.179	0.073
	Tendon	0.030	0.075	-0.069	-0.062
Palmar-Dorsal direction					
	Neve	-0.211*	0.412**	-0.572**	0.554**
	Tendon	-0.075	0.121	-0.084	-0.095

*: significant correlation, P<0.05.

** : significant correlation, P<0.01.

◆ Nothing of financial value to disclose

AM E-POSTER 30: Scaphoid Fractures Are Not Transverse Waist Fractures - Three Dimensional Analysis

Category: Basic Science - Clinical Research

Keyword: Wrist

Not a clinical study

- ◆ Shai Luria, MD
- ◆ Yonatan Schwarcz
- ◆ Ronit Wollstein, MD
- ◆ Patrick Emelif
- ◆ Gershon Zinger, MD
- ◆ Eran Peleg, PhD

Hypothesis: Knowing the morphology of any fracture, including scaphoid fractures, is important in order to determine the fracture stability and the appropriate fixation technique. Scaphoid fractures are classified according to their radiographic appearance, and simple transverse waist fractures are considered the most common¹. There is limited knowledge of the 3-dimensional morphology of scaphoid fractures². Our hypothesis was that most scaphoid fractures are not perpendicular to its long axis, i.e. they are not transverse waist fractures.

Methods: A 3-dimensional analysis was performed of CT scans of acute scaphoid fractures, conducted at two medical centers during a period of 6 years. A total of 124 scans were analyzed (Amira Dev 5.3, Visage Imaging Inc). Thirty of the fractures were displaced and virtually reduced. Anatomical landmarks were marked on the distal radius articular surface in order to orient the scaphoid in the wrist. Shape analysis of the scaphoids and a calculation of the best fitted planes to the fractures were carried out implementing principal component analysis (Figure 1). The angles between the scaphoid's first principal axis to the fracture plane, articular plane and to the palmar-dorsal direction were measured. The fractures were analyzed both for location (proximal, waist and distal) and for displacement.

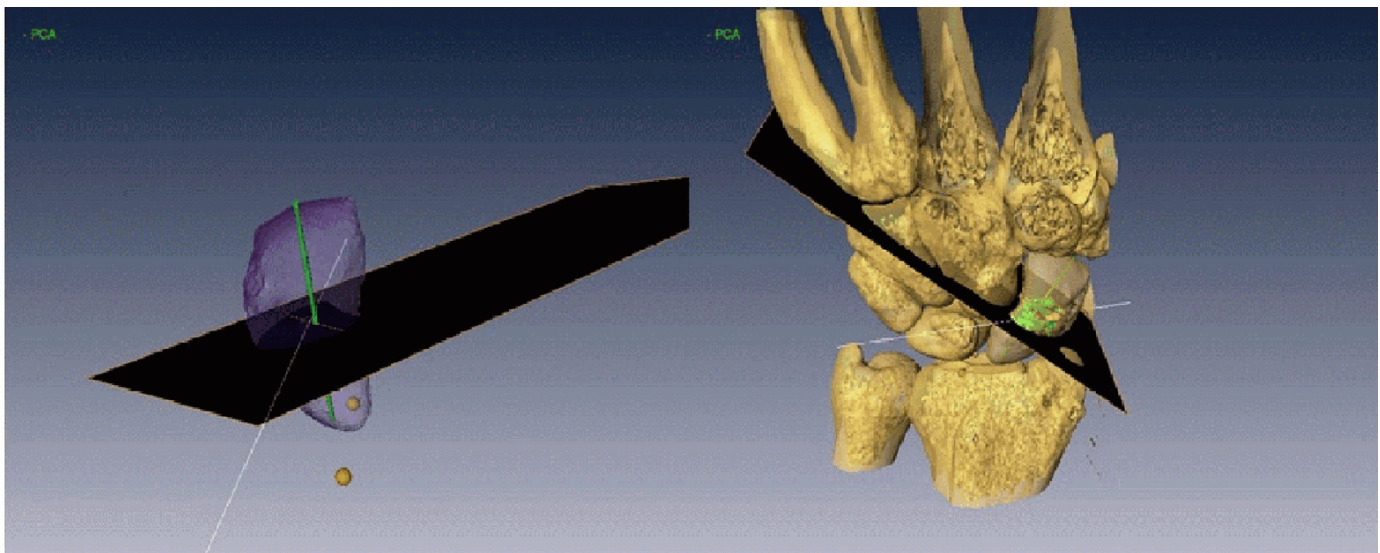
Results: There were 86 fractures of the waist (76 percent), 13 of the distal third and 25 of the proximal third. The average angle between the long axis of the scaphoid and the fracture plane was 52.6 degrees (SD 17) for all fractures, 55.6 degrees (SD 17.2) for the waist fractures, both differing significantly from a right angle ($p < 0.001$). The majority of fractures were found to be horizontal oblique. We found no difference between the angles of the waist fractures which were displaced and those that were not displaced. In contrast, a significant difference was found between the displaced and non-displaced fractures when evaluating the orientation of the scaphoid long axis in relation to the articular plane (140.6 degrees with reduction vs 148.0 without; $p = 0.038$).

Summary:

- Most waist fractures were found to be horizontal oblique in relation to the long axis of the scaphoid and not transverse.
- The orientation of the scaphoid's long axis in relation to the radial articular surface was correlated with fracture displacement.
- Optimal fixation of acute scaphoid fractures may call for better analysis of each fracture configuration and the fixation should be guided by this analysis.

References:

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(a)

(b)

(a) A surface model of a scaphoid and the fracture plane (black surface). The green line represents the first principal axis. The two landmarks marked on the articulating plane are used to calculate the palmar-dorsal direction. (b) An isosurface model of the hand region. The scaphoid bone and the fracture plane are segmented

◆ Nothing of financial value to disclose

AM E-POSTER 31: Evaluation of Bone Atrophy After Treatment of Forearm Fracture Using Non-Linear Finite Element Analysis: A Comparative Study of Locking and Conventional Plates

Category: Basic Science - Clinical Research

Keyword: Forearm

Level 4 Evidence

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- ◆ Kazuki Kuniyoshi, MD, PhD
- ◆ Takane Suzuki, MD
- ◆ Tomoyuki Rokkaku, MD
- ◆ Kenichi Murakami, MD
- ◆ Kazuhisa Takahashi, MD, PhD

Hypothesis: Forearm diaphyseal fractures are usually treated with open reduction and internal fixation. Recently, locking plates have been used for treatment. Some patients have bone atrophy adjacent to the plate in the years following their operation. However, there have never been reports of bone atrophy after forearm fracture using locking plates compared with using conventional plates. The aim of this study is to investigate bone atrophy after plate fixation for forearm fractures.

Methods: Fourteen patients followed for more than 5 years after their operation volunteered for the study. The mean age at surgery was 48.1 years. Eight had locking plates and six had conventional plates. The mean follow-up periods were 86.5 months and 105.7 months in locking and conventional plate groups, respectively. We measured thickness of cortical bone and local bone mineral density from CT data and images of both forearms. Bone strengths without the plate were predicted using the finite element method. The values of injured side were compared with healthy side and it was defined as the injury-healthy ratio. The ratio was compared between locking and conventional plate and statistically analyzed using a Mann–Whitney U-tests.

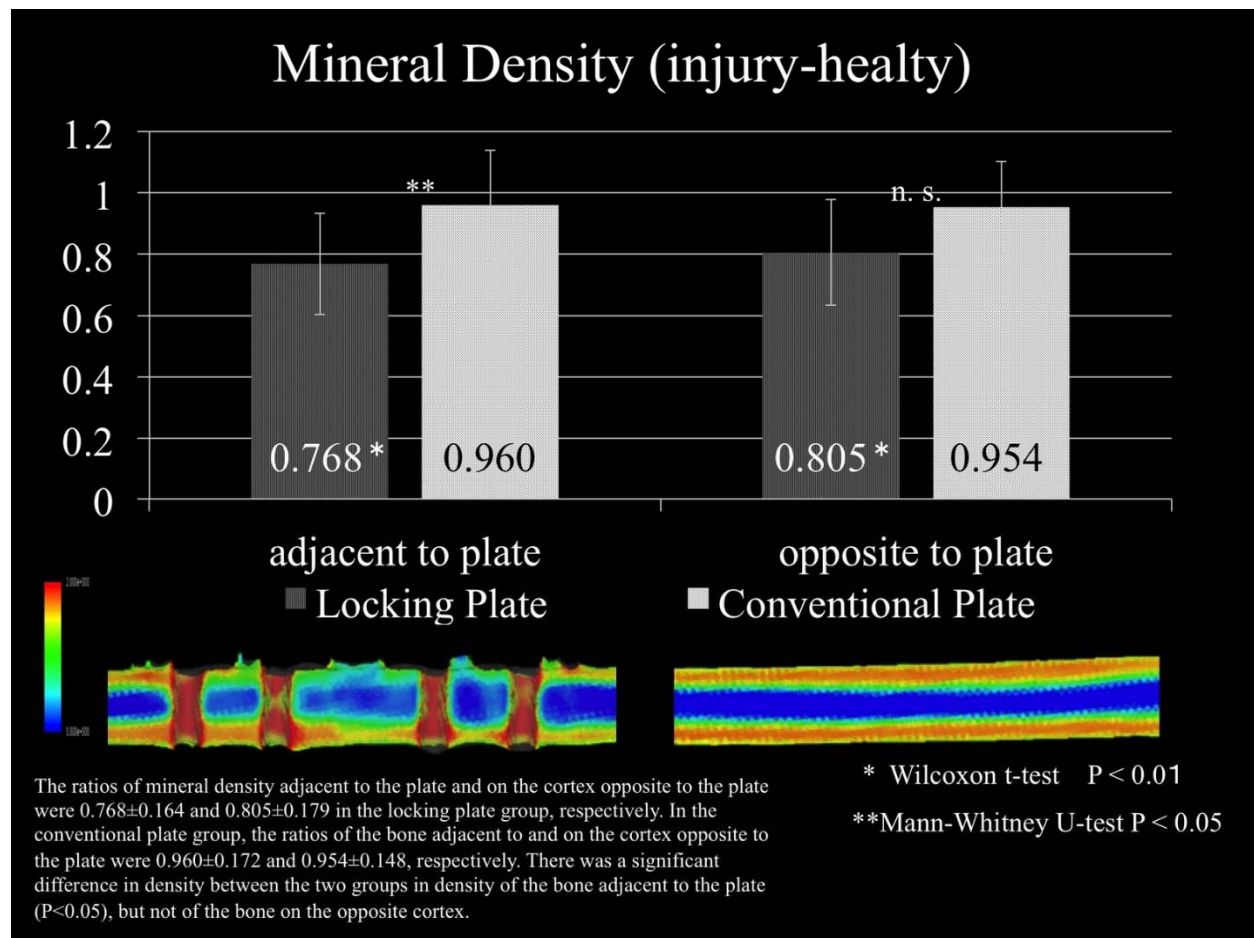
Results: The ratio of cortical thickness of bone adjacent to the plate and on the opposite cortex to the plate on the fractured radius was 0.627 ± 0.191 and 1.058 ± 0.220 in the locking plate group, respectively. In the conventional plate group, the ratio of cortical thickness of bone adjacent to the plate and on the opposite cortex to the plate was 0.728 ± 0.519 and 0.912 ± 0.165 , respectively. There were no significant differences between the locking plate and conventional plate groups. The ratios of mineral density adjacent to the plate and on the cortex opposite to the plate were 0.768 ± 0.164 and 0.805 ± 0.179 in the locking plate group, respectively. In the conventional plate group, the ratios of the bone adjacent to and on the cortex opposite to the plate were 0.960 ± 0.172 and 0.954 ± 0.148 , respectively. There was a significant difference in density between the two

groups in density of the bone adjacent to the plate ($P < 0.05$), but not of the bone on the opposite cortex. The ratios of bone strength were 0.587 ± 0.316 and 0.933 ± 0.165 in locking and conventional plate groups, respectively ($p < 0.05$).

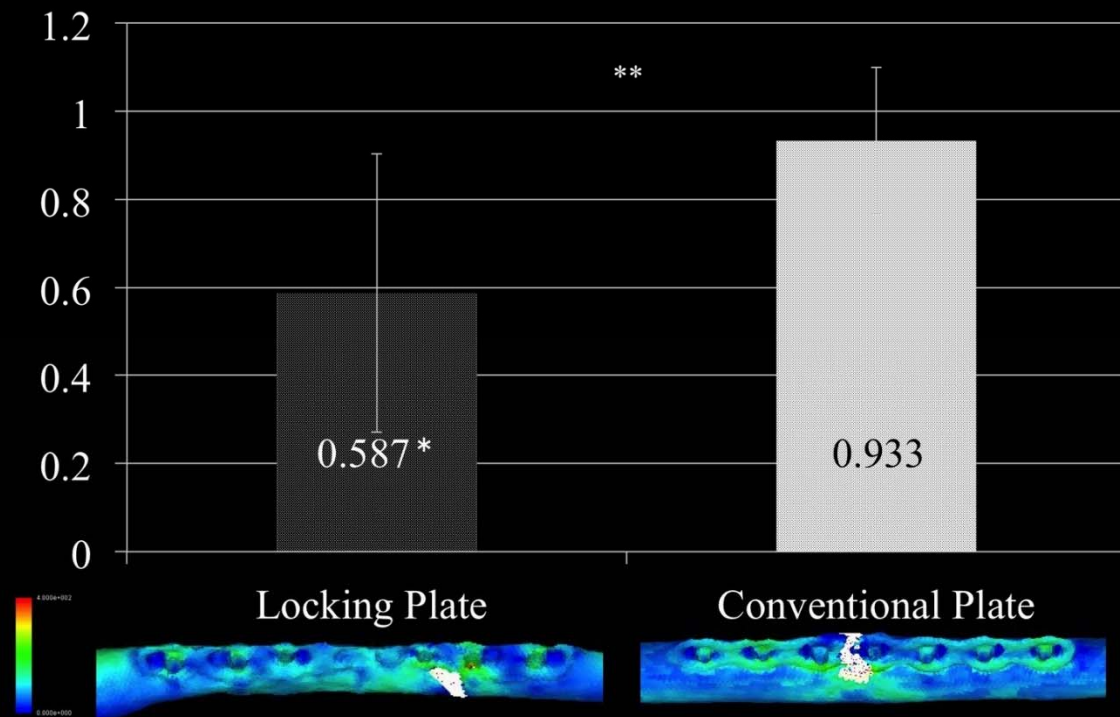
Summary: This study demonstrated the occurrence of bone atrophy after locking plate fixation for forearm fractures.

References:

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Fracture Load (injury - healthy)



The ratios of bone strength were 0.587 ± 0.316 and 0.933 ± 0.165 in locking and conventional plate groups, respectively ($p < 0.05$).

* Wilcoxon t-test $P < 0.01$

**Mann-Whitney U-test $P < 0.05$

◆ Nothing of financial value to disclose

AM E-POSTER 32: Evaluation of Suture and Osseous Tunnel Position for TFCC Repair in Relation to Clinical Outcomes: A Cadaveric Study.

Category: Basic Science - Clinical Research

Keyword: Wrist

Not a clinical study

- ◆ Taiichi Matsumoto, MD
- ◆ Peter Tang, MD, MPH
- ◆ Keiji Fujio, MD
- ◆ Robert J. Strauch, MD
- Melvin P. Rosenwasser, MD

Hypothesis: Transosseous repair of foveal detachment of the triangular fibrocartilage complex (TFCC) is effective in stabilizing the distal radioulnar joint. However, studies of the optimal fovea and TFCC suture positions are scant. To clarify the optimal suture positions, we studied seven cadavers.

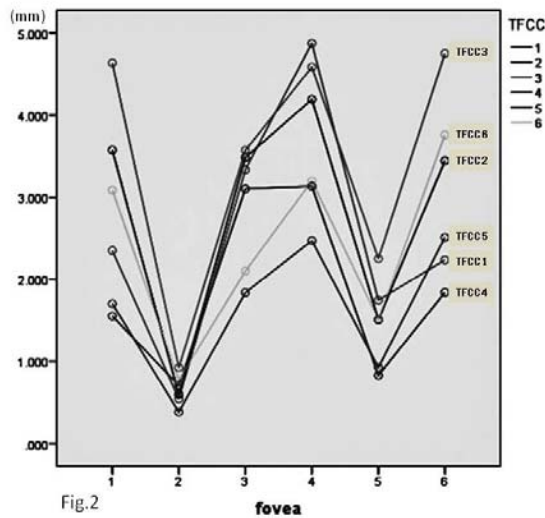
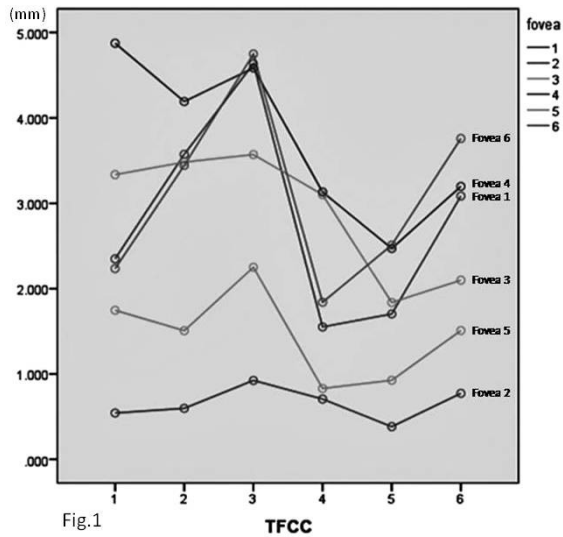
Methods: Before the study, the entire musculature was removed from the cadavers, and all joints related to the carpal bones were disarticulated. The distal ulna was cut and inverted, and the TFCC was incised from the fovea. All ligaments and the interosseous membrane were left untouched. The TFCC was sutured at six points (TFCC 1–6) using inelastic sutures, and six osseous tunnels were created in the fovea (fovea positions 1–6). The six suture threads were subsequently sutured through each of the six osseous tunnels in order, producing 36 points of suture between the TFCC and fovea. The degree of movement was measured from each of the five positions between maximum supination and pronation, and one-factor ANOVA was used to identify significant differences.

Results: The average degree of movement was 2.4 ± 1.3 mm. The degree of movement for fovea positions 2 and 5 was lowest for all TFCC points (Fig.1). A line graph of TFCC points 1–6 with all fovea positions displayed on the x-axis showed a substantially smaller degree of movement for fovea positions 2 and 5 (Fig.2). For fovea position 2, the degree of movement did not differ between the six TFCC points. For fovea position 5, the degree of movement was significantly lower for TFCC points 4 and 5 compared with TFCC point 3 ($p=0.002$ and $p=0.004$, respectively).

Summary: This study suggests that that, for the transosseous repair of foveal detachment of the TFCC performed through the osseous tunnel, fovea position 2 may produce the highest clinical success rate regardless of the TFCC suture position. Fovea osseous tunnel position 5 with a TFCC suture position 4 or 5 may also be clinically successful.

References:

1. Nakamura T, Takayama S, Horiuchi Y, Yabe Y. Origins and insertions of the triangular fibrocartilage complex: a histological study. *J Hand Surg Br.* 2001 Oct;26(5):446-54.
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- Royalties/Honoraria received from: Biomet
- Consulting Fees (e.g. advisory boards) received from: Stryker
- ◆ Nothing of financial value to disclose

AM E-POSTER 33: Internet Self-Diagnosis in Hand Surgery

Category: Basic Science - Clinical Research

Keyword: Hand

Level 3 Evidence

◆ Michiel G.J.S. Hageman, MD

◆ Jade Anderson, BSc

◆ Robin Blok, BSc

◆ Jeroen Bossen, MD

● David C. Ring, MD, PhD

Hypothesis: Online self-diagnosis does not correspond with the final diagnosis of the hand surgeon.

Methods: Eighty-six outpatients were prospectively enrolled and used an online diagnostic tool to guess their diagnosis. We collected demographic information, hours spent on the Internet per week, and the following questionnaires: Pain Catastrophizing Scale (PCS), Pain Self Efficacy Questionnaire (PSEQ) and Center of Epidemiological Studies Depression scale (C-ESD).

Results: Thirty-three percent of online diagnoses matched the final diagnosis of the hand surgeon. Factors associated with an online diagnosis corresponding to the hand surgeon's diagnosis included sex (women) and patients who studied their symptoms online prior to the visit. The best multivariable model included sex ($p < 0.01$, OR 4.3), more years of education ($p = 0.02$, OR 1.2), and prior use of the internet to research their medical condition ($p = 0.02$, OR 3.7) and explained 15% of the variation in correspondence of diagnosis.

Summary:

- The majority of online diagnoses for hand and upper extremity conditions don't correspond with the diagnosis of the treating hand surgeon.
- Psychological factors do not influence the correspondence of online diagnosis with the hand surgeon's diagnosis.

References:

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- Contracted Research with: Skeletal Dynamics
- Royalties/Honoraria received from: AO North America, AO International, Wright Medical, Medartis
- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Illuminos
- Consulting Fees (e.g. advisory boards) received from: Wright Medical, Skeletal Dynamics
- Other Financial/Material Support received from: Journal of Hand Surgery, Journal of Orthopaedic Trauma, Journal of Shoulder and Elbow Surgery
- ◆ Nothing of financial value to disclose

AM E-POSTER 34: Does the Absence of Crepitus Prove Screws do not Violate the Articular Surface of the Distal Radius?

Category: Basic Science - Clinical Research

Keyword: Wrist

Not a clinical study

- ◆ James Richard Phelps, MD
- ◆ Matthew Bengard MD
- ◆ O. Alton Barron MD
- ◆ Louis Catalano MD
- ◆ Steven Glickel MD
- ◆ Elizabeth Olecki

Hypothesis: Distal radius fractures treated with ORIF with volar plates have the potential complication of screw penetration into the radiocarpal joint. The purpose of this study is to investigate if penetration into the joint may be present despite fluoroscopy not showing penetration and without demonstrable crepitus with wrist passive range of motion (PROM).

Methods: A volar distal radius plate was placed at the watershed line of the intact distal radius in 15 cadaveric limbs. Each distal row screw hole was drilled at the maximum 15 degree angle towards the joint beginning with position 1 at the radial styloid and progressing ulnarly to position 4. The depth of each hole was measured and screw length was increased or decreased by two millimeters until crepitus was elicited with PROM of the manually-loaded joint. A screw of the length producing crepitus was then inserted into the respective hole and four radiographs were taken: AP 10° palmar tilt, PA, lateral 21° tilt, and 45° pronated . This was repeated with the maximum length of screw that did not produce crepitus. The distal radiocarpal joint was exposed to determine the location, length, and height of the exposed screw tip if it extended beyond the articular surface for both sets of screws. Each set of radiographs were reviewed by three fellowship trained hand surgeons.

Results: Forty-one of the 60 screws penetrated the articular surface and produced crepitus with PROM. When the screws were shortened to not produce crepitus, nine of 60 (15%) did not penetrate the joint on fluoroscopy, these screw tips still extended into the joint on inspection. Five of these 9 screws were longer than the length measured with a depth gauge. Four of the screws were shorter than the length measured but still penetrated the joint by an average length of 2.4 mm. No violation of the articular surface occurred in the first screw position; however, three screw tips penetrated the joint at each position 2, 3, and 4. The average length and height of screw penetration was 1.9 mm and 1.2 mm respectively.

Summary: Clinically, fluoroscopy and PROM are used to evaluate joint penetration in distal radius fractures. In this cadaver model, 15% of the screws violated the articular surface and were not detectable fluoroscopically or on clinical exam via crepitus. Screws that penetrated the joint but were not clinically demonstrable occurred in all positions but the radial styloid.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 35: Prediction of Optimal Proximal Interphalangeal Joint Fusion Angle Using Simulated Joint Arthrodesis

Category: Basic Science - Clinical Research

Keyword: Hand

Level 3 Evidence

- ◆ Yevheniy Lider, BE
- ◆ Karen DeChello, MS, OTR/L
- ◆ Mitchell Fourman, MPhil
- ◆ Arjun Iyer, BS
- ◆ Sue A. Sisto, PhD, FACRM
- ◆ Alexander B. Dagum, MD

Hypothesis: Arthrodesis is a common treatment for PIP joint arthritis; however, few studies have investigated the impact of the loss of mobility within the joint. As a result, the selection of the angle at which to fuse is dictated by the surgeon's personal experience. Here we simultaneously investigate the effects of PIPJ fusion on hand performance, subjective perception, and upper extremity kinematics as we aim to identify the optimal PIP joint fusion angle.

Methods: In a randomized trial, a battery of hand function tests were administered to healthy participants whose index PIP joints have been splinted at specific angles (30°, 40°, 50°, 60°). For each of the four splinted conditions and one unsplinted control, each participant performed the Purdue Pegboard Dexterity Test, the Jebsen-Taylor Hand Function Test, and a pulp-to-pulp pinch dynamometer while the kinematics of the upper extremity was measured using a motion capture system. The Michigan Hand Questionnaire, QuickDASH, and a custom survey were administered to measure the perceived impact of the simulated fusion. Statistical analysis was performed using the Friedman test and Wilcoxon signed-rank test. $P < 0.05$ was considered significant.

Results: Data were collected for 14 participants who attained the mean scores of: 16.0(SD=1.5), 14.3(SD=1.7), 14.5(SD=2.3), 14.0(SD=2.4) 13.6(SD=2.1) for the pegboard task, 10.0(SD=2.2), 8.98(SD=1.7), 9.38(SD=1.9), 9.65(SD=1.7), 9.17(SD=2.2) for the pinch strength test, and 44.7(SD=6.5), 49.0(SD=5.8), 50.6(SD=5.7), 49.2(SD=5.5), 49.1(SD=5.3) for the Jebsen-Taylor test during the unsplinted, 30°, 40°, 50°, and 60° conditions respectively. A learning trend was observed and the data were normalized using the group average for each trial prior to statistical analysis. Participants performed best while splinted at 40° during the pegboard task, 50° during the pinch strength test, and 30° during the Jebsen-Taylor task. However, no significant difference has been observed among the splinted conditions for the pegboard and Jebsen-Taylor tasks, but

has been observed for the pinch test. Significant difference in pinch strength has been observed between the angles of 30° and 50° ($t=-2.277$, with $df=13$, $P=0.048$).

Summary:

- Preliminary performance data (N=14) suggests that splinting the PIP joint had the most impact on tasks requiring fine manipulation and pinch strength application, while gross functional tasks were impacted the least.
- Best performing angle was 40° for Purdue Pegboard task and 50° for the pinch strength test; in fact, no significant difference in pinch strength was observed between unsplinted and 50° conditions.
- A number of individuals performed best while splinted at other angles suggesting that optimal angle may be a function of the individual's hand.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 36: Collagenase Enzymatic Fasciotomy for Dupuytren's Contracture in Patients on Chronic Immunosuppression

Category: Basic Science - Clinical Research

Keyword: Hand

Level 4 Evidence

- ◆ Michael J. Waters, BMBS
- ◆ Mark Belsky, MD
- ◆ Matthew Leibman, MD
- ◆ Philip Blazar, MD
- ◆ David E. Ruchelsman, MD

Hypothesis: Collagenase enzymatic fasciotomy is an accepted non-surgical treatment for disabling hand contractures caused by Dupuytren's disease¹. We aim to determine its safety for use in immunosuppressed individuals.

Methods: Retrospective review of data collected from two academic hand surgical practices. Eight patients on chronic immunosuppressive therapies were treated with collagenase for digital contractures between 2010 and 2011. Thirteen collagenase enzymatic fasciotomies were performed in these eight patients.

Results: Of the 13 joints treated, seven were MP joints and six were PIP joints. Mean pre-injection contracture was 53.0 degrees. Twelve of 13 joint contractures improved. At mean follow-up of 6.7 months, the mean magnitude of contracture improved to 12.5 degrees. The mean MP joint contracture improved from 42.0 degrees to 3.3 degrees. The mean PIP joint contracture improved from 65.8 degrees to 21.7 degrees. All injections were tolerated well with no systemic reactions. Three of the fasciotomies (23%) were complicated by skin tears, but all healed within two weeks with local wound care. There were no cases of infection.

Summary: Collagenase enzymatic fasciotomy appears to be a safe and efficacious alternative to traditional surgical intervention for Dupuytren's disease in immunosuppressed patients. As more patients seek non-surgical treatment for Dupuytren's disease, its safety and efficacy in select cohorts of patients should continue to be evaluated prospectively.

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Table 1. Summary of outcomes and adverse events.

Patient	Treated Joint	Pre-injection contracture (degrees)	Contracture at latest follow-up (degrees)	Length of Follow-up	Adverse Events (other than pain, peripheral <u>edema and bruising</u>)
1	L RF PIP	55	30	6 months	-
	R SF PIP	45	20	3 months	Skin tear, blood blister
2	R RF PIP	90	10	9 months	-
	L RF PIP	90	0	8 months	-
3	R SF PIP	40	45	22 months	-
4	L MF MP	50	-*	-	-
5	R MF MP	30	0	1 month	-
6	R RF MP	39	0	14 months	-
7	R RF PIP	75	25	1 months	Skin tear
8	L SF MP	80	10	8 months	Skin tear
	L RF MP	35	10	6 months	Blood blister
	R SF MP	20	0	1 month	-
	R RF MP	40	5	1 month	-
	<i>Mean</i>	<i>53.0</i>	<i>12.5</i>	<i>6.7 months</i>	

L= left, R= right, MF= middle finger, RF= ring finger, SF= small finger, PIP= proximal interphalangeal joint, MP= metacarpophalangeal joint, *=patient lost to follow-up following injection and manipulation.

◆ Nothing of financial value to disclose

AM E-POSTER 37: Dominant Hand: Stronger but Smaller. A Study on Grip Strength and Anthropometry of Dominant and Nondominant Hands

Category: Basic Science - Clinical Research

Keyword: Hand

Level 4 Evidence

◆ Chew-Wei Chong, MBBCh, BAO

◆ Sandeep J. Sebastin, MCh

Hypothesis: There are differences in anthropometry between the dominant and nondominant hand.

Methods: Healthy adults above 21 years old were recruited randomly. Persons with upper limb or neck pathology or injury were excluded from this study. Subjects were positioned according to American Society of Hand Therapists recommended standardised positioning. Grip strength was measured using a digital dynamometer (J-Tech Commander Grip Track). Bilateral grip strengths were measured at Jamar 2. This was repeated after a 1-minute rest. A similar protocol was used for grip strength measurement at Jamar 3.

A series of predetermined anthropometric parameters were measured from photographs of the hands. Hand span is the distance from the tip of thumb to the tip of little finger (LF). Hand width is the distance from the radial border of second metacarpophalangeal joint (MCPJ) to ulnar border of fifth MCPJ. Pinch span is the distance from the distal interphalangeal joint crease of IF to the interphalangeal joint crease of thumb. Palm length is the distance from distal wrist crease to proximal digital crease of middle finger (MF). Finger length is the distance from the proximal digital crease of the MF to the tip of the MF. Oblique palm length is the distance from the proximal digital crease of the thumb to the proximal digital crease of LF.

Statistical analysis was done with Statistical Product and Service Solutions (SPSS).

Results:

- A total of 277 subjects (141 male and 136 female) were included in the study. The median age is 41 years old. 52% of the subjects were Chinese, 14% were Malay, 13% were Indian, and 21% were other races.
- 74% of the maximum grip strength was recorded at Jamar level 2. The maximum grip strength is 89.7 lbs in male and 56.2 lbs in female. The dominant hand is significantly stronger than nondominant hand at both Jamar level 2 and 3 for both genders.
- Hand span, pinch span, finger length and palm length are significantly greater ($p < 0.05$) on the nondominant hand for both genders.

Summary:

- Hand strength in Asian is generally weaker than the reported results in Western countries.

- The dominant hand is significantly stronger than the nondominant hand.
- Hand span, pinch span, finger length and palm length are significantly greater ($p < 0.05$) on the nondominant hand for both genders.
- This study allows better understanding of the role and functions of dominant and nondominant hands.

References:

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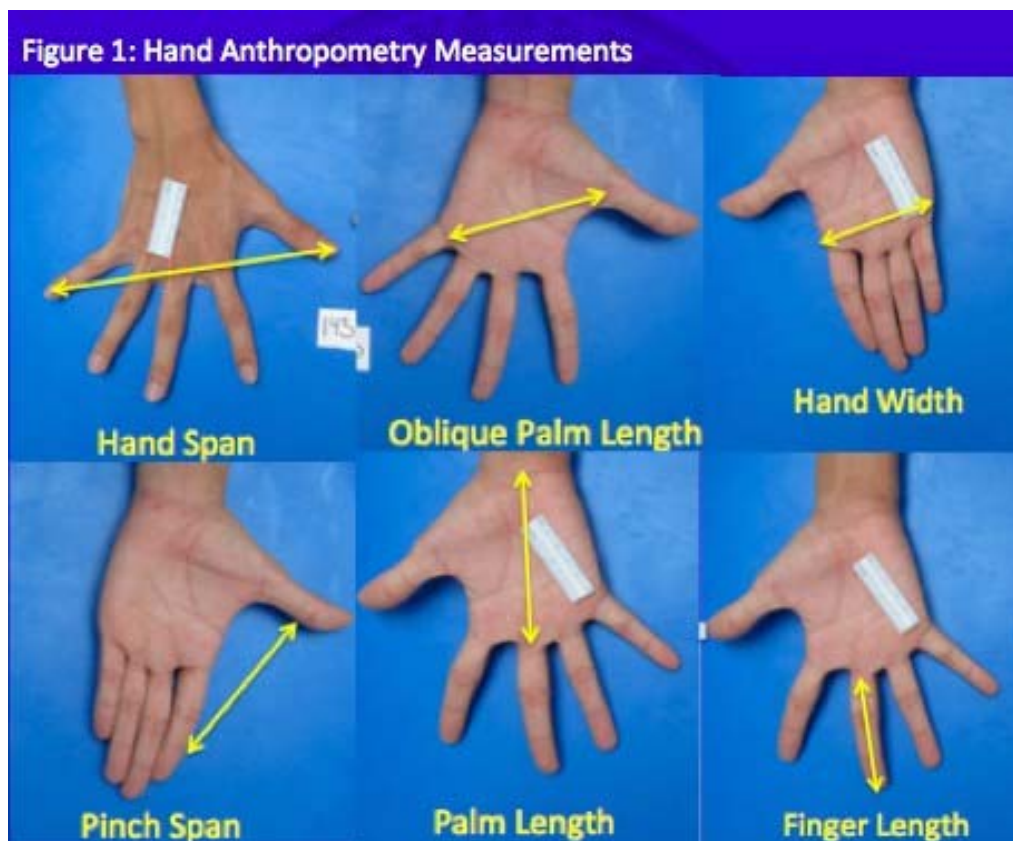


Table 1: Mean values of hand anthropometry measurements in male and female

	Male		Female	
	Dominant	Non dominant	Dominant	Non dominant
Hand span	19.1cm	19.5cm	17.3cm	17.5cm
Pinch span	9.1cm	9.4cm	8.1cm	8.4cm
Oblique palm length	9.8cm	9.7cm	8.7cm	8.7cm
Hand width	8.2cm	8.1cm	7.4cm	7.3cm
Palm length	10.7cm	10.6cm	9.8cm	9.7cm
Finger length	7.3cm	7.3cm	6.8cm	6.8cm

◆ Nothing of financial value to disclose

AM E-POSTER 38: Development of Computer Assisted Surgery Technique for Fixation of Scaphoid Fractures

Category: Basic Science - Lab Research

Keyword: Wrist

Not a clinical study

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◆ Eran Peleg, PhD

◆ Gil Segal

◆ Amjad Hamad, MD

◆ Shai Luria, MD

Hypothesis: Proper positioning of the a screw for the fixation of a scaphoid fracture remains technically challenging and therefore computer assisted surgery (CAS) may have an advantage. Navigation assisted techniques require placement and registration of stable reference markers which is technically impossible in the scaphoid. Custom made wrist-positioning devices with built-in reference markers have been developed for this purpose [1-3]. The purpose of this study was to evaluate a different method of navigation assisted scaphoid fracture fixation. Temporary stabilization with a pin of the scaphoid to the radius enables placement of the reference markers on the radius. Our hypothesis was that this method will achieve precise fracture fixation, superior to the standard free hand technique.

Methods: In 20 identical saw bone models with mobile scaphoids (Synbone AG, Switzerland), the scaphoid was stabilized to the radius using one Kirschner wire (KW). An additional KW representing the fixating screw was placed either using the Mazor Renaissance Robotic System (MAZOR Surgical Technologies, Israel) or standard free hand technique. CT scans were performed prior to fixation and after fixation in order to plan the location of the KW and compare this planned location with the final result.

Results: No significant difference was found between the measures of KW location between groups and in comparison with the planned location, including entry and exit points of the KW, length of KW through the scaphoid (mean axis length of 28.7 mm [SD 1.5] with the robot system vs. 29.6 mm [SD 2.1] with the free hand technique) and difference in angle of fixation with the planned axis of fixation (mean of 1.7 degrees [SD 5.5] with the robot vs. 3.8 degrees [SD 5.6] free hand). Significant differences were found between exposure to radiation (mean of 0.07 Rad [SD 0.04] with the robot system vs. 13.9 Rad [SD 18.4] with the free hand technique; $p=0.04$) and the number of attempts in placing the KW (mean of 1.1 attempts [SD 0.32] with the robot vs. 8 attempts [SD 6.65] free hand; $p=0.01$).

Summary:

- Computer assisted fixation of a scaphoid fracture was found to be as accurate as the free hand technique, after fixation of the scaphoid to the radius, without the need for a custom splint.
- Computer assisted fixation was found to be superior by decreasing the exposure to radiation and number of attempts of KW placement.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 39: Different Dose Effects of Anti-NGF Receptor (p75NTR) on the Behavior and Activation of Spinal Microglia and Astrocytes in the Rat Brachial Plexus Avulsion Model

Category: Basic Science - Lab Research

Keyword: Other

Not a clinical study

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- ◆ Kazuki Kuniyoshi, MD, PhD
- ◆ Yusuke Matsuura, MD
- ◆ Kenichi Murakami, MD
- ◆ Takane Suzuki, MD
- ◆ Seiji Ohotori, MD, PhD

Hypothesis: We hypothesized that inhibition of the p75 neurotrophin receptor (p75NTR), the low affinity NGF receptor and common neurotrophin receptor, can reduce neuropathic pain in the rat brachial plexus avulsion (BPA) model.

Methods: Twenty-three male Wistar rats were used in this study. In the BPA group (n=7), the C8–T1 roots were avulsed from the spinal cord at the lower trunk level and saline was administered intraperitoneally. In the anti-p75NTR 1.0 µl and 50 µl groups (n=5 each), the C8–T1 roots were avulsed and 1.0 or 50 µl of anti-p75NTR antibody, respectively, was administered intraperitoneally. In the sham-operated group (n=6), the lower trunk level was simply exposed and saline was administered intraperitoneally. Mechanical hyperalgesia and pain-induced walking patterns were measured using von Frey filaments and CatWalk gait analysis before surgery, three days post-surgery, immediately before administration of anti-p75NTR antibody or saline, and at 1, 3, 6, 12, 24, 48 hours and 3, 6, 9, 12, 15 days after administration. Activation of astrocytes and microglia, a marker of spinal pain transmission, was immunohistochemically examined in the ipsilateral dorsal-horn of the spinal cord (C7) using anti-GFAP and anti-Iba1 antibodies 15 days after administration of anti-p75NTR antibody or saline. Data between groups were analyzed using a Kruskal–Wallis test, followed by Mann–Whitney U-tests. Bonferroni corrections were also performed.

Results: Rats in the BPA group displayed significant mechanical hyperalgesia compared with the sham group ($p < 0.01$). Mechanical hyperalgesia in both p75 groups was significantly improved 6 hours after administration of anti-p75NTR antibody compared with the BPA group. In the gait CatWalk analysis, rats in the BPA group displayed a significantly greater pain-induced gait pattern compared with the sham group ($P < 0.01$). Gait pattern was significantly improved in both p75 groups 1 hour after administration of anti-p75NTR antibody compared

with the BPA group. GFAP-immunoreactive astrocytes and Iba1-immunoreactive microglia were significantly activated in the BPA group and both p75 groups compared with the sham group. However, activation of astrocytes and microglia in both p75 groups was significantly reduced compared with the BPA group ($P < 0.01$), and there was no significant difference between the 1.0 and 50 μ l p75 groups (Figures 1 and 2).

Summary:

- Anti-p75NTR antibody administration improved pain behavior and suppressed spinal glia cell activation.
- Inhibition of p75NTR reduces neuropathic pain, thus making it a potential therapeutic target for the clinical treatment of pain in brachial plexus avulsion injury.

References:

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Figure 1. Number of GFAP-immunoreactive astrocytes (C7 ipsilateral side)

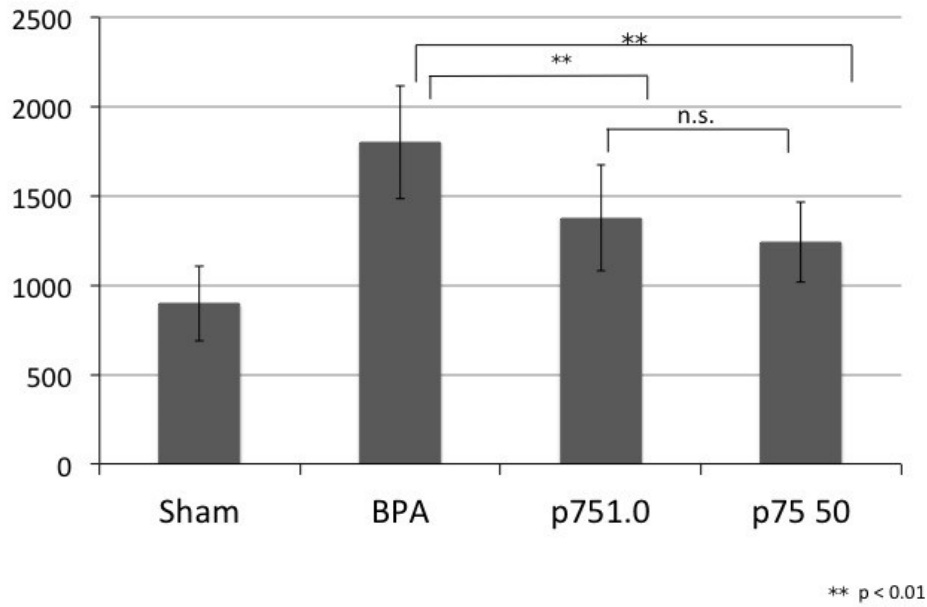
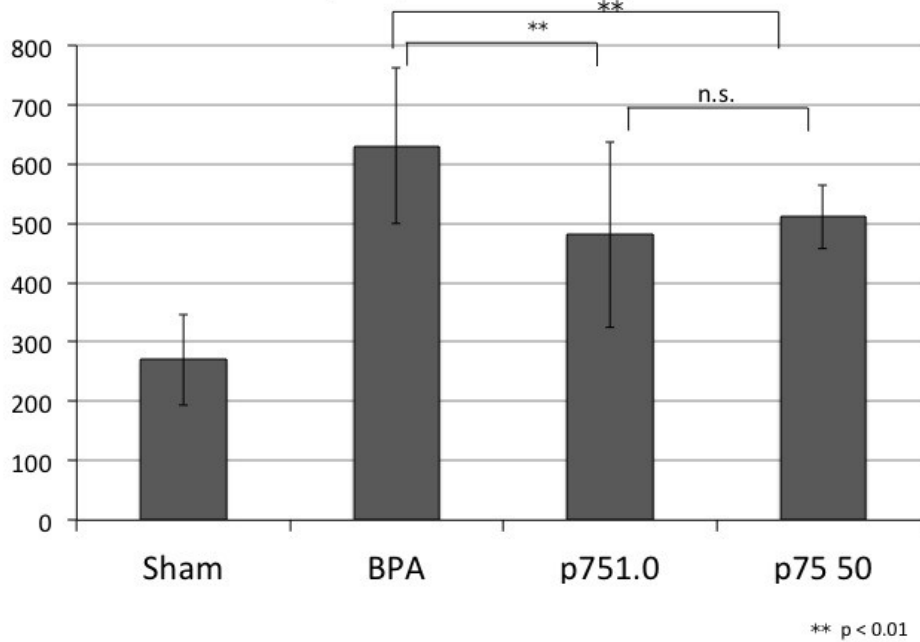


Figure 2. Number of Iba1-immunoreactive microglia (C7 ipsilateral side)



◆ Nothing of financial value to disclose

AM E-POSTER 40: Ciliary Neurotrophic Factor Mitigates Denervation Induced Muscle Growth Impairment Following Neonatal Brachial Plexus Injury

Category: Basic Science - Lab Research

Keyword: Elbow

Not a clinical study

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- ◆ Liangjun Hu, MS
- ◆ Holly Weekley, BS
- ◆ Christopher Wylie, PhD
- ◆ Roger Cornwall, MD

Hypothesis: Contractures following neonatal brachial plexus injury (NBPI) have recently been shown to be associated with impaired longitudinal growth of denervated muscle, characterized by increased sarcomere elongation under stretch. The current study tests the hypothesis that this denervation-induced growth impairment following NBPI can be mitigated by the exogenous administration of ciliary neurotrophic factor (CNTF), based on its ability to mitigate denervation-induced atrophy in adult muscle.

Methods: Immunohistochemical identification of CNTF receptors (CNTFR α , LIFR β and gp130) in muscle satellite cells was carried out in biceps and brachialis muscles harvested from 5-day-old CD-1 mice by 100X confocal microscopy. Extraforaminal global (C5-T1) brachial plexus injuries were surgically created in 31 5-day-old CD-1 mice, who were subsequently randomized to receive 10 daily subcutaneous injections of either placebo (PBS) or CNTF (0.5mg/kg). Animals were sacrificed 4 weeks post-operatively. Elbow passive range of motion was measured with a validated digital photography technique while blinded to treatment group. The biceps and brachialis muscles from 14 mice (7 CNTF; 7 PBS) were harvested and stained with Masson's Trichrome for histologic cross-sectional area (CSA) measurement. The forequarters from the remaining 17 mice (9 CNTF, 8 PBS) were removed and fixed in formalin at 90° elbow flexion. Following fixation, the biceps and brachialis were removed, stained with 25% Lugol's solution and imaged by MicroCT for muscle volume and stretched CSA, and then dissected into fiber bundles for sarcomere length measurements under 40x oil DIC microscopy.

Results: CNTF receptors (CNTFR α , LIFR β and gp130) were expressed in biceps and brachialis muscle satellite cells during the relevant neonatal age period. CNTF administration following NBPI significantly reduced the denervation-induced increase in brachialis sarcomere elongation under stretch when compared to placebo (CNTF: mean 2.55 μ m; PBS: mean 2.70 μ m; $p=0.0106$, unpaired t-test). This improvement of longitudinal growth was more robust than the nearly

significant improvement in stretched CSA (CNTF: mean 0.66mm^2 ; PBS: mean 0.58mm^2 ; $p=0.0730$, unpaired t-test). However, at this dose, the mitigation of longitudinal muscle growth impairment did not statistically reduce the severity of elbow flexion contractures. CNTF caused no significant effects on biceps growth, either in sarcomere elongation or cross-sectional area.

Summary: CNTF mitigates the denervation-induced longitudinal growth impairment of the brachialis following NBPI. Further investigation is warranted regarding dosing or combination therapies in order to translate this effect on brachialis muscle growth into clinically appreciable effects on contractures. The present study demonstrates the potential for medical mitigation of the growth-related component of NBPI-induced contractures.

◆ Nothing of financial value to disclose

AM E-POSTER 41: The Distribution and Prevalence of Mechanoreceptors in Ligaments of the First Carpometacarpal Joint in Surgical Patients with Osteoarthritis.

Category: Basic Science - Lab Research

Keyword: Hand

Not a clinical study

◆ Cassie Ludwig, BS

◆ Nathalie Mobargha, MD

◆ Elisabet Hagert, MD, PhD

● Amy L. Ladd, MD

Hypothesis: Intact ligament innervation is essential for joint stability and proprioceptive mechanisms to function properly. In this study we have examined the innervation and distribution of mechanoreceptors in the two principal ligaments of the first carpometacarpal joint (CMC1), the AOL (anterior oblique ligament) and DRL (dorsal radial ligament) in surgical patients with osteoarthritis (OA). We hypothesize that the innervation patterns of these subjects differ from cases without signs of OA.

Methods: Two ligaments were harvested from the hands of 11 subjects undergoing trapeziectomy with ligament stabilization. Subjects included 10 females and 1 male, 6 right and 5 left hands (mean age 67 years, age range 51-83). The ligaments were divided into their proximal and distal portions (yielding 42 samples total; 2 ligaments were too small to divide) sectioned in paraffin and analyzed using immunofluorescent triple staining microscopy. The results were analyzed using student's paired t-test, standard linear regression analysis as well as the Pearson correlation coefficient.

Results: In contrast to previous non-OA cadaver ligament studies, no statistically significant mean difference was found between innervation of the Distal DRL and Proximal DRL ($p = .108$) or between innervation of the Distal AOL and Proximal AOL ($p = .757$) of surgical patients with CMC OA. The average proportion of sensory nerve endings in ligaments of patients with CMC OA consisted of 74% Unclassifiable Corpuscles, 14% Free Nerve Endings and 12% Ruffini Endings. While Unclassifiable Corpuscles were the most abundant mechanoreceptors, found in 11/11 (100%) DRLs and 7/11 (63.6%) AOLs, no significant difference existed between ligament type and location of this sensory receptor type. Similarly, no significant difference existed between ligament type and location of Free Nerve Endings. While significantly more Ruffinis were found in the Distal DRL than Proximal AOL ($p = .039$), only one Pacini Corpuscle was found in the Distal DRL of 1 patient.

Summary:

- Unclassifiable corpuscles were the most prevalent type of mechanoreceptor found in both DRL and AOL.
- There is no difference in the distribution of mechanoreceptors in the proximal or distal portion of the ligaments.
- Distribution and prevalence of mechanoreceptors in cases with CMC1 OA differs from cases without signs of OA.

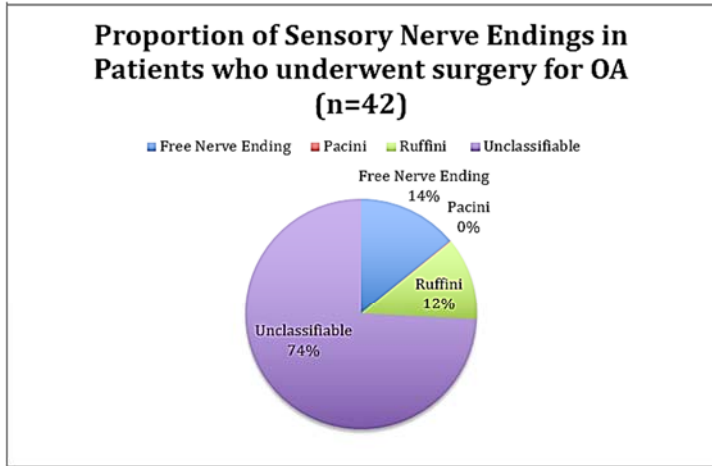


Figure 1. The proportion of sensory nerve endings in patients who underwent surgery for OA is shown as an average of the proportions of each sensory nerve ending in 42 ligament samples. Four samples were analyzed from each of 11 patients (three from two patients with ligaments too small for multiple sections).

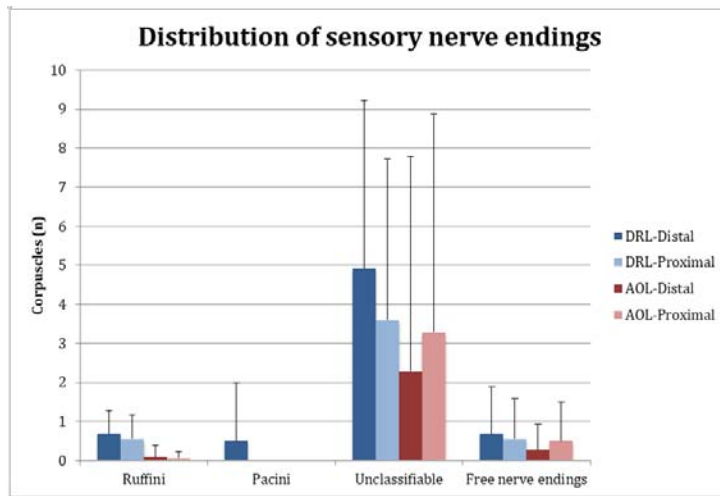


Figure 2. Means with standard deviation of mechanoreceptors in the proximal and distal locations of the DRL and AOL ligaments.

- Contracted Research with: NIH
- Other Financial/Material Support received from: Williams Foundation
- ◆ Nothing of financial value to disclose

AM E-POSTER 42: Architecture and Innervation of Thumb Carpometacarpal Ligaments in Surgical Patients with Osteoarthritis.

Category: Basic Science - Lab Research

Keyword: Hand

Not a clinical study

◆ Nathalie Mobargha, MD

◆ Cassie Ludwig, BS

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◆ Elisabet Hagert, MD, PhD

Hypothesis: Ligament innervation contributes to joint stability and proprioception. Recent evidence implicates abnormal ligament innervation associated with osteoarthritis (OA) in large joints; little is known about CMC1 ligament innervation characteristics in patients with OA. This study's purpose is to examine the ultrastructural architecture and mechanoreceptors of CMC1 ligaments in surgical OA patients using immunohistochemical techniques. We studied the dorsal radial ligament (DRL) and the anterior oblique ligament (AOL), ligaments with a reported divergent presence of mechanoreceptors in non-osteoarthritic joints.

Methods: The AOL and DRL were harvested from 11 patients with OA during trapeziectomy (10 females/1 male, 6 right/5 left hands, mean age 67 years). The 22 ligaments were sectioned in paraffin and analyzed using immunofluorescent triple staining microscopy. The results were analyzed using student's paired t-test and linear regression models.

Results: Mechanoreceptors were identified in CMC1 ligaments of all OA patients. The DRL was significantly more innervated than the AOL. In contrast to the organized collagen bundles of the DRL, the AOL appeared to be composed of disorganized connective tissue with few collagen fibers and little innervation.

Summary:

- DRL has an important proprioceptive and stabilizing role.
- AOL was found to have little to no innervation and is mainly composed of disorganized tissue.
- Ligament innervation characteristics may correlate with proprioceptive and neuromuscular changes in OA pathophysiology.

◆ Nothing of financial value to disclose

AM E-POSTER 43: Proximal Row Carpectomy and Scaphoid-Excision Four-Corner Fusion Impact the Mechanical Actions of Wrist and Hand Muscles

Category: Basic Science - Lab Research

Keyword: Wrist

Not a clinical study

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◆ Robert M. Havey, MS

◆ Wendy M. Murray, PhD

Hypothesis: Proximal row carpectomy (PRC) and scaphoid-excision four-corner fusion (SE4CF) permanently impair wrist and hand function^{1,2}. Previous studies have focused on examining how bones (e.g., carpal motion, impingement) influence function^{3,4}. However, changing joint geometry also influences muscles. Therefore, we examined how PRC and SE4CF impact wrist and hand muscles. Specifically, we measured changes in muscle moment arms, the geometric factor that transforms muscle force into joint torque, and explored whether these changes influence impairments. We hypothesize that following PRC and SE4CF moment arms change in divergent ways because these procedures alter wrist geometry differently.

Methods: Moment arms of the primary wrist and extrinsic thumb muscles were measured in 8 cadavers (avg. age 62.3 ± 8.9 years) using the tendon excursion method⁵. In this method, moment arms are calculated as change in tendon excursion divided by change in joint angle. Tendon excursions and joint angles were measured during passive, planar wrist motion for flexion-extension and radial-ulnar deviation. In each specimen, three conditions were tested: nonimpaired, SE4CF, and PRC. Statistically significant differences between nonimpaired and surgically-altered moment arms were determined using mixed effects models. When the F-test of the ANOVA was significant ($p < 0.05$), multiple comparisons with a Tukey correction were used.

Results: The data indicate that moment arms diverge following salvage procedures: PRC primarily alters flexion-extension moment arms, while SE4CF primarily alters radial-ulnar deviation moment arms (Table 1). Additionally, all four extrinsic thumb muscles demonstrated significant changes following at least one procedure.

Examining moment arms in a functional posture, such as 30° wrist extension, provides insight into the clinical implications of altering moment arms. For example, following PRC, wrist extensor moment arms are biased toward flexion (Figure 1A, squares below circles for extensors). This suggests that following PRC extensors must generate more force to extend the

wrist. Alternatively, following SE4CF, moment arms are biased toward radial deviation (Figure 1B, triangles left of circles). This suggests that when extending the wrist following SE4CF muscles must produce forces to prevent the wrist from falling toward radial deviation. Thus, different moment arms indicate that different forces are required to maintain an equivalent posture in nonimpaired, PRC, and SE4CF wrists.

Summary:

- This study is the first to compare nonimpaired, PRC, and SE4CF moment arms.
- By influencing flexion-extension and radial-ulnar deviation moment arms differently, PRC and SE4CF impose different force-generating requirements.
- Functional impairments likely result when muscles are unable to compensate for the altered force-generating requirements.

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4. Blankenhorn et al., J Hand Surg Am. 32(1):37-46, 2007
5. An et al., J Biomech. 16:419-425, 1983

Table 1. Changes in Muscle Moment Arm*

Muscles		Flexion-Extension Moment Arm		Deviation Moment Arm	
		SE4CF	PRC	SE4CF	PRC
Wrist	FCR	-	X	X	-
	FCU	-	-	-	-
	ECRB	-	X	X	-
	ECRL	-	-	X	-
	ECU	-	X	X	X
Thumb	FPL	-	X	X	-
	EPL	X	X	-	-
	APL	-	-	X	-
	EPB	-		X	X

*Differences between data from the nonimpaired wrist and the indicated surgery are reported. Significant differences denoted by X. Data excluded due to paucity of high quality trials denoted by gray shading.

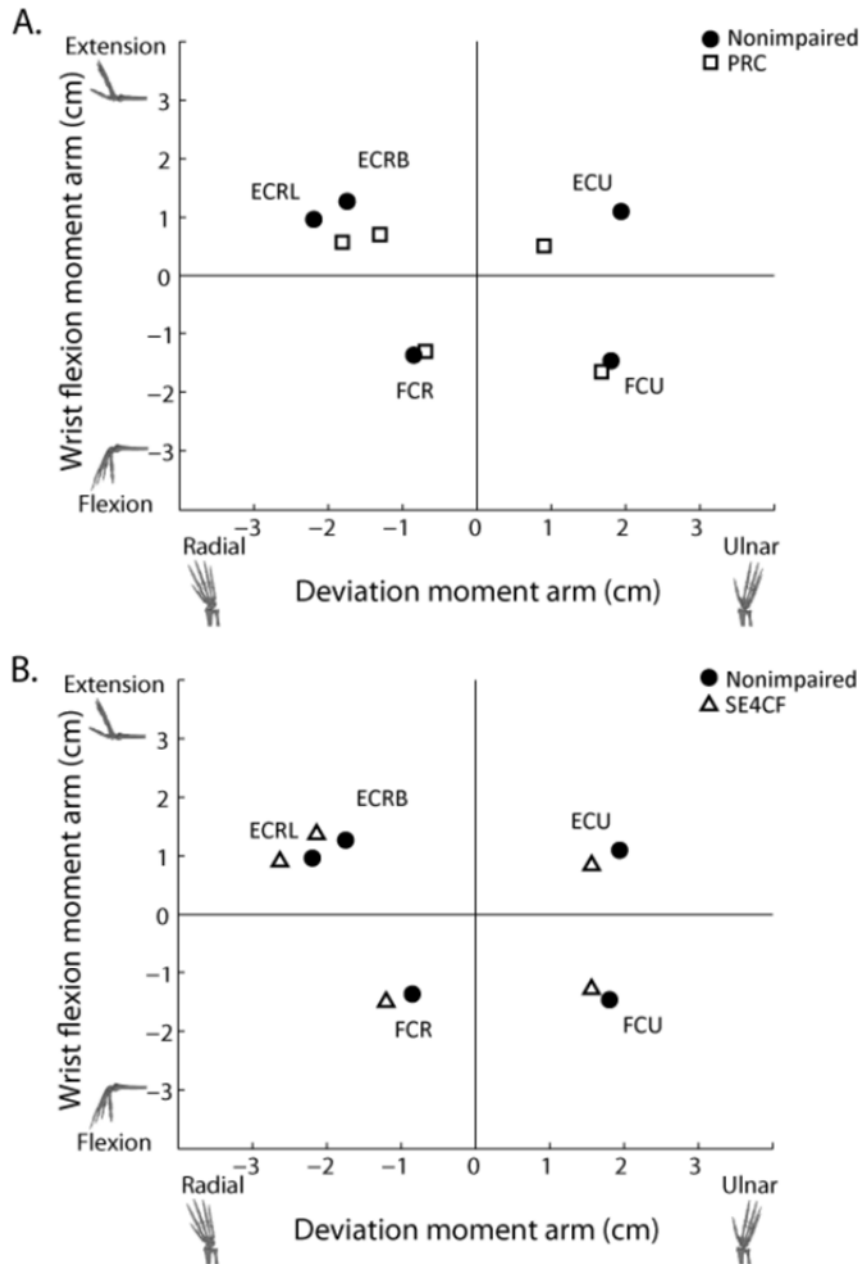


Figure 1. Flexion-extension moment arms plotted as a function of radial-ulnar deviation moment arms for the primary wrist muscles when the wrist is positioned in 30 degrees of extension. The nonimpaired wrist (filled circles) is compared to (A) the wrist following PRC (open squares) and (B) the wrist following SE4CF (open triangles). Positive moment arms indicate extension and ulnar deviation; negative moment arms indicate flexion and radial deviation.

◆ Nothing of financial value to disclose

AM E-POSTER 44: A Potential Novel Method for Composite Tissue (CT) Preservation in Replant and Transplant, Using Persufflation (PSF) in a Swine Model.

Category: Basic Science - Lab Research

Keyword: Hand

Not a clinical study

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- ◆ William E. Scott III, PhD
- ◆ Thomas M. Suszynski, MS.PhD
- ◆ Bradley P. Weegman, BS
- ◆ Warren C. Breidenbach, MD, FRCS
- ▲ Klearchos K. Papas, PhD

Hypothesis: Tissue preservation is a major issue in CT transplantation and replantation. Presently, CT must be revascularized in 4-6 hours. PSF, gaseous oxygen perfusion, is an emerging preservation technique, which has shown promise in liver and islet transplantation. We hypothesize that PSF, by providing continuous vascular oxygen delivery, will improve upon traditional methods of preservation and may extend preservation period to 24 hours. If this can be achieved, we anticipate significant improvements in outcomes by enabling longer transfer times for replant and better HLA matching for transplant.

Methods: Ten porcine forelimbs were obtained from 125-150 lb heparinized donor pigs following cardiac arrest. Forelimbs were flushed via the brachial arteries with 1 L of HTK solution and packed with ice. PSF was performed via the brachial arteries with a portable electrochemical oxygen concentrator (Giner Inc, Newton MA) at a flow rate of 25 cc/min and an oxygen concentration of 40%. Efficacy was assessed by visual observation of gas outflow from veins when submerged in water. One pig leg was examined by MRI at 4.7 T. ³¹P-NMR spectroscopy was also used to non-invasively measure relative ATP levels in a limb with and without PSF.

Results: Cannulation of the brachial artery was achieved and gas was successfully delivered throughout all tissues in each forelimb. Gas was visually observed exiting from the cut bone surface and the cephalic vein on all ten animals. MRI of distal portions of the one forelimb confirmed the presence of gas in the muscle plane, the vessels within the toes as well as in the subcutaneous venous system. ³¹P-NMR spectra exhibited no detectable ATP in static cold preserved tissue whereas ATP was observed in persufflated tissue. PSF was continuously performed on composite tissues for 24 hours with stable pressures and no deterioration of muscle tissue or edema was observed.

Summary: This study supports the feasibility of utilizing PSF to extend CT preservation to at least 24 hours. Oxygen gas can be delivered throughout the forelimb as demonstrated by MRI. Unlike traditional preservation (cold storage), PSF demonstrated the ability to maintain ATP production throughout preservation. Further development of this technique may enable the establishment of a nationwide distribution network providing optimal color, size, and HLA matching in transplant. In addition PSF may allow for prolonged preservation in replantation. Further investigation of PSF for CT preservation is warranted.

References:

1. Energetic recovery in porcine grafts by minimally invasive liver oxygenation. Minor T, Scott WE 3rd, Rizzari MD, Suszynski TM, Luer B, Efferz P, Papas KK, Paul A. *J Surg Res.* 2012 Dec;178(2):e59-63. doi: 10.1016/j.jss.2012.01.018. Epub 2012 Mar 10.
2. Persufflation (or gaseous oxygen perfusion) as a method of organ preservation. Suszynski TM, Rizzari MD, Scott WE 3rd, Tempelman LA, Taylor MJ, Papas KK. *Cryobiology.* 2012 Jun;64(3):125-43. doi: 10.1016/j.cryobiol.2012.01.007. Epub 2012 Jan 26.
3. Persufflation improves pancreas preservation when compared with the two-layer method. Scott WE 3rd, O'Brien TD, Ferrer-Fabrega J, Avgoustiniatos ES, Weegman BP, Anazawa T, Matsumoto S, Kirchner VA, Rizzari MD, Murtaugh MP, Suszynski TM, Aasheim T, Kidder LS, Hammer BE, Stone SG, Tempelman LA, Sutherland DE, Hering BJ, Papas KK. *Transplant Proc.* 2010 Jul-Aug;42(6):2016-9
4. Pancreas oxygen persufflation increases ATP levels as shown by nuclear magnetic resonance. Scott WE 3rd, Weegman BP, Ferrer-Fabrega J, Stein SA, Anazawa T, Kirchner VA, Rizzari MD, Stone J, Matsumoto S, Hammer BE, Balamurugan AN, Kidder LS, Suszynski TM, Avgoustiniatos ES, Stone SG, Tempelman LA, Sutherland DE, Hering BJ, Papas KK. *Transplant Proc.* 2010 Jul-Aug;42(6):2011-5

- ▲ This presentation will discuss a device by Giner, Inc.
- Consulting Fees (e.g. advisory boards) received from: Giner, Inc.
- ◆ Nothing of financial value to disclose

AM E-POSTER 45: Kinematics of the PIP Joint with Sequential Injury in a Cadaver Model

Category: Basic Science - Lab Research

Keyword: Hand

Not a clinical study

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- ◆ Paolo Caravaggi, PhD
- ◆ Benhoor Shamian, MD
- ◆ Kyle P. Kokko, MD, PhD

Hypothesis: The PIP joint is commonly injured in the hand due to its tendency for instability. This joint has been characterized as a true hinge joint with stability created by bony and soft-tissue anatomy. We theorize that the PIP joint is not a true hinge joint and will not show instability until a large amount of the bony buttress is removed.

Methods: Eight digits (three 2nd; five 4th) from 5 cadaver hands (80 ± 15 yrs) were tested. A servohydraulic testing machine (MTS 851) applied tension to the extrinsic tendons to simulate flexion/extension motion at the PIP joint. An Optical Tracking system (Optotrak Certus) was employed to measure triplanar rotations and translations between the proximal and middle phalanges. The following scenarios were tested:

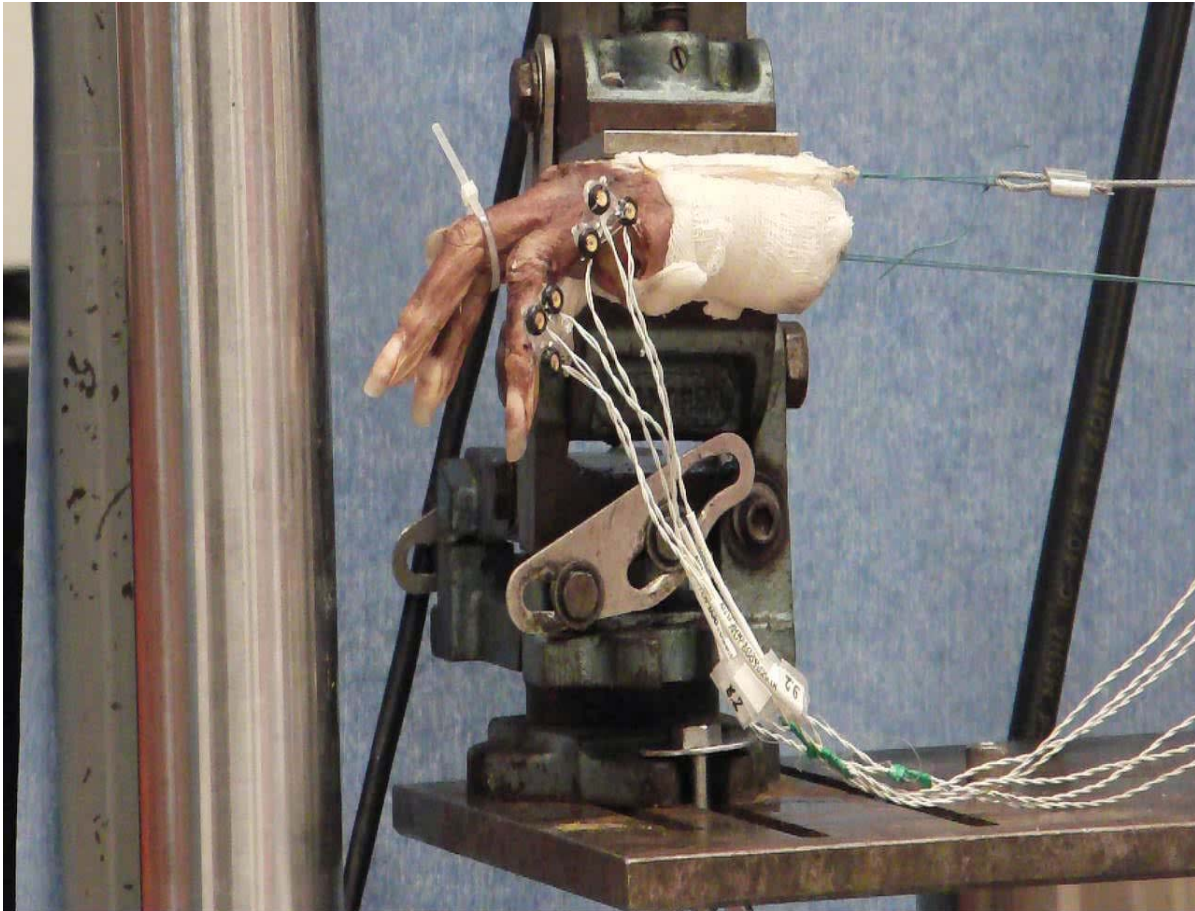
- CF1 - Intact PIP joint
- CF2 - CF1 + release of the collateral ligaments
- CF3 - CF2 + release of the volar plate
- CF4 - CF3 + 25% P2 palmar lip disruption
- CF5 - CF4 + 35% P2 palmar lip disruption
- CF6 - CF5 + 50% P2 palmar lip disruption

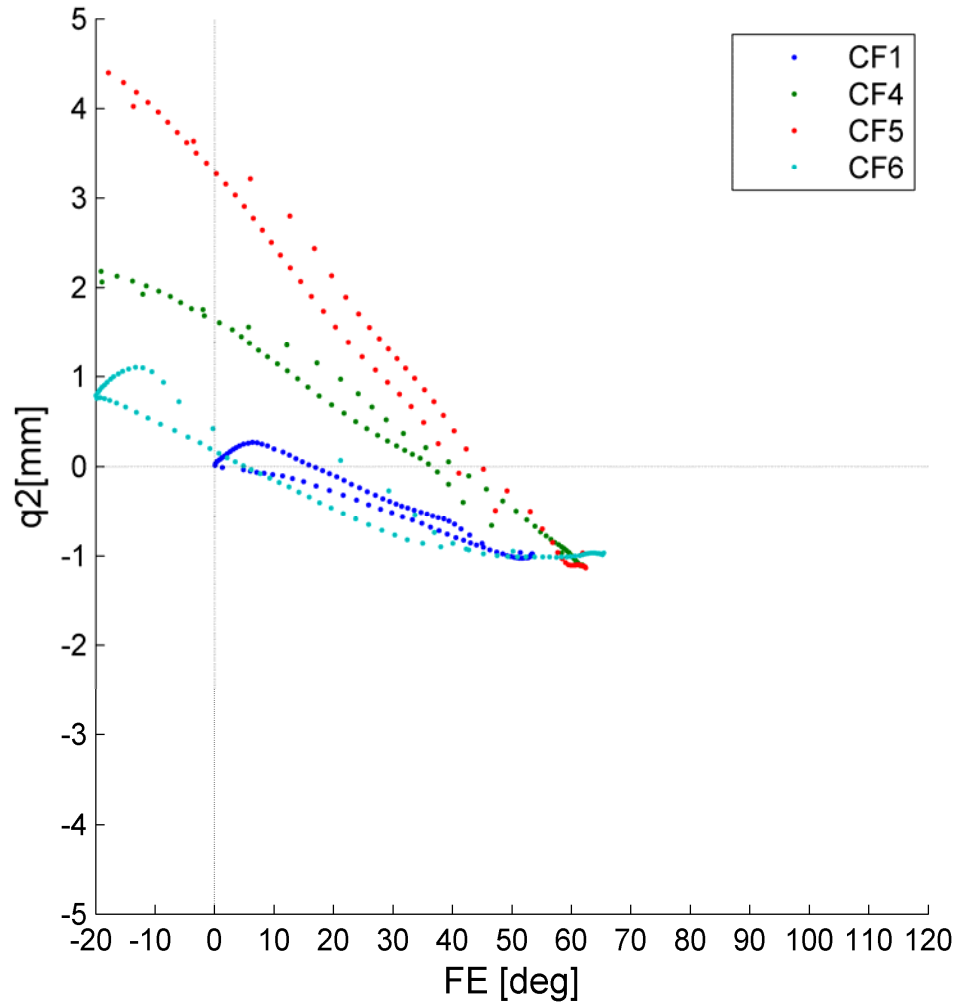
Results: The intact PIP joint did not behave as a true hinge joint. There were components of radial-ulnar deviation and internal-external rotation. Release of the volar plate and collateral ligaments minimally altered joint kinematics. Sequential release of the volar lip of the middle phalanx induced progressive subtle instabilities. In most specimens, gross instability at the PIP joint was first observed at 35% joint disruption at the palmar lip.

Summary: This study helps provide a kinematic characterization of several stages of injury at the PIP joint in a cadaver model. The PIP joint does not function as a pure hinge joint. The bony buttress of the middle phalanx is the critical stabilizing structure that creates PIP joint stability.

References:

1. Cheah AE, Tan DM, Chong AK, Chew WY. Volar plating for unstable proximal interphalangeal joint dorsal fracture-dislocations. *J Hand Surg Am.* 2012 Jan;37(1):28-33.
2. Ellis SJ, Cheng R, Prokopis P, Chetboun A, Wolfe SW, Athanasian EA, Weiland AJ. Treatment of proximal interphalangeal dorsal fracture-dislocation injuries with dynamic external fixation: a pins and rubber band system. *J Hand Surg Am.* 2007 Oct;32(8):1242-50.
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4. Capo JT, Hastings H 2nd, Choung E, Kinchelov T, Rossy W, Steinberg B. Hemicondylar hamate replacement arthroplasty for proximal interphalangeal joint fracture dislocations: an assessment of graft suitability. *J Hand Surg Am.* 2008 May-Jun;33(5):733-9.





- Royalties/Honoraria received from: Wright Medical Technology
- Consulting Fees (e.g. advisory boards) received from: Synthes, Wright Medical Technology
- Other Financial/Material Support received from: Integra Life Sciences
- ◆ Nothing of financial value to disclose

AM E-POSTER 46: Acceleration of Peripheral Nerve Regeneration Using Nerve Conduits in Combination with Induced Pluripotent Stem Cell Technology and a Basic Fibroblast Growth Factor Drug Delivery System

Category: Basic Science - Lab Research

Keyword: Other

Not a clinical study

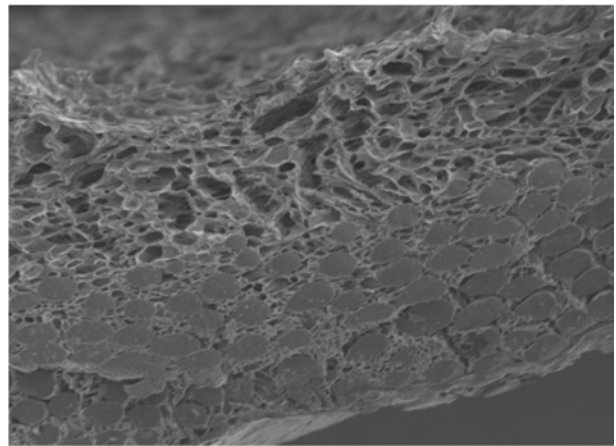
- ◆ Takuya Uemura, MD, PhD
- ◆ Kiyohito Takamatsu, MD, PhD
- ◆ Mikinori Ikeda, MD
- ◆ Mitsuhiro Okada, MD, PhD
- ◆ Kenichi Kazuki, MD
- ◆ Hiroaki Nakamura, MD, PhD

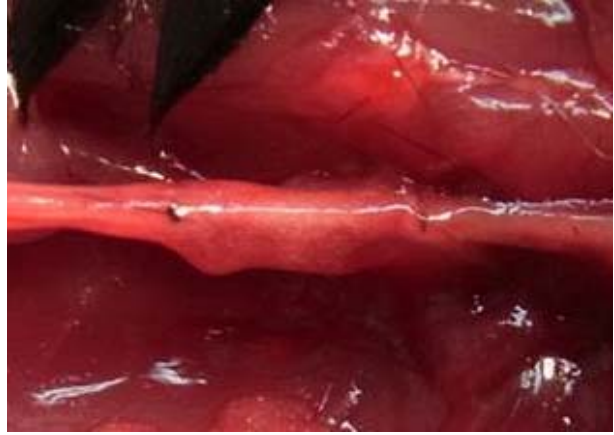
Hypothesis: For peripheral nerve repair, various modifications including addition of Schwann cells or incorporation of growth factors with bioabsorbable nerve conduits have been explored. However, no reports about nerve conduits containing both supportive cells and growth factors have been published as regenerative medicine for peripheral nerves. The purpose of this study was to repair sciatic nerve gaps in mice using tissue-engineered bioabsorbable nerve conduits coated with basic fibroblast growth factors (bFGF) in combination with induced pluripotent stem cell (iPSC)-derived neurospheres as a way to deliver both supportive cells and growth factors.

Methods: The bioabsorbable nerve conduit (external diameter 2 mm, internal diameter 1 mm and length 7 mm) was composed of an outer layer of a poly L-lactide mesh and an inner layer of a porous sponge composed of 50% L-lactide and 50% ε-caprolactone. Mouse iPSCs were neurally induced in vitro using a published protocol. The secondary neurospheres (4.0×10^6 cells per conduit) derived from iPSCs were suspended in each conduit. The bFGF (100 μg)-incorporated gelatin microspheres (5 mg), which create a slow-release drug delivery system, were suspended in the nerve conduits coated with neurospheres derived from iPSC just before transplantation into mice. The 5-mm sciatic nerve gaps in mice were reconstructed in the following groups: nerve conduit alone (control group, 18 mice), nerve conduit coated with iPSC-derived neurospheres (iPSC group, 18 mice), nerve conduit coated with iPSC-derived neurospheres and bFGF-incorporated gelatin microspheres (iPSC+bFGF group, 8mice), and autograft (autograft group, 12 mice). The recovery of motor and sensory function of each mouse's hindlimb was assessed at 4, 8, and 12 weeks after repair of the peripheral nerve gaps. At 12 weeks, the nerve conduits and grafted nerve were harvested, and nerve regeneration was evaluated by histological analysis.

Results: The fastest functional recovery and the greatest axon regeneration occurred in the autograft group, followed in order by the iPSC+bFGF group, iPSC group, and control group until 12 weeks after reconstruction.

Summary: Peripheral nerve regeneration using nerve conduits and functional recovery in mice were accelerated by a combination of iPSC-derived neurospheres and a bFGF drug delivery system. The combination of all three fundamental methodologies, bioabsorbable nerve conduits for scaffolds, iPSC technology for supportive cells, and a bFGF drug delivery system for growth factors, was essential and useful for peripheral nerve regenerative medicine.





◆ Nothing of financial value to disclose

AM E-POSTER 47: What Provides Transverse Stability of the Forearm?

Category: Basic Science - Lab Research

Keyword: Forearm

Not a clinical study

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● Frederick W. Werner, MME

◆ Emily R. Tucci, BS

◆ Brian James Harley, MD, FRCS(C)

Hypothesis: The purpose of this study was to determine the contributions of the annular ligament, proximal band, and the central band of the interosseous membrane of the forearm in preventing transverse dislocation of the radius. Up to this point, the central band was thought to be the main structure for prevention of dislocation; we hypothesize that the proximal band and annular ligament will also provide support when transverse forces are applied to the forearm, such as when bicep force is applied.

Method: Eight fresh cadaver forearms were tested in an MTS machine. The muscle and surrounding tissue were removed so that only the interosseous membrane, capsular structures, annular ligament, and bone remained. The ulna was then anchored in an aluminum channel and the radius was displaced away from the ulna until a force of 150 N was reached. The forearms were tested to this displacement while intact and then again after sectioning the central band, after sectioning the proximal band, and again after sectioning the annular ligament in a random sequence. After sectioning these three structures, the remaining structures included the distal radioulnar ligaments as well as the wrist extrinsic ligaments. The radius was moved to the same displacement following each cut and the force required to achieve that displacement was recorded (Figure 1). The results were then analyzed using a repeated measures analysis of variance.

Results: The peak force from the final cycle of each test was compared to the maximum force found when the structures were intact to determine the percent contribution each structure had in preventing transverse displacement of the radius. There was no statistically significant difference ($P>0.46$) between the different stabilizing structures (Table 1).

Summary:

- Knowledge of forearm biomechanics is important for our understanding of elbow dislocations and ultimately for treatment of forearm instability in general.
- The longitudinal stability of the forearm can be attributed to the radial head, the TFCC and the interosseous membrane.

- Disruption of these components can lead to painful sequelae such as chronic wrist and elbow pain, limited motion and weakness of grip.
- Stability in the transverse plane may be no less important.
- As seen in our study, the central band, annular ligament and proximal band each have an important role in resisting transverse forces which can contribute to proximal radius dislocation.
- Clinically this information could be used to improve positioning of grafts for interosseous membrane reconstruction.

Figure 1: Transverse force as a function of displacement for one illustrative forearm after indicated stabilizing structures are incrementally sectioned

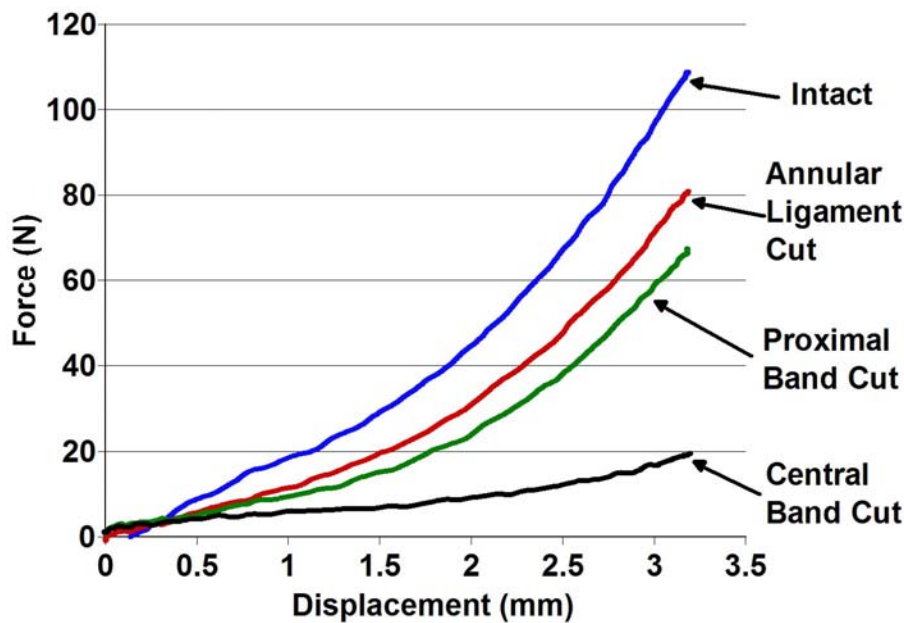


Table 1. Percent contribution of each structure in preventing transverse movement of the radius relative to the ulna.

% Contribution of each structure to transverse loading (std deviation)	Central Band	Proximal Band	Annular Ligament	Remaining Structures
Average	24.8 (15.5)	18.8 (13.8)	25.3 (10.3)	31.1 (13.5)

- Contracted Research with: Stryker Orthopedics
- ◆ Nothing of financial value to disclose

AM E-POSTER 48: Histological Comparison Between the Preganglionic and Postganglionic Injuries of Brachial Plexus in a Rat Model

Category: Basic Science - Lab Research

Keyword: Other

Not a clinical study

- ◆ Takashi Noguchi, MD
- ◆ Soichi Ohta, MD, PhD
- ◆ Yukitoshi Kaizawa, MD
- ◆ Ryosuke Kakinoki, MD, PhD
- ◆ Shuichi Matsuda, MD, PhD

Hypothesis: Brachial plexus injury (BPI) is categorized into two types, preganglionic and postganglionic injuries. The former is an avulsion injury and the latter is rupture of the nerve roots outside of the vertebral foramen. The avulsion injury causes motoneuron loss in the ventral horn, but the postganglionic injury does not. We hypothesized that the pre-ganglionic injury would induce greater the glial reaction in the spinal cord than the postganglionic injury. In this study, we compared histological differences between the preganglionic and postganglionic injuries in rats.

Methods: 9wk-adult male SD rats (n= 54) were used. The animals were randomly divided into two groups, preganglionic injury group (group A) and postganglionic injury group (group B). In group A, the left C6 spinal root was avulsed from outside of the foramen. The avulsion was confirmed by leakage of the spinal fluid and protrusion of the bifurcated nerve root (ventral root and dorsal root). In group B, the left C6 spinal root was pulled and ruptured just distal to the union between C5 and C6 spinal nerve root. The rats were fixed transcardiac fixation using 4% paraformaldehyde followed by removal of the C6 spinal segment. The segment was sectioned using a cryostat and the consecutive 40 μ m-thickness sections were obtained. The sections made at 12 hr after injury were processed with hematoxyline eosine staining. The sections made at 28 days after injury were processed with Nissl staining. The surviving motoneurons were counted in bilateral ventral horns. The number of the surviving motoneurons in the lesioned side was expressed as percentage of that in the contralateral unaffected side. Immunohistochemistry was performed for Iba1 (microglia), GFAP (astrocyte).

Results: At 12 hr after injury, intraspinal bleeding was found in four of 5 rats in group A, and none in group B. At 28 days after injury, the mean ratio of the surviving motoneurons in group A was 44%, which was significantly smaller than 98% in group B (p.05).

Summary: The ratio of surviving motoneurons in group A was less than group B, however both types of the BPI induced similar glial reaction. Considering the intraspinal bleeding after the avulsion injury, the motoneuron loss might be mainly caused by the direct traction force through the ventral rootlets.

References:

1. Koliatsos et al. Ventral root avulsion: an experimental model of death of adult motor neurons, *Journal of Comparative Neurology*; 1994 35-44.
2. Penas et al. Cytoskeletal and activity-related changes in spinal motoneurons after root avulsion, *J Neurotrauma*; 2009 763-79.

◆ Nothing of financial value to disclose

AM E-POSTER 49: Lasso Procedure for Intrinsic Minus Finger: A Cadaveric Study

Category: Basic Science - Lab Research

Keyword: Hand

Not a clinical study

- ◆ Yusaku Kamata, MD
- ◆ Toshiyasu Nakamura, MD, PhD
- ◆ Shinjiro Sueda, PhD
- ◆ Mitsunori Tada, MD, PhD
- ◆ Dinesh K. Pai, PhD
- ◆ Yoshiaki Toyama, MD, PhD

Hypothesis: Zancolli's lasso procedure is one of the most popular operations for intrinsic muscle deficiency. Omer also modified this procedure to loop the FDS tendon around the A2 pulley. The differences between the fingertip trajectory in these procedures had not been clarified, however. Our hypothesis is the trajectory of the fingertip forms larger arc in the A2 pulley insertion group than the A1 pulley insertion group.

Methods: Six fresh-frozen cadaver hands were used. We exposed six tendons (FDP, FDS, EDC, EIP, IOD, IOV) that contribute to the index finger motion, and tied a silk string to each tendon so that we can pull each tendon independently with our computer-controlled apparatus. Five tendons except FDS were pulled by our apparatus to set the reference position. We cut the FDS tendon just distal to the A2 pulley and sutured the tendon to itself around the A2 or A1 pulley. FDP tendon was pulled at 2mm per second separately. Threaded wires were drilled into each bone in order to support a triangular platform where three optical markers with diameter of 4mm were glued. The motions of these markers were recorded by a motion capture system. The 3D-CT data was obtained simultaneously to calculate the positional relationship between the markers and bones. Surface geometries of the markers and bones were fit into the marker trajectories from the motion capture data to reconstruct the bone motion. Using a static weight, we measured the finger motion under nine different FDS activation levels, 0.00N, 0.10N, 0.20N, 0.39N, 0.48N, 0.96N, 1.47N and 1.96N. First we performed this experiment around the A2 pulley, and then performed around the A1 pulley.

Results: Figure 1 shows the fingertip trajectory in the A1 and the A2 group in one specimen. Figure 2 shows the joint angles of each joint. These figures demonstrate that the fingertip trajectory forms a larger arc in the A2 group than in the A1 group with the lower activation levels. In the A1 group, the PIP and DIP joints start flexing faster than in the A2 group with lower activation levels.

Summary:

- The arc of fingertip trajectory is larger in the A2 group than in the A1 group especially with lower activation levels.
- In the A1 group, the PIP and DIP joints start flexing faster than in the A2 group with lower activation levels.
- Omer modification is superior for finger trajectory than Zancolli's procedure in weaker muscle power.

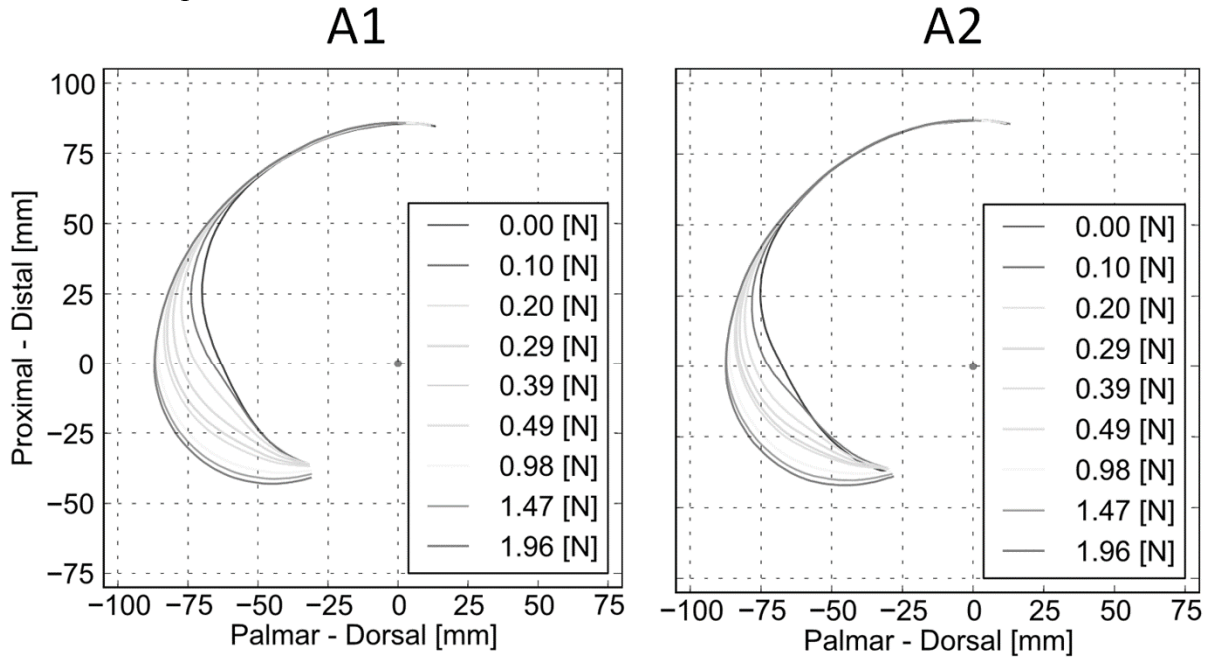


Fig.1 The fingertip trajectory under nine different FDS activation levels

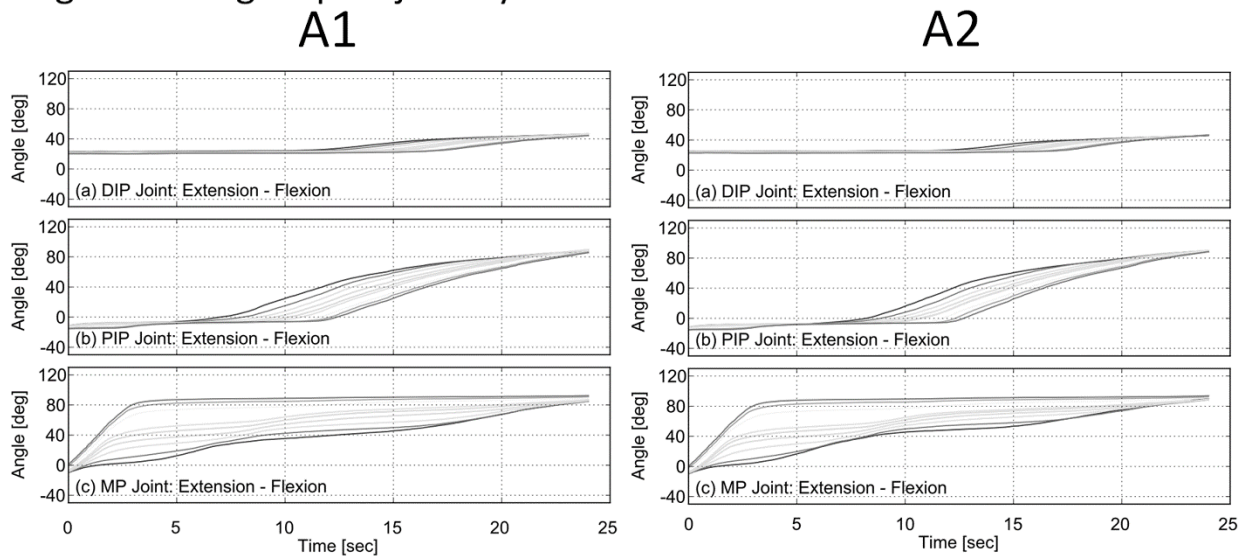


Fig.2 The joint angles of each joint

◆ Nothing of financial value to disclose

AM E-POSTER 50: The Biomechanical Assessment of Factors Affected the Fatigue and Tensile Strength in Interlocking Cross-stich Peripheral Sutures of Flexor Tendon Repair

Category: Basic Science - Lab Research

Keyword: Hand

Not a clinical study

- ◆ Masahiro Matsuda, MD
- ◆ Hiromichi Mitsuyasu, MD, PhD
- ◆ Katsuhiko Kikuchi, MD
- ◆ Naohide Takeuchi, MD, PhD
- ◆ Yukihide Iwamoto, MD, PhD

Hypothesis: The peripheral suture for the flexor tendon repair was originally designed to smooth the repaired surface, but in our recent studies, interlocking cross-stich suture had the greater mechanical properties. The factors may contribute for the mechanical properties could be 1) the width of longitudinal peripheral strand from the stump (longitudinal width; LW), 2) the width of transverse segments of each cross-stich suture (transverse width; TW), and 3) the numbers of the strands crossing the stump (numbers of strands). At 2012 ASSH meeting, we reported that LW was the important factor to improve the strength of the flexor tendon repair. The purpose of this study is to evaluate the mechanical role of the TW and numbers of strands for the mechanical properties in the peripheral suture.

Methods: 150 (75 pairs) of artificial rolls, Parotisroll™ (Coltene/Whaldent GmbH+Co., Germany), were used.

Study 1: All pairs of the rolls were sutured with only interlocking cross-stich peripheral suture using 6-0 Polypropylene (Prolen™, Ethicon, North Ryde, Australia). Each pair was sutured with 5mm of LW, and divided to 2mm (24 strands), 3mm (18 strands), 4mm (12 strands), 6mm (8 strands), 8mm (6 strands) of TW.

Study 2: To assess the role of the numbers of strands, pairs of the rolls were sutured with 5mm of LW, and divided to 24 strands for 2mm of TW, 4mm of TW (twice of peripheral sutures), 6mm and 8mm of TW, and 18 strands for 3mm, 6mm and 8mm of TW respectively. The assessment done included 1) the tensile strength measured by a load cell (LC4102-K015, A&D orientec, Tokyo, Japan) and 2) the fatigue strength measured by a custom made cyclic loading machine. The values were evaluated by one-way analysis of variance followed by a Tukey-Kramer honest significant difference testing.

Results: In study 1, 4mm of TW had both greatest tensile strength and fatigue strength in our tested groups. The size of TW related to how much grasp around the tendon. However, it decreased the number of strands TW was increased, the strength is weakened. In study 2, when it is the same number of strands, the fatigue and tensile strength have been shown to increase the size of the TW becomes greater.

Summary: The TW and numbers of strands were both important factors to improve the strength of the flexor tendon repair.

References:

1. Takeuchi N, et al. Strength enhancement of the interlocking mechanism of cross-stitch peripheral sutures for flexor tendon repair. *J Hand Surg E.* 2010, 35: 46-50
2. Takeuchi N, et al, The biomechanical assessment of gap formation after flexor tendon repair using partial interlocking cross-stitch peripheral sutures. *J Hand Surg E.* 2011 36 584-589

◆ Nothing of financial value to disclose

AM E-POSTER 51: In-Vitro Durability Evaluation of Linked Semi-Constrained Total Elbow Prostheses

Category: Basic Science - Lab Research

Keyword: Elbow

Not a clinical study

- Ravikumar Varadarajan, PhD
- Brian L. Kincaid, MS
- Matthew L. Ramsey, MD
- Bernard F. Morrey, MD

Hypothesis: Isolated fracture and gross deformation of the “hinge-pin” and ultra-high molecular weight polyethylene (UHMWPE) bearings in linked semi-constrained total elbows has been reported clinically^{1,2}. It is hypothesized that patient and prosthesis design factors influence these fracture modes in-vivo.

Methods: The Zimmer® Coonrad/Morrey (C/M) Total Elbow (Zimmer, Inc.) design employs three conventional GUR1050 UHMWPE bearings and a transverse two-piece CoCr / Ti-6Al-4V hinge-pin modular connection while the *Nexel*[™] (Zimmer, Inc.) design utilizes three *Vivacit-E*® (Vitamin E blended, highly crosslinked UHMWPE) bearings with a solid CoCr axle pin and two posterior CoCr screws (Figure 1). A laboratory test method was developed and shown to replicate the appearance of clinically fractured C/M components, thereby validating the test methodology. Nine (n=9) C/M and six (n=6) *Nexel* articular constructs were tested on a torsional bi-axial load frame equipped with an orthogonal slider table (MTS Corporation, Eden Prairie, MN). A dynamic, multi-axial loading profile consisting of a compressive joint reaction force (JRF), and alternating varus / valgus (VV) moment as a function of assumed weight-in-hand (WIH) and elbow flexion angle (0°-130°), was applied at a frequency of 0.7 Hz in 37°C DI water for 200,000 cycles representing 25 high-demand load activities per day for 20 years (Figure 1). Various load levels were tested in order to determine the “run-out” load (i.e. no fractures prior to test end) for C/M.

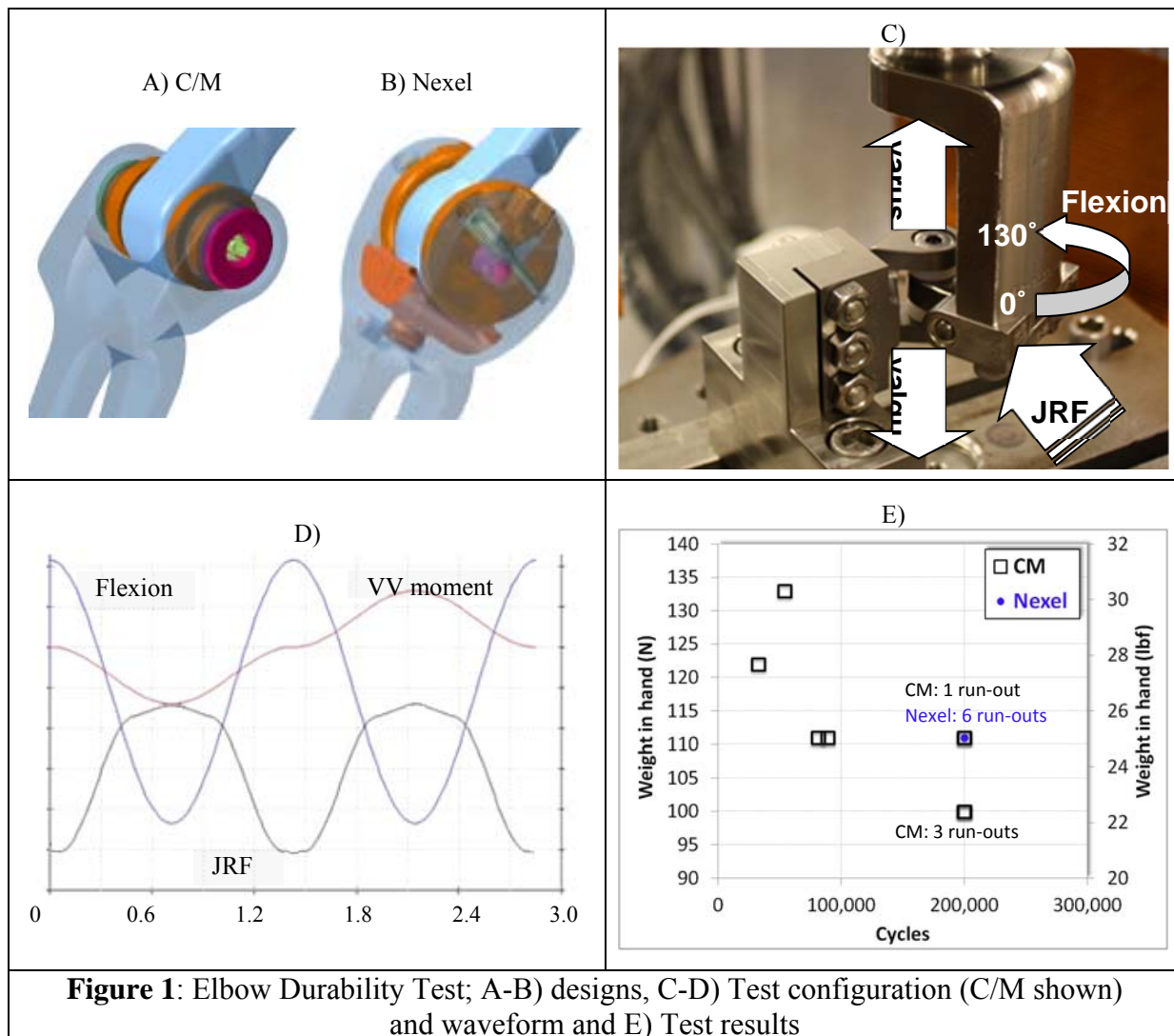
Results: The run-out load for C/M was found to be 1511N JRF / 4.9Nm VV moment (100N WIH). None of the *Nexel* components experienced fracture when tested as high as 1680N JRF / 5.3 Nm VV moment (111N WIH). Typical post-test component appearances are compared in Figure 2 along with representative C/M retrievals.

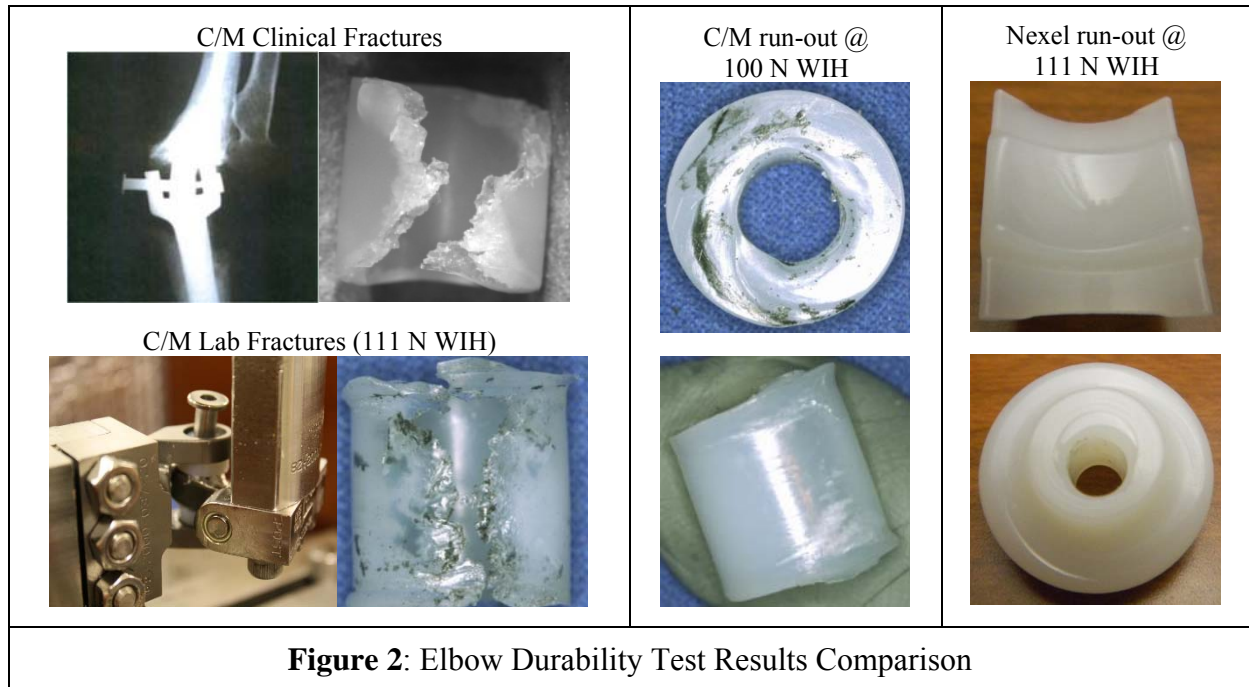
Summary:

- High joint loads and VV moments corresponding to 111N (25 lbf) WIH were necessary to induce component fracture consistent with C/M retrieval observations.
- No fractures or significant wear were induced in the *Nexel* design, no humeral screws “backed-out” and all screws had measureable torque upon removal post-test.
- The Durability improvements realized in *Nexel* are attributed to the load-sharing bearing design, posteriorization of the modular connection and the thicker, more conforming *Vivacit-E* bearing material.

References:

1. Seitz WH, Jr., Bismar H, Evans PJ. Failure of the hinge mechanism in total elbow arthroplasty. *J Shoulder Elbow Surg* 2010 Apr;19(3):368-75.
2. Goldberg SH et al., Modes of wear after Semiconstrained Total Elbow Arthroplasty. *J Bone Joint Surg Am*, 2000; 90(3): 609-19.





- Contracted research with: Zimmer, Inc (Varadarajan)
- Consulting Fees (e.g. advisory boards) received from: Zimmer, Inc. (Ramsey, Morrey)
- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Zimmer, Inc. (Kincaid)
- Royalties/Honoraria received from: Zimmer, Inc. (Morrey)
- Other Financial/Material Support received from: Employee of Zimmer, Inc. (Kincaid)

AM E-POSTER 52: Biomechanics of the Radius Following Drilling of the Radial Tuberosity to Mimic an EndoButton Distal Biceps Repair

Category: Basic Science - Lab Research

Keyword: Elbow

Not a clinical study

◆ Nikhil R. Oak, MD

◆ John R. Lien, MD

◆ Alexander Brunfeldt, MS

● Jeffrey N. Lawton, MD

Hypothesis: A fracture through the proximal radius is a theoretical concern after Endobutton distal biceps fixation in an active patient population subjected to a fall eliciting a rotational and compressive force. We hypothesized that during simulated torsion and compression, in comparison to unaltered controls, the Endobutton distal biceps repair model will have decreased torsional and compressive strength and will fracture in the vicinity of the radial tuberosity bone tunnel.

Methods: Ten fourth-generation composite radius sawbone models used and validated in previous studies for biomechanical testing were employed in this study. For the experimental model, a bone tunnel was created through the radial tuberosity to mimic the exact bone tunnel made for an EndoButton (Acufex, Smith & Nephew, Inc, Andover, MA) distal biceps tendon repair. The radius was then prepared and mounted on either a torsional or compression type MTS (Material Test Systems, Eden Prairie, MN) machine. The radius was then tested with a compressive load through the radial head via a ball bearing or a torsional force about the proximal radius. Stiffness, peak load, peak torque, failure load, failure torque, and gross fracture characteristics were then collected in both control and experimental models.

Results: For the radius specimens tested in compression, in controls the average stiffness was 149.86 N/mm, peak load was 661.72 N and failure load was 270.35 N (Figure 1). In the drilled radius tested in compression, the average stiffness was 164.45 N/mm, peak load was 741.30 N, and failure load was 333.22 N. For the radius specimens tested in torsion, the stiffness in the control was 0.778 in-lbs/Deg with a peak torque of 60.87 in-lbs and failure torque of 60.87 in-lbs. The drilled radius tested in torsion had a stiffness of 0.81 in-lbs/Deg with a peak torque of 52.58 in-lbs and failure torque of 52.58 in-lbs. The gross fracture pattern between groups was fairly similar when tested in compression. When testing in torsion however, it was observed in the drilled radius, fracture occurs through the bone tunnel in the radial tuberosity (Figure 2).

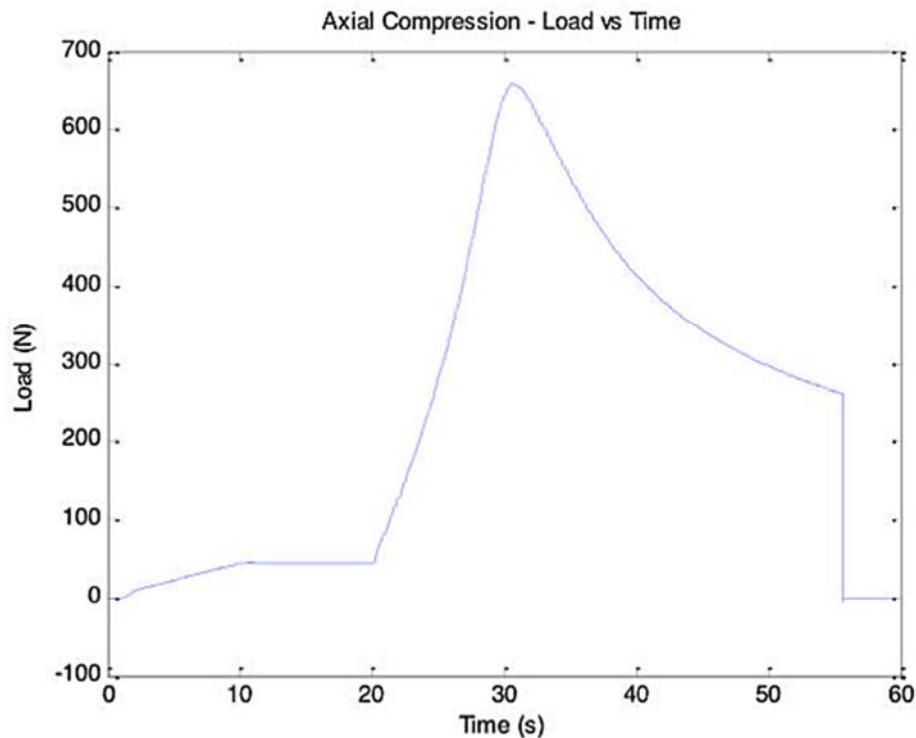
Summary:

- There is a potential concern for fracture through the vicinity of the bone tunnel in the proximal radius during torsional stressing of the proximal radius.
- There does not appear to be statistically significant differences in stiffness and peak loads between drilled and control radius specimens.
- Distal biceps tendon repairs employing Endobutton fixation have the potential of creating important biomechanical consequences in the proximal radius.

References:

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Figure 1: Representative graphs of a control radius specimen tested in axial compression



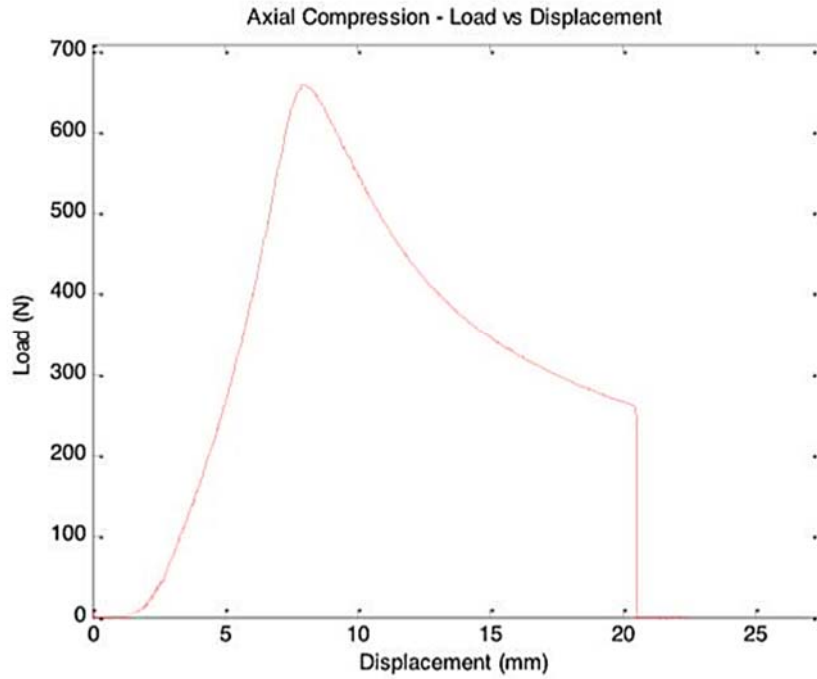


Figure 2: Typical fracture pattern of control (left) compared to fracture pattern following EndoButton drilling (right)



- Consulting Fees (e.g. advisory boards) received from: Innomed
- ◆ Nothing of financial value to disclose

AM E-POSTER 53: Transplanted Cell number is Important for Success of Ambulation Function Restoration by Motoneuron Integrated Striated Muscles (MISM)

Category: Basic Science - Lab Research

Keyword: Other

Not a clinical study

◆ Shuichi Kato, MD

◆ Shigeru Kurimoto, MD

◆ Tomonori Nakano, MD

◆ Michiro Yamamoto, MD

◆ Hisao Ishii, MD

◆ Hitoshi Hirata, MD

Hypothesis: Peripheral nerve injury induces both rapid muscle atrophy and widespread motoneuron death in the spinal cord. In the previous studies, we demonstrated that less than 1,000 motoneurons per nerve can generate MMT3 or higher muscle power in MISM technology. However, the survival rate of the transplanted cells was extremely low. In this experiment, therefore, we tried to determine the least requirement of transplantation cell number for successful ambulation restoration by MISM technology.

Methods: E14.5 ventral spinal cord neurons was dissected from pregnant Fischer rats and dissociated for transplantation. Six adults Fischer rats were used as recipient and divided into two groups, group A; transplanted 200,000 cells and group B; transplanted 1,000,000 cells. In both group, left sciatic nerves were transected at the mid thigh level and the proximal nerve stump were sutured into hip muscles to prevent axonal regeneration. 1 week later, dissociated embryonic spinal cord cells suspended in the medium were transplanted into the distal stump of the left peroneal nerve. Twelve weeks after transplantation, electrophysiological assessment was performed, and stainless steel wire electrodes were placed on the left peroneal nerves and stimulated. Using video technique, ankle angles which was formed by the lateral head of femoral condyle, lateral malleolus and the fifth metatarsal head were measured with or without electrical stimulation of the peroneal nerves. Then peroneal nerves and tibialis anterior muscles were weighed and harvested for immunohistochemical and histochemical analyses.

Results: The mean motor nerve conduction velocity was 7.5 ± 0.6 m/s in group A and that of group B was 12.5 ± 0.6 m/s ($P=0.000$). The mean amplitude of CMAP was 0.6 ± 0.1 mV in group A and that of group B was 1.8 ± 0.3 mV ($P=0.001$). The mean wet muscle weight ratio of the body weight was 0.47 ± 0.02 % in group A, 0.68 ± 0.02 % in group B ($P=0.000$). The ankle angle with electrical stimulation was 75 ± 8 degree in Group A, 27 ± 5 degree in Group B

(P=0.000). Immunofluorescent staining with anti-neurofilament antibody and anti-GFAP antibody detected transplanted neurons and astrocytes at the implantation site. In addition, staining with toluidine blue stain confirmed the presence of myelinated axons. The mean myelinated axon number was 73 ± 14 in group A and that in group B was 376 ± 73 (P=0.011).

Summary: In conclusion, this study demonstrates that the necessary minimum number of cells transplanted for MISM was 1 million at present.

References:

1. Erb DE, et al. *Exp Neurol* 1993;124:372-376
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◆ Nothing of financial value to disclose

AM E-POSTER 54: Hand Surgery for Epidermolysis Bullosa

Category: Congenital/Pediatric

Keyword: Other

Level 4 Evidence

◆ Shai Luria, MD

◆ Saleh Radwan, MD

◆ Gershon Zinger, MD

◆ Sharon Eylon, MD

Hypothesis: Epidermolysis bullosa (EB) is a group of inherited, mechanobullous disorders caused by mutations in various structural proteins in the skin. The manifestation of this disorders in the hand is of digital contractures and pseudosyndactyly or "cocoon hands", causing significant functional impairment.

The surgical treatment of these patients involves separation of the digits from the palm and between them, primarily the adducted thumb, and recurrence is common¹. Our hypothesis was that functional improvement is gained regardless of recurrence of contractures.

Methods: Four patients, 2 males and 2 females, whose average age was 11 years old, were treated surgically by the separation of all their digits and by coverage with skin grafts. The follow-up period was between 6 months and 3 years.

Results: Partial recurrence of the pseudosyndactyly was noted in all patients and is thought to be dependent on the constant use of splints or bandages to separate the digits as well as the use of the hand. Recurrence was more pronounced in the non-dominant hand, especially between the digits and of flexion contractures but did not preclude the use precision or oppositional pinch at final follow up. The patient with the longest follow up has been referred for revision surgery to gain further release of contractures.

Significant rehabilitation goals were achieved in all 4 patients after surgery. After 6 months, both of the younger patients were measured for finger dexterity which showed lower scores than the norm although this was felt to be dependent on which daily manual activity they were more familiar with. These tests could not have been performed prior to surgery.

Summary:

- All patients and families felt the effort was worthy.
- Separating the thumb and straightening the digits was found to be significant
- The indication for separating all the digits is debatable.
- The need for revision surgery, in order to maintain the digit function, is clear.

References:

1. Ladd AL, Kibele A, Gibbons S.: Surgical treatment and postoperative splinting of recessive dystrophic epidermolysis bullosa. *J Hand Surg Am.* 1996 Sep;21(5):888-97.

◆ Nothing of financial value to disclose

AM E-POSTER 55: Functional Outcomes of Microsurgical Toe Transfers for Reconstruction of the Pediatric Adactylous Hand

Category: Congenital/Pediatric

Keyword: Hand

Level 3 Evidence

◆ Jesse Kaplan, BS

◆ Neil F. Jones, MD

Hypothesis: Some hand surgeons still maintain that children with severe hand deformities will adapt over time and do not require reconstruction. Outcomes data for children undergoing surgical reconstruction of hand anomalies has been used infrequently or not at all. The purpose of this study was to evaluate the motor, sensory and functional outcomes of children with adactylous hands, who had undergone double microsurgical toe-to-hand transfers in comparison with non-reconstructed adactylous hands and the normal pediatric population.

Methods: Nine children (2 females and 7 males with a mean age of 11.9 years) were identified with congenital or traumatic absence of all five digits distal to the wrist. One group of 5 children underwent reconstruction with 2 microsurgical toe-to-hand transfers to create radial and ulnar digits and one group of 4 children had not been reconstructed. Range of motion, writing ability, sensibility, 2 point discrimination, Semmes-Weinstein testing, grip and pinch strength and the box blocks dexterity test were evaluated. Results were compared between the two groups and with normal pediatric controls using student paired t-tests.

Results: Children receiving toe transfers had a mean total active range of motion in the radial and ulnar digits of 66° and 52° respectively and a mean total passive range of motion of 128° and 92° respectively. All five children could write legibly with the reconstructed hand and had regained full sensation. Mean 2-point discrimination was 2.6 mm and tactile sensation was at least the 3.61 monofilament level. No child had measurable grip strength but the mean pinch strength was 1.2 psi. The toe transfer children moved a mean of 30.8 blocks per minute with their reconstructed hand, which was not significantly different from the normal contralateral hand in those with unilateral deficiencies. The non-reconstructed group was unable to write, grip, pinch or move blocks using only the involved hand. Using both hands, the non-reconstructed group moved an average of 34.5 blocks per minute which was not significantly different from the reconstructed group.

Summary:

- Children with congenital or traumatic adactyly who undergo reconstruction with 2 or more microsurgical toe-to-hand transfers can achieve remarkable gains in function, sensibility and ability to perform daily activities.

- Children reconstructed with toe-transfers were able to function with their reconstructed hand similar to the hand of a normal child.
- Children reconstructed with toe-transfers were able to function with their reconstructed hand at the same level that non-reconstructed children required both hands.

References:

1. Ohtsuka H, Torigai K, Shioya N. Two toe-to-finger transplants in one hand. *Plast. Reconstr. Surg.* 1977;60(4):561–565.
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◆ Nothing of financial value to disclose

AM E-POSTER 56: Developing a Pollicization Outcomes Measure

Category: Congenital/Pediatric

Keyword: Hand

Level 4 Evidence

- Dan A. Zlotolow, MD
- ◆ Rick Tosti, MD
- ◆ Sarah Ashworth, OTR/L
- ◆ Scott H. Kozin, MD
- ◆ Joshua Abzug, MD

Hypothesis: We created an objective and subjective pollicization outcomes instrument that builds on most of the factors cited in previous outcomes studies. For initial validation, we hypothesized that the objective measures would correlate with subjective impressions of outcome, and that those correlations would be consistent among observers.

Methods: An objective and subjective outcomes measure instrument was used to evaluate 42 pollicizations in 35 patients. In addition to a pictogram, we also used visual analogue scale (VAS) subjective measures for the therapist, caretaker, and surgeon and objective range of motion and strength data. The results of this instrument were then retrospectively evaluated to look for trends within the subjective and objective portions of the instrument. A linear regression analysis was performed to see if the objective data correlated with the subjective data.

Results: Caretakers graded the patients most favorably followed by the surgeons and then the therapists. The surgeons and therapists tended to correlate objective and subjective criteria more frequently than the caretakers. The caretaker did not correlate any objective data with “looks like a thumb,” but had a few weak correlations for “works like a thumb.” The therapists’ responses to “looks like a thumb” and “works like a thumb” correlated with 5 and 8 objective categories respectively with moderate strength found in the sticker test and acquisition of a bead, die, and ping-pong ball. The surgeon’s responses to the appearance and function of the thumb correlated significantly with 8 and 9 discrete objective criteria respectively with a moderate correlation found in the sticker test and tip-pinch strength (Table 1). When combining the sum of the subjective functional measures, moderate correlates were found for composite flexion, MP joint range of motion, IP joint range of motion, and the sticker test. Objective small and large object acquisition measures tended to correlate with subjective impressions, with the strongest correlation between small object acquisition and the sticker test (Table 2).

Summary:

- Composite flexion, MP and IP joint arc of motion, and the sticker test correlated the strongest with subjective criteria of function.

- The objective and subjective measures for small and large object acquisition correlated with each other
- The objective measures of function, particularly object acquisition and thumb flexion, responded as expected relative to subjective scales.
- Subjective impressions of “looks like a thumb” did not correlate with any objective measures of appearance, but did correlate moderately with the sticker test among surgeons and therapists.

References:

1. Goldfarb et al. Incidence and treatment of complications, suboptimal outcomes, and functional deficiencies after pollicization. J Hand Surg Am (2009) vol. 34 (7) pp. 1291-7
2. Manske et al. Long-term functional results after pollicization for the congenitally deficient thumb. J Hand Surg Am (1992) vol. 17 (6) pp. 1064-72
3. BUCK-GRAMCKO. Pollicization of the Index Finger: METHOD AND RESULTS IN APLASIA AND HYPOPLASIA OF THE THUMB. J Bone Joint Surg (1971) vol. 53 pp. 1605-1617
4. Percival et al. A method of assessment of pollicisation. J Hand Surg Br (1991) vol. 16 (2) pp. 141-3
5. Roper and Turnbull. Functional assessment after pollicisation. J Hand Surg Br (1986) vol. 11 (3) pp. 399-403

Table 1: Significant Objective Correlations for “Works like a thumb”

Evaluator	Objective criterion	Spearman coefficient	p value
Surgeons	small finger opposition	0.49	< 0.01
	palmar adduction	0.41	0.01
	IP arc	0.46	< 0.01
	MP arc	0.45	< 0.01
	die acquisition	0.32	0.04
	ping pong ball acquisition	0.44	< 0.01
	sticker test	0.49	< 0.01
	lateral pinch strength	0.31	0.05
	tip pinch strength*	0.50*	< 0.01
Therapists	small finger opposition	0.32	0.05
	palmar adduction	0.41	0.01
	IP arc	0.49	< 0.01
	MP arc	0.49	< 0.01
	bead acquisition*	0.51*	< 0.01
	die acquisition*	0.55*	< 0.01
	ping pong ball acquisition*	0.53*	< 0.01
	sticker test *	0.61*	< 0.01
	tip pinch strength	0.44	0.01
Caretakers	small finger opposition	0.32	0.05
	palmar adduction	0.41	0.01
	IP arc	0.46	< 0.01
	MP arc	0.49	< 0.01
	sticker test*	0.55*	< 0.01
	tip pinch strength	0.32	0.05
	cmc stability	0.31	0.05

* moderate strength correlation

Table 2: Significant Objective Correlations for Subjective Functional Criteria

Subjective	Objective criterion	Spearman coefficient	p value
How often does the child use their thumb to pinch versus scissor pinch for small objects?	small finger opposition	0.39	0.02
	palmar abduction	0.37	0.02
	IP arc*	0.58*	< 0.01
	MP arc*	0.60*	< 0.01
	bead acquisition	0.42	0.01
	die acquisition	0.42	0.01
	ping pong ball acquisition	0.46	0.01
	sticker test*	0.61*	< 0.01
	tip pinch strength	0.36	0.02
How often does the child incorporate the thumb when holding larger objects like a bottle?	small finger opposition	0.33	0.05
	ping pong ball acquisition	0.35	0.03
How often do you have to remind the child to incorporate the thumb into daily activities?	no significant correlations	n/a	n/a

* moderate strength correlation

- Royalties/Honoraria received from: Arthrex, Elsevier
- Consulting Fees (e.g. advisory boards) received from: Arthrex, Osteomed
- Receipt of Intellectual Property Rights/Patent Holder with: Arthrex, Osteomed
- ◆ Nothing of financial value to disclose

AM E-POSTER 57: The Predictive Value of Clavicle Fracture in Brachial Plexus Birth Palsy

Category: Congenital/Pediatric

Keyword: Shoulder

Level 2 Evidence

◆ Holly B. Hale, MD, MPH

◆ Andrea S. Bauer, MD

◆ Nina R. Lightdale-Miric, MD

Hypothesis: The relationship between brachial plexus birth palsy (BPBP) and birth fractures is not understood, although it has been postulated that concurrent clavicle fracture may spare nerve injury. We aimed to compare those children with BPBP presenting to a tertiary care center with and without concurrent fractures and assess the utility of the presence of a birth fracture as a predictor of injury severity in children with BPBP.

Methods: Records of all patients belonging to the TOBI (Treatment and Outcomes of Brachial Plexus Injuries) Study Group, a prospective multicenter cohort of infants with BPBP were analyzed for demographic and birth information. Children presented to one of six medical centers (Boston Children's Hospital, Akron Children's Hospital, Children's Healthcare of Atlanta, Children's Hospital Los Angeles, Cincinnati Children's, and Shriners Hospitals for Children Northern California). We defined severe injuries as those requiring microsurgical intervention in infancy. Patients with missing data were excluded.

Results: The records of 639 children were reviewed. Thirteen patients were excluded for incomplete data. There were 96 children with concurrent birth fractures. Of those children, 57 sustained clavicle fractures, 44 sustained humerus fractures, and 4 sustained other fractures. There was no difference between those children who sustained birth fractures and those that did not in terms of admission to NICU ($p=0.08$), gender ($p=1.0$), preeclampsia ($p=0.40$), breech delivery (0.11), level of complexity of the delivery ($p=1.0$), shoulder dystocia ($p=0.62$), respiratory complication ($p=1.0$), birth weight ($p=0.76$), Horner's syndrome ($p=0.66$) or age at first clinical visit ($p=0.28$). Only presence of gestational diabetes was found to be significantly higher in those children with fractures versus those without ($p=0.003$). The presence of birth fracture did not change incidence of microsurgical intervention (24.0% vs 23.4%, $p=.98$). Statistical analysis was repeated for clavicle fractures only, and the presence of a clavicle fracture specifically did not change the incidence of microsurgery (22.8% vs 23.9%, $p=0.98$).

Summary:

- 15% of children presenting with BPBP sustained a concurrent birth fracture.

- Severity of brachial plexus injury, defined as the need for microsurgery in infancy, was no different between children with or without birth fractures.
- In this study population of children with severe enough BPBP to present to a tertiary care center, the presence of a clavicle fracture was not predictive of injury severity.

References:

1. al-Qattan MM, Clarke HM, Curtis CG. The prognostic value of concurrent clavicular fractures in newborns with obstetric brachial plexus palsy. *J Hand Surg Br.* 1994 Dec;19(6):729-30.
2. McBride MT, Hennrikus WL, Mologne TS. Orthopedics. Newborn clavicle fractures. *1998 Mar;21(3):317-9; discussion 319-20.*
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◆ Nothing of financial value to disclose

AM E-POSTER 58: Variation in Documentation of Pediatric Supracondylar Fractures

Category: Congenital/Pediatric

Keyword: Elbow

Level 4 Evidence

◆ Carissa Meyer, MD

◆ Lauren Rinaca, PA

◆ Ebrahim Paryavi, MD, MPH

◆ Joshua Abzug, MD

Hypothesis: Supracondylar humerus fractures are the most common pediatric elbow fracture. As children can be difficult to examine and many may have associated neurovascular injuries that can alter timing of treatment, the purpose of this study was to assess adequacy and accuracy of documentation regarding these injuries.

Methods: A retrospective chart review was performed of all pediatric supracondylar fractures in children under the age of 15. Data collected included patient age, type of fracture (Type I, II, III extension, flexion), clinician type (Emergency Department or Orthopaedic surgeon) and level of training, motor exam documentation (anterior interosseous nerve, radial nerve and ulnar nerve function) and presence of nerve palsy. Linear regression was used to analyze documentation with regards to patient age and clinician level of training.

Results: Thirty patients were identified during the study period, including 3 patients with associated nerve palsies (2 AIN and 1 radial nerve palsy). In all cases, the nerve palsy was not recognized by the ED physicians or the orthopaedic resident(s) prior to the orthopaedic attending evaluation. In patients with a nerve palsy, motor documentation continued to be incomplete or failed to document a nerve palsy in >50% of notes even after attending documentation of the nerve palsy.

Incomplete motor exam documentation, defined as failure to document function pertaining to a particular nerve, occurred in 97% of notes done by Emergency Department attendings or residents. There was no correlation between motor exam documentation and year of residency training. Improved documentation by orthopaedic residents was significantly improved as patients increased in age (p-value 0.046). Documentation was complete in 90% of patients aged 6 years or older. There was no correlation between improved motor documentation and correctly identifying a nerve palsy (odds ratio 0.88, p-value 0.43).

Summary:

- Inadequate or incorrect documentation may occur at any step of the evaluation process and may persist despite appropriate documentation by an attending surgeon

- Motor exam documentation improved with patient age and reached 90% for patients 6 and older, implying that barriers exist to appropriate neurologic examination in young children
- Improved education of emergency department physicians and orthopaedic residents is important to provide specific and age-appropriate neurologic examinations in young children with skeletal trauma
- Proper documentation is necessary to improve recognition and monitoring of neurologic status in pediatric patients with supracondylar humerus fractures

References:

1. Abzug JM, Herman MJ. Management of supracondylar humerus fractures in children: current concepts. *J Am Acad Orthop Surg.* 2012;20:69-77.
2. Babal JC, Mehlman CT, Klein G. Nerve injuries associated with pediatric supracondylar humeral fractures: a meta-analysis. *J Pediatr Orthop.* 2010;30(3):253-63.
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◆ Nothing of financial value to disclose

AM E-POSTER 59: Does the Modified Gartland Classification Clarify Decision-making in the Treatment of Pediatric Supracondylar Humerus Fractures?

Category: Congenital/Pediatric

Keyword: Elbow

Not a clinical study

◆ Sophia Leung, MD

◆ Ebrahim Paryavi, MD, MPH

◆ Martin Herman, MD

◆ Paul Sponseller, MD

◆ Joshua Abzug, MD

Hypothesis: The modified Gartland classification system for pediatric supracondylar fractures is often utilized as a communication tool to aid in determining whether or not a fracture warrants operative intervention. This study sought to determine the inter- and intra-observer reliability of the classification system as well as to determine if the study participants agreed that a fracture warranted operative intervention regardless of the classification system.

Methods: 200 AP and lateral radiographs of pediatric supracondylar humerus fractures were retrospectively reviewed by 3 fellowship trained pediatric orthopaedic surgeons and classified as Type I, IIa, IIb or III. The surgeons were then asked to record whether they would treat the fracture non-operatively or operatively. Kappa coefficients were calculated to determine inter- and intra-observer reliability.

Results: Overall, the modified-Gartland classification had moderate interobserver reliability with kappa coefficients of 0.638 (0.557-0.710), as well as high intraobserver reliability, with coefficient of 0.799. However, a low interobserver rate was found when differentiating between Type IIa and IIb, with a coefficient of 0.240 (0.116-0.372). There was moderate to high interobserver reliability for decision to operate, with a coefficient of 0.691 (0.598-0.773), and high intraobserver reliability, with a coefficient of 0.760. For fractures classified as Type I, the decision to operate was made 3% of the time. If classified as Type IIa, the decision to operate was made 27% of the time, and 99% of the time if classified as Type IIb. The decision was made to operate for 100% of fractures classified as Type III.

Summary:

- There is almost full agreement for the non-operative treatment of Type I fractures and operative treatment for Type III fractures.

- There is agreement that Type IIb fractures should be treated operatively and that the majority of Type IIa fractures should be treated non-operatively. However, the interobserver reliability for differentiating between Type IIa and IIb fractures is low.
- Our results validate the Gartland classification system as a method to help direct treatment of pediatric supracondylar humerus fractures, although the modification of the system, IIa versus IIb, seems to have limited reliability and utility. This suggests that rotational deformity is difficult to assess in pediatric supracondylar humerus fractures.
- Terminology based on decision to treat would lead to a more clinically useful classification system in the evaluation and treatment of pediatric supracondylar humerus fractures.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 60: Assessment of the Symmetry of Shoulder Skin Folds: Inter- and Intra-observer Reliability

Category: Congenital/Pediatric

Keyword: Shoulder

Not a clinical study

◆ Keya Manshadi, BS

◆ Ebrahim Paryavi, MD, MPH

◆ Martin Herman, MD

◆ Scott H. Kozin, MD

◆ Joshua Abzug, MD

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

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

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

Summary:

- While asymmetry of skin folds has been shown to occur with certain shoulder pathologies, agreement of what "asymmetry" means is not present amongst pediatric orthopaedic surgeons.
 - Patient positioning or movement may cause variation in skin fold alignment and therefore the same patient may have symmetry at one moment and asymmetry at the next.
 - Utilization of skin folds as a screening tool, in isolation, is unreliable when assessing for shoulder pathology.
- ◆ Nothing of financial value to disclose

AM E-POSTER 61: The Utility of Type A Ulnar Polydactyly Classification in Syndromic Diagnosis

Category: Congenital/Pediatric

Keyword: Hand

Level 4 Evidence

◆ Freida Angullia, MD, MRCS

◆ Gillian D. Smith, FRCS

Hypothesis: Surgical management of Type A ulnar (post-axial) polydactyly largely depends on its radiological classification. Several such categories exist and are useful for examining patterns of associated anomalies, providing a guide to reconstructive surgery. A significant proportion of Type A ulnar polydactyly have syndromic association which is not reflected in its classifications. These syndromes can have adverse effects on the child's general health as well as increase their anaesthesia risk during surgery. Pattern of limb involvement and ethnicity of children presenting with Type A ulnar polydactyly can support the diagnosis of an associated syndrome. We propose to examine the ethnic variance of the radiological subgroups of Type A ulnar polydactyly and test the hypothesis that its classification can be utilised to aid in syndromic diagnosis.

Methods: 53 cases of Type A ulnar polydactyly of both hands and feet from a single institution from May 2007 to September 2012 were retrospectively reviewed. The patients' medical records and radiographs were interrogated. All patients were entered into a five-subgroup classification previously described by Pritch, et al. based on the skeletal origin of the extra digit. The ethnic demographic of each subgroup was compiled and those of syndromic association identified.

Results: The classification system accommodated ninety-eight percent (84/86) of the anomalies included in this study of primarily Caucasian and Asian ethnicity. Of the five subgroups, the metacarpophalangeal joint (MCPJ) type was the most common anomaly (39/86), comprising 70 percent (19/27) Caucasian digits. The metacarpal (MC) subgroup (19/86) contained fifty-four percent (7/13) Caucasians and forty-six percent (6/13) Asians. The fully developed (FD) type (15/86) was eighty percent (8/10) Asian.

Sixty-six percent (19/29) of Caucasian digits belonged to the MCPJ category, twenty-four percent (7/29) to the MC subgroup and one percent (2/29) was of FD type. Nineteen percent (6/31) of Asians were from both MCPJ and MC categories, twenty-six percent (8/31) were from both FD and phalageal type subgroups. Majority of the digits in MCPJ and MC type categories of Caucasian ethnicity were syndromic and likewise for Asians of MC and FD types. This increased risk of syndromic association correlates with greater limb involvement observed in our institution.

Summary: Different subgroups of Type A ulnar polydactyly in our institution were found to contain a distinct ethnic mix corresponding to that observed in those with a syndromic association. This skeletal classification is therefore a useful aid, coupled with ethnicity and pattern of limb involvement, for the diagnosis of syndromes involving post-axial polydactyly.

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◆ Nothing of financial value to disclose

AM E-POSTER 62: MRI Has a Low Sensitivity for Evaluating Collateral Ligament Injuries of the Metacarpophalangeal Joints of the Lesser Digits.

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Hand

Level 4 Evidence

- Kevin Lutsky, MD
- Pedro Beredjikian, MD

Hypothesis: MRI has been shown to be accurate in assessing collateral ligament injuries of the MCP joint of the thumb. The purpose of this study is to evaluate the accuracy of MRI for diagnosing collateral ligament tears of the MCP joint of the lesser digits. Our hypothesis is that MRI would accurately detect complete tears of collateral ligaments of the lesser digit MCP joints.

Methods: We retrospectively evaluated 22 digits in 20 patients undergoing lesser digit MCP joint collateral ligament repair over a 3-year period. All patients had physical exam findings consistent with complete collateral ligament tear, and had pre-operative MRI scans. The findings on pre-operative imaging studies were compared to the intra-operative findings.

Results: All patients had surgically confirmed complete tears of the collateral ligament in question. In 8 of 22 MRI scans (36%), the pre-operative imaging study was inaccurate. Of these 8 patients, MRI was interpreted as no tear in 1 and a partial tear in 7. The sensitivity of MRI for diagnosing a complete tear was 73%. In all 3 digits in which 3-Tesla MRI scanning was utilized and documented, the pre-operative imaging results did not correlate with the intra-operative findings.

Summary: Although MRI can be considered a useful adjunct to evaluating patients with collateral ligament injuries of the lesser digits, the sensitivity is poor and the imaging results can underestimate the extent of injury. In light of this, the emphasis for determining appropriate course of treatment remains on history and mechanism of injury, physical examination, and patient disability.

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- Consulting Fees (e.g. advisory boards) received from: Synthes (Lutsky)
- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Tornier (Beredjiklian)
- Other Financial/Material Support received from: Speaker's Bureau for Trimed (Beredjiklian)
- ◆ Nothing of financial value to disclose

AM E-POSTER 63: Use of the Intraoperative Radial Groove View for Preventing Complications of the Extensor Pollicis Longus Tendon by Prominent Screws Following Volar Plating for Distal Radius Fractures

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Wrist

Not a clinical study

◆ Sang Ki Lee, PhD

◆ Jae Won Lee, MD

◆ Youn Moo Heo, MD

Hypothesis: Volar plating has been recently preferred to dorsal plating for the treatment of distal radius fractures due to extensor complications. Nevertheless, the incidence of extensor complications, especially in the extensor pollicis longus (EPL), has been reported to range between 2% and 12.5%. The aims of the present study were (1) to propose the use of a newly designed radiographic method, the radial groove view, for the detection of prominent screws in the EPL groove; (2) to standardize an ideal position for the use of the radial groove view in intraoperative applications; and (3) to report on the effectiveness of this radiographic method.

Methods: We analyzed the anatomy of the EPL groove by performing 3-dimensional (3D) computed tomography (CT) for 51 normal forearms. We intraoperatively applied the radial groove view with this standardized position for detecting prominent screws in the EPL groove in 91 patients who underwent volar plating. Immediately after the operation, wrist CT was performed to confirm the presence of screw penetration in the EPL groove.

Results: In the analysis with the postoperative radial groove view, a standardized position was designated at 20° in the horizontal angle and 5° in the sagittal angle. Using intraoperative radial groove view based on this standardized position, we detected 13 prominent screws in the EPL groove and therefore changed these to shorter screws. On the postoperative CT, a prominent screw in the EPL groove was observed in 1 patient. The sensitivity of the detection of the prominent screw in the EPL groove by the intraoperative radial groove view was 95 %.

Summary: Our findings show that the intraoperative radial groove view is a valuable radiographic approach for improving the sensitivity of detecting prominent screws in the EPL groove after volar plating for distal radius fractures. The present study could serve as a guideline in applying this radiographic method intraoperatively for preventing complications of the EPL tendon by prominent screws after volar plating of distal radius fracture.

◆ Nothing of financial value to disclose

AM E-POSTER 64: Chronic Radial Collateral Ligament Injuries of the Thumb Metacarpophalangeal Joint: Reconstruction With Ligament Advancement and Transfer of a Half-Slip of the Abductor Pollicis Brevis Tendon

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Hand

Level 4 Evidence

- ◆ Kousuke Iba, MD
- ◆ Takuro Wada, MD
- ◆ Gosuke Oki, MD
- ◆ Kohei Kanaya, MD
- ◆ Toshihiko Yamashita, MD

Hypothesis: A new reconstructive method for chronic radical collateral ligament (RCL) injuries of the thumb metacarpophalangeal (MCP) joint, which is used in combination with RCL advancement and the transfer of a half-slip of the abductor pollicis brevis (APB) tendon is an effective surgical method.

Methods: Eight patients (male 4, female 4; mean age 25 years) suffering from chronic RCL injury of the thumb MCP joint were enrolled. All patients were referred to our institution due to continuing pain in the radial MCP joint when grasping or pinching objects. The mechanism of the injury was adduction stress to the thumb during various activities included basketball in 2, baseball in 1, snowboarding in 1, judo in 1, heavy object falling on the thumb in 1 and an isolated fall in 2 patients. The mean duration from RCL injury to surgery was 143 days. The average interval from surgery to follow-up evaluation was 51 months. We evaluated post-operative outcomes including pain, range of motion (ROM) of the thumb MCP joint, grip strength, key pinch strength, Disabilities of the Arm, Shoulder and Hand (DASH) score and their ability to return to their pre-injury work or sporting activities.

Results: No patients demonstrated any symptoms and the MCP joint was stable after surgery. Post-operative grip and pinch strength were increased in comparison with pre-operative values. All patients fully returned their pre-injury work or sporting activities within 6 months after surgery. Although post-operative flexion was decreased by an average of 6.3° , no patients revealed any functional deficiency.

Summary: We showed that all patients with chronic RCL injury were symptom-free and demonstrated a stable and pain-free MCP joint after surgery. We believe that our reconstructive

procedure for chronic RCL injuries of the thumb MCP joint, using a combination of RCL advancement and transfer of a half-slip of the APB tendon, is an effective surgical method.

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◆ Nothing of financial value to disclose

AM E-POSTER 65: Clinical Results after Bone Peg Grafting for Osteochondritis Dissecans of the Humeral Capitellum in Teenage Athletes

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Elbow

Level 4 Evidence

- ◆ Hiroyuki Oshiba, MD
- ◆ Toshiro Itsubo, MD, PhD
- ◆ Shigeharu Uchiyama MD PhD
- ◆ Hiroyuki Kato MD PhD

Hypothesis: Bone peg grafting (BPG) has been advocated for early to middle stage humeral capitellar osteochondritis dissecans (capitellar OCD). However, its clinical and radiological results have not been reported precisely. The International Cartilage Repair Society (ICRS) classification of OCD-II of capitellar OCD could be treated successfully by BPG.

Methods: Eleven consecutive teenage baseball players who underwent BPG for capitellar OCD were enrolled in this study. All patients were male whose age at the time of surgery averaged 14 years. No improvement was confirmed in all cases by radiography over 3 months of preoperative non-throwing observation. Immediately prior to surgery, radiographs demonstrated a radiolucent area without obvious bone fragments in 1 case and non-displaced fragments in 10 cases. All patients were classified as having ICRS OCD-II from arthroscopic findings. The adolescents were treated by BPG, in which 3-5 bone pegs with a mean diameter of 2.1 mm harvested from the cortex of the ipsilateral olecranon were inserted into the OCD lesion. We evaluated all patients directly at 1 and 2 years after surgery with regard to elbow pain and function, sports activity, radiographs, and MRI over a mean follow-up period of 33 months.

Results: The mean Timmerman score improved from 172 preoperatively to 194 postoperatively. Nine of 11 (82%) patients could return to the same baseball skill level within 12 months, while the remaining 2 could return at a diminished level. In 8 cases, complete radiological healing of the lesion was confirmed at 24 months. For the 3 radiographically incomplete healing cases, we found that the floor of the lesions remained fragmented. The average Henderson MRI score improved to 6.5 and 5.1 at 12 and 24 months after BPG, respectively. All 4 cases with the lesion in the central capitellum achieved complete healing. In contrast, only 4 of 7 cases with the lesion in the lateral capitellum healed completely.

Summary: BPG enabled 100% of patients with ICRS OCD-II to return to sports activities, among which 82% could perform at pre-surgery levels. BPG is therefore indicated for patients

with ICRS OCD-II capitellar OCD. The site of the OCD lesion in the capitellum may affect healing after BPG.

◆ Nothing of financial value to disclose

AM E-POSTER 66: Provocative Tests for Carpal Tunnel Syndrome

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Hand

Level 2 Evidence

◆ Melissa Arief, MD

◆ Mukund R. Patel, MD

Hypothesis: This prospective study sought to evaluate the clinical usefulness of seven tests for carpal tunnel syndrome - Durkan, Paley-McMurtry, Mackinnon, Phalen, Phalen extension, Berger and the Tinel's test and to determine which tests or combination of tests offers the highest sensitivity for diagnosis.

Methods: Forty one patients (a total of 62 hands) with electrodiagnostically confirmed carpal tunnel syndrome (CTS) were recruited for this study. Twenty five healthy volunteers were recruited to determine a rate of false positives. Each of the tests was evaluated for time to onset of symptoms and sensitivity of the tests was calculated and compared to the standard Phalen's test.

Results: The calculated sensitivity of the tests were: Mackinnon flexion (92%), Paley-McMurtry (89%), Durkan (87%), Phalen flexion (84 %), Berger (82 %), Phalen extension (76%) and Tinel (67%). There was no statistical difference between Phalen's test and other tests. One test (Mackinnon flexion) confirmed the diagnosis of CTS in 92% of patients, two tests (Mackinnon flexion and/or Paley-McMurtry) in 94%, three tests (Mackinnon flexion, and/or Paley-McMurtry and/or Berger) in 95% and four tests (Mackinnon flexion, and/or Paley-McMurtry, and/or Berger and/or Phalen flexion) in 97% of the hands. It was found that a combination of 3 tests or more was more sensitive than Phalen's test alone ($p < 0.001$). In 50 hands of 25 normal control subjects, no more than two tests simultaneously occurred as false positives in any given hand.

Summary:

- The clinical usefulness of each of the seven provocative tests was determined by calculating the sensitivity for each of these tests.
- This study also calculated the sensitivities of these tests in combination to determine the optimal combination of tests for the highest sensitivity.
- The results of this study suggest that the best method for the clinical diagnosis of carpal tunnel syndrome is to use three most sensitive tests simultaneously. The three tests (Mackinnon flexion, and/or Paley-McMurtry and/or Berger) which take only a total of 3 minutes to perform offers a 95% sensitivity rate.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 67: Utility of Diffusion-weighted Neurography for Evaluation of Postganglionic Brachial Plexus Lesions

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Other

Level 4 Evidence

- ◆ Kazuki Kuniyoshi, MD, PhD
- ◆ Shinobu Saito, MD
- ◆ Ken-ichi Murakami, MD
- ◆ Yusuke Matsuura, MD
- ◆ Masataka Shibayama, MD
- ◆ Seiji Okamoto, MD

Hypothesis: Conventional MR imaging is unreliable for visualizing postganglionic brachial plexus (BP) lesions. Recently, diffusion-weighted neurography was developed and its feasibility for this purpose has been proposed. The purpose of this retrospective study was to evaluate its diagnostic value for postganglionic BP lesions.

Methods: Traumatic BP injury patients were enrolled in this study: 11 males and 2 females whose mean age was 32 years (range: 18-64 years). The causes of injury were motor cycle accidents (8), car accidents (2), falls (2), and labor (1). Paralysis involved total BP (4), upper BP (6), and lower BP (3). At their initial visits, all patients had complete paralysis. MRI scans using Philips 1.5 Tesla Achieva Nova Dual were done at a mean of 2 months after injury (0.5-4 months). Nine patients had surgery at a mean of 4 months after injury (1-8 months). For the other four patients, spontaneous recovery was confirmed at 5 months and all paralyzed muscles showed recoveries of at least > MRC Grade 2. Presumably, none of these patients had root avulsions or nerve ruptures. Evaluations of neurographic findings were by a radiologist and a hand surgeon for each spinal nerve root (C5-T1) and the total area distal to the root level, including each trunk and cord; 6 areas were evaluated in each patient. The neurographic findings of these 6 areas were compared to the intraoperative findings, and the sensitivity, specificity, and accuracy of the neurographic diagnoses were estimated. Interobserver reliability was assessed by kappa coefficient (K).

Results: Sensitivity was 57% for the root level and 80% for the distal level. Specificity was 92% for the root level and 100% for the distal level. The overall diagnostic accuracy of the neurographic findings was 82% for the root level and 92% for the distal nerve area. Interobserver reliability was nearly perfect ($\alpha = 0.90$).

Summary: Partial root avulsion may have accounted for the very low sensitivity for the root level. However, specificity was quite high for both the root and the distal levels. Diffusion-weighted neurography has a considerable advantage for detecting postganglionic brachial plexus ruptures and, when combined with MR or CT myelography, may help in decisions regarding whether to operate or to wait.

◆ Nothing of financial value to disclose

AM E-POSTER 68: Demographic Aspects of Pediatric and Adolescent Patients Who Have Undergone Ulnar Shortening Osteotomy

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Wrist

Level 4 Evidence

◆ Abdo Bachoura, MD

◆ Joshua Abzug, MD

◆ Sidney Jacoby, MD

◆ Dan A. Zlotolow, MD

◆ Scott H. Kozin, MD

Hypothesis: Ulnar Shortening Osteotomy (USO) is an effective treatment for ulnar impaction syndrome (UIS) in adults. In adolescent and pediatric patients however, the outcomes and demographics of this procedure have been sparsely described. The purpose of this study was to document the demographic aspects of pediatric patients who have undergone an USO.

Methods: A retrospective chart review of all patients under the age of 18 who had undergone an USO procedure between 1/1/2000 - 9/1/2011 was performed. Data collected included age, sex, the mechanism of ulnar impaction, time from injury to surgery, complications and ulnar variance (both pre and post-op).

Results: 58 procedures in 55 patients were identified. There were 17 males and 38 females with a mean age of 15.1 years (range 11-17). The mechanism of UIS was related to late effects of traumatic wrist fractures and injuries in 25 (45.5%), competitive gymnastics in 10 (18.2%), intensive racquet sport playing/training 7 (12.7%), Madelung's deformity 4 (7.3%), no identifiable cause 2 (5.5%) and other causes in 7 patients (12.7%) (1 osteogenesis imperfecta, 1 brachial plexus birth injury, 1 radial hypoplasia, 1 in utero radial growth arrest, 1 joint pain following acute Lyme disease, 2 other unspecified congenital forearm deformities). The mean time from injury to surgery was 21.4 months. Complications occurred in 10 patients (18.2 %). These included: recurring deformity in 4, cubital tunnel syndrome in 2, 2nd compartment extensor tendonitis in 2, medial and lateral epicondylitis in 1, delayed union in 1 patient taking chemotherapy, nail bed ischemia in 1 and nonunion in 1 patient. Hardware removal procedures were performed in 7 patients (12.7%). Mean ulnar variance was +4.1 mm (range -1 to +10) preoperatively and -0.5 mm (Range -4 to +6) post-operative.

Summary:

- USO in pediatric patients is typically performed months to years after attempted conservative or prior surgical treatment measures have failed.

- Female involvement was 2.2 times that of males.
- Intense sports activities that chronically load the wrist contributed to a large proportion of UIS requiring USO (31%).
- Traumatic wrist fracture is a leading cause of UIS requiring USO, but UIS in highly competitive children such as gymnasts and tennis players may be a preventable injury.

◆ Nothing of financial value to disclose

AM E-POSTER 70: Hand Performance Test for Evaluating Functional Outcomes Following Finger Tip Reconstruction

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Hand

Level 4 Evidence

◆ Daisuke Kaji, MD

◆ Ryotaro Fujitani, MD

◆ Koichi Kawanishi, MD

◆ Shohei Omokawa, MD, PhD

◆ Yasuhito Tanaka, MD, PhD

Hypothesis: The purpose of this retrospective cohort study was to evaluate the functional outcomes following digital artery flap reconstruction for fingertip injuries. We hypothesized that hand performance test score would correlate with the score of self-reported questionnaire, objective findings and patients' satisfaction.

Methods: Thirteen consecutive patients (8 index and 5 long fingers involved) sustained amputation injury at the level of Tamai zone 1 or 2. Ten patients underwent reverse-flow pedicle island flap, 2 had oblique triangular advancement flap, and 1 had neurovascular island flap. The clinical evaluations included complications, Likert scale of satisfaction level for surgery, and questionnaire regarding how the patients use the affected finger in the daily living. Assessment of functional outcomes included objective finding of sensory recovery measured by Semmes-Weinstein monofilaments, strength of key pinch, and the total active finger motion (TAM). Self-reported outcomes of the Disabilities of the Arm, Shoulder, and Hand (DASH) and Hand20 score were derived. Hand performance test (Purdue pegboard test) was carried out both with and without using the injured finger. Correlations of hand performance score with the other functional outcome measures were analyzed by Spearman Correlation Coefficient. (Values of $p < 0.05$ were considered statistically significant.)

Results: All except one patient were either highly or moderately satisfied with the reconstructive surgery, and there was no postoperative complication. Regarding the frequency of finger use, 12 patients answered the seldom use of injured finger in the fine motor skill activities. Patients regained on average 82.5% of TAM and 83.5% of key pinch strength compared to the contralateral hand. The average value of Semmes-Weinstein monofilaments test was 3.48 (mean 2.83-4.08). Quick-DASH averaged 7 (mean 0-25) and Hand20 averaged 10 (mean 0-30). Purdue pegboard test score on assembly averaged 63% of normative population averages with the use of injured finger, while the score increased without the use of injured finger (86%). Purdue

pegboard test score correlated with TAM ($r=0.58$, $p=0.042$), but didn't correlate with the other functional outcomes.

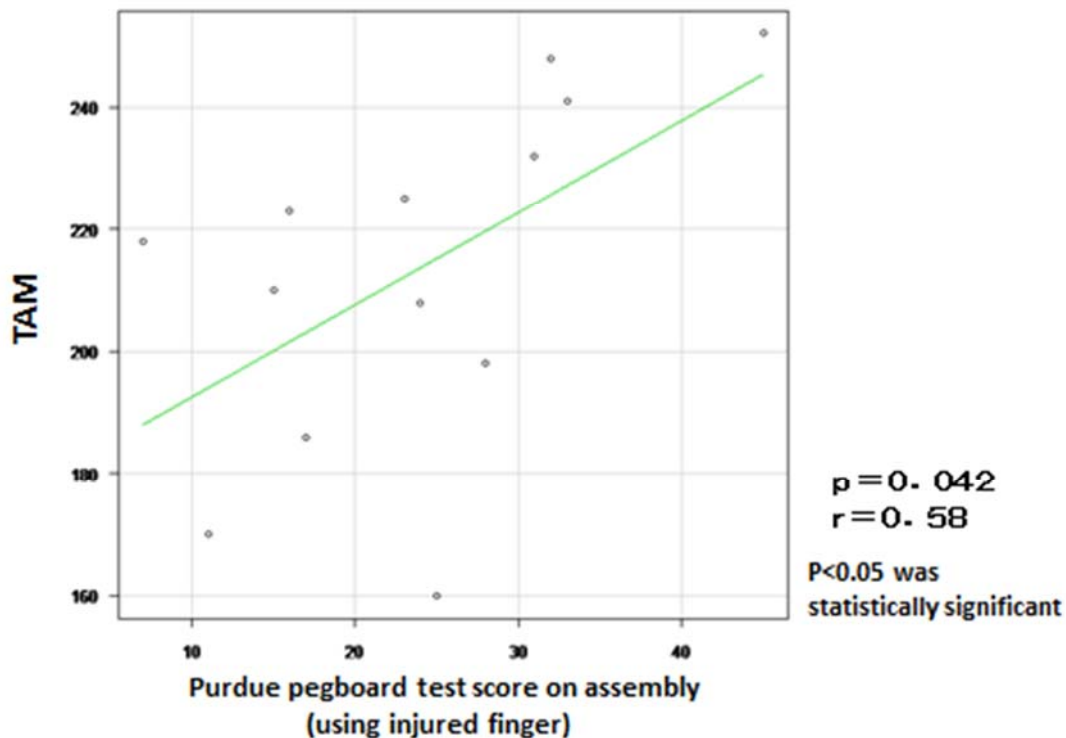
Summary:

- Patients who underwent digital artery flap reconstruction were mostly satisfied with the clinical result, and the objective and self-reported outcomes were satisfactory.
- Despite of the feasible objective and self-reported outcomes, most patients didn't use the injured finger in the motor skill activities.
- Hand function score didn't correlate with the objective findings or self-reported questionnaire scores except TAM, and the hand performance with the use of injured finger decreased compared to that without using the affected finger.

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Correlation of hand performance score with TAM



Functional Outcomes following Finger Tip Reconstruction (n=13) (average \pm SD)

S-W Test	%Key Pinch	%TAM	DASH Score	Hand20 Score	PPT (Without using injured finger)	PPT (Using injured finger)
3.48 \pm 1.25	83.5 \pm 46	82.5 \pm 33	7 \pm 25	10 \pm 30	32 \pm 39	24 \pm 38

S-W : Semmes-Weinstein Monofilaments

TAM : The total active finger motion

PPT : Purdue pegboard test

◆ Nothing of financial value to disclose

AM E-POSTER 71: Reliability and Validity of Radiographic Carpal Alignment Measurements for Evaluating Flexion Deformity of Scaphoid Fractures

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Wrist

Not a clinical study

- ◆ Young Hak Roh, MD
- ◆ Jong Ryoan Baek, MD
- ◆ Beom Koo Lee, MD
- ◆ Won Sub Kim, MD
- ◆ Hyun Sik Gong, MD
- Goo Hyun Baek, MD

Hypothesis: Several radiographic carpal alignment indices are used to indirectly evaluate three dimensional flexion deformity of scaphoid fracture. But the reliability and validity of carpal alignment indices for evaluating the deformity of scaphoid fracture have not been well evaluated. We determined the validity and reliability of commonly used radiographic carpal alignment indices for measuring the flexion deformity of scaphoid fractures.

Methods: Thirty six patients with scaphoid fracture and 36 sex- and side- matched individuals without scaphoid fractures were evaluated. Five carpal alignment indices on lateral plain radiographs were assessed: scapholunate angle, radioscapoid angle, radiolunate angle, radiocapitate angle, and capitulunate angle. Three examiners measured the radiographic indices at two sessions, and intraobserver and interobserver reliability were determined and expressed by intraclass correlation coefficients (ICCs). Discriminant validity of radiographic carpal alignment indices between patients with scaphoid fracture and healthy individuals was evaluated. For convergent validity testing, the correlation with the intrascaphoid angle (ISA) and height-to-length (HL) ratio on CT longitudinal scan were assessed.

Results: The scapholunate and radiolunate angle had the highest reliability, and the radiocapitate angle had the lowest. The radiolunate showed highest discriminant validity in terms of effect size r and Cohen's d , followed by the scapholunate, and capitulunate angles. In convergent validity testing, the ISA angle correlated with the scapholunate angle and radiolunate angle ($r = 0.571$, $p = 0.04$; and $r = 0.619$, $p = 0.01$), while the HL ratio correlated only with the radiolunate angle ($r = 0.685$, $p = 0.01$).

Summary: The radiolunate angle is the most reliable and valid carpal alignment index for determining the flexion deformity of scaphoid fracture. The scapholunate angle can be used

alternative option with less validity, but the other angles are not recommended for measuring scaphoid deformities.

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Table 4. Discriminant validity of radiographic carpal alignment indices.

	SL angle	RL angle	RS angle	RC angle	CL angle
Cohen's D	2.97	3.02	2.14	1.11	2.89
Effect size r	.536	.569	.439	.172	.527

Table 5. Convergent validity of radiographic carpal indices presented as correlation coefficients with flexion deformity indices on CT scans..

	ISA	HL	SL angle	RL angle	RS angle	RC angle	CL angle
ISA		.676	.571	.619	.153	.214	.350
		0.01	0.04	0.01	0.33	0.42	0.12
HL	.676		.278	.685	.370	.100	.339
	0.01		0.12	0.01	0.06	0.52	.008

- Other Financial Relationship: Seoul R&D Program (ST090809)
- ◆ Nothing of financial value to disclose

AM E-POSTER 72: A Comparison of Sensory Tests for Detecting Sensory Deficit in Carpal Tunnel Syndrome

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Wrist

Level 4 Evidence

◆ George S. Edwards, III, MD

◆ George S. Edwards Jr., MD

◆ J. Megan Patterson, MD

◆ Cheryl E. Reese, MD

Hypothesis: Light touch followed by pin prick are the best methods to detect a sensory deficit in patients with carpal tunnel syndrome.

Methods: 48 patients (74 hands) meeting the CTS-6 diagnostic criteria for carpal tunnel syndrome were recruited to participate in this study. Each patient underwent sensory testing including light touch, pin prick, monofilament, static and moving two point discrimination tests. The patients were divided into mild, moderate and severe CTS groups. The amount of time to perform the tests was also recorded. All patients underwent nerve conduction velocity (NCV) testing.

Results: Light touch was significantly more likely to identify a sensory deficit than monofilament or two-point discrimination (moving or static) in patients with carpal tunnel syndrome. Light touch was also more likely to identify a sensory deficit than pin prick, though this difference was not significant. The specificity of each of these tests is greater than 90%. Light touch took the least amount of time to perform and the two-point discrimination tests took the longest.

Summary: In the busy hand surgery clinic it is critical to have a fast and reliable method to test sensibility when evaluating carpal tunnel syndrome. Light touch is both fast and also the most likely test to identify a sensory deficit when compared to monofilament, static and moving two-point discrimination.

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Figure 1.

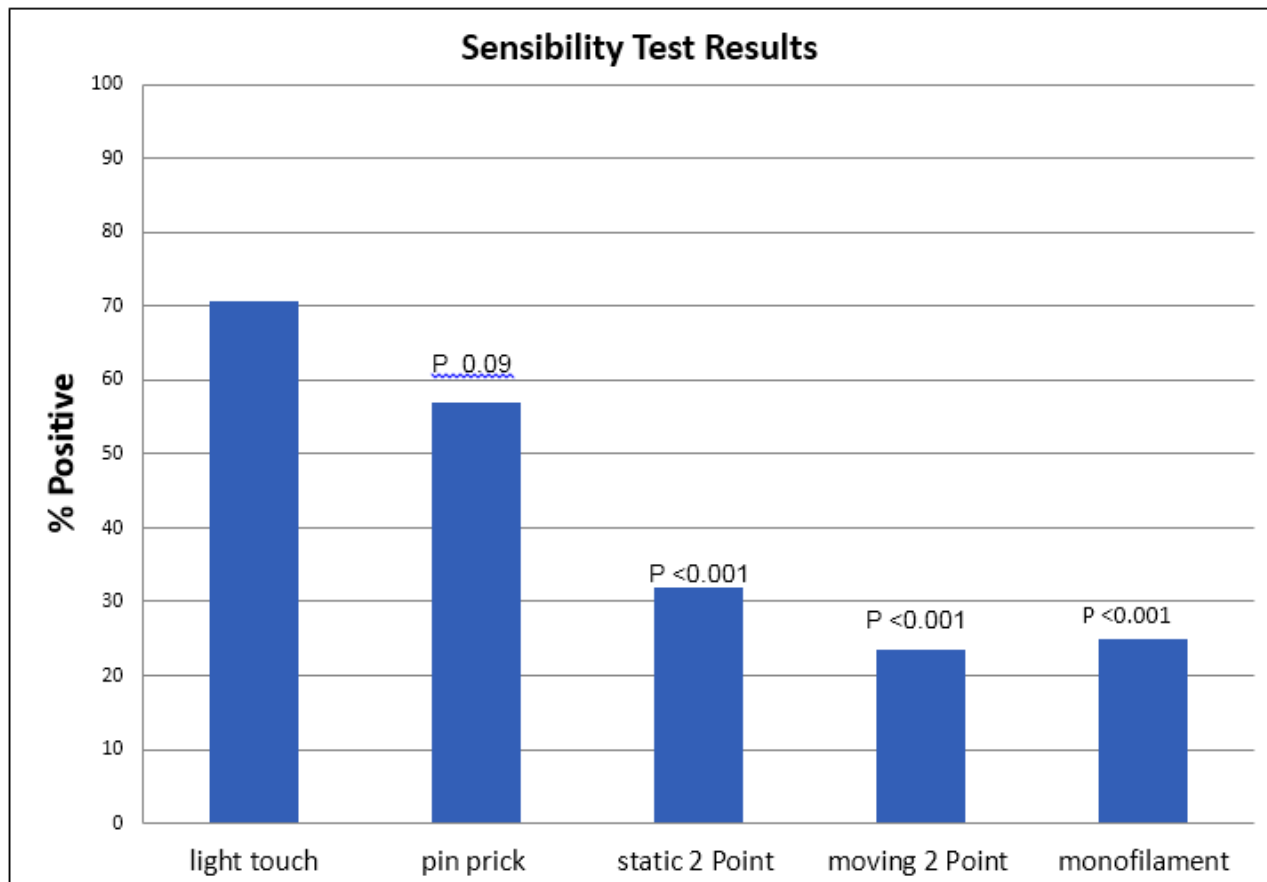


Figure 1. Results of the five sensibility tests showing the percentage that each test was positive among all patients (n=74 hands). P values listed above the bar for each test.

◆ Nothing of financial value to disclose

AM E-POSTER 73: Outcomes of Conservative Therapies for the Treatment of Lateral Epicondylitis with Minimum One Year Follow-up

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Elbow

Level 4 Evidence

- ◆ Christopher M. Judson, MD
- ◆ Jenna M. Bernstein, BS
- ◆ Masai M. McIntosh, BA
- Augustus M. Mazzocca, MD
- ◆ Jennifer Moriatis Wolf, MD

Hypothesis: Lateral elbow tendinopathy is a common musculoskeletal issue affecting 1-3% of the population. The majority of patients are treated with conservative therapy, including observation, splinting, physical therapy, and injections. There are minimal data comparing various modalities of treatment in the medium term. We hypothesized that there would be no difference in outcomes between patients treated with different conservative therapies one year after initial treatment of lateral epicondylitis.

Methods: A retrospective review was performed of all patients diagnosed with lateral epicondylitis by two orthopaedic surgeons over a one-year period. Length of symptoms and any prior therapies were recorded. Patients who had already received treatment were excluded from the study. All patients were contacted one year after initial treatment and the Disabilities of the Arm, Shoulder, and Hand (DASH), Visual Analog Scale (VAS), and remaining symptoms were recorded. The DASH disability/symptom score was calculated for all patients.

Results: Thirty-eight patients met inclusion criteria and consented to participate in the study. Complete data was available for the first 15 patients at one year after initial treatment. There were no significant differences in DASH scores between patients who had observational therapy (17.8), physical therapy (19.3), or bracing (13.6). Patients who received corticosteroid injections had a trend toward a higher DASH score at one year (20.5) than those who did not receive injections (11.3), although this did not reach significance with the preliminary sample size. Interestingly, the length of symptoms prior to initial treatment correlated with final outcomes. Patients with less than 4 months of symptoms had a mean DASH score of 18.5 points lower than those with greater than 4 months of symptoms prior to treatment (6.4 vs 24.9) and had a greater chance of being asymptomatic at one year (88% vs 33%).

Summary:

- Different conservative therapies for lateral epicondylitis resulted in similar outcomes at one year
- Patients who received steroid injections had a trend toward worse DASH scores at one year
- Patients with symptoms for greater than 4 months before diagnosis had a greater chance of remaining symptomatic and had higher DASH scores at one year, although this difference did not reach significance.

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- Consulting Fees (e.g. advisory boards) received from: Arthrex
- ◆ Nothing of financial value to disclose

AM E-POSTER 74: Clinical and Radiographic Results Following Isolated Capitate Shortening Osteotomy For Stage II or III of Kienböck's Disease

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Wrist

Level 4 Evidence

◆ Mitsuru Horiki, MD, PhD

◆ Kakurou Danno, MD, PhD

◆ Reiko Nakagawa, MD

Hypothesis: Capitate shortening osteotomy is the surgical technique for the Kienböck's disease with ulnar neutral or positive variance and Lichtman stage I to III. Capitate shortening osteotomy is usually performed with capito-hamate fusion. The purpose of this study was to evaluate an isolated capitate shortening osteotomy for the stage II or III of Kienböck's disease in middle and elderly patients.

Methods: This is a retrospective study of 10 cases (three male, seven female). The mean age at the time of surgery was 57 years. All patients were diagnosed with Lichtman stage II or stage III Kienböck's disease with ulnar neutral or ulnar positive variance. Capitate shortening osteotomy was performed through dorsal approach, a 2mm shortening osteotomy and fixed with double threaded screw. Overall clinical results were evaluated by modified Mayo wrist score (wrist range of motion, grip strength, pain, satisfaction). Carpal height ratio and radio-scaphoid angle were evaluated by radiographs. Stahl index and morphological changes of the lunate (fragmentation, cystic change, collapse, remodeling) were evaluated by radiographs and CT scans.

Results: At the final follow up evaluation (mean, 23 months), the mean modified Mayo wrist score was 65 points (range, 40 to 80). Pain and grip strength were significantly improved. Carpal height ratio decreased from preoperative 0.54 to 0.5 at final follow up. Stahl index and radio-scaphoid angle did not change significantly in radiographs. But Stahl index significantly decreased from preoperative 0.42 to 0.35 at final follow up in CT scans. Fragmentation, cystic change and collapse of the lunate were detected more clearly by CT scans than by radiographs. Remodeling of the lunate was only detected in 2 cases by radiographs, but it was detected in 7 cases by CT scans.

Summary: Simple capitate shortening osteotomy is effective in the treatment of Kienböck's disease. CT scan was a very helpful examination tool to detect the postoperative change of the lunate.

◆ Nothing of financial value to disclose

AM E-POSTER 75: The Limited Fasciotomy for Dupuytren's Contracture

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Hand

Level 4 Evidence

◆ Colyn Watkins, MD

◆ Jimmy Daruwalla, MD

◆ Michael Sridhar, MD

◆ Gary McGillivary, MD

Hypothesis: The limited fasciotomy is a safe and effective technique for releasing contracture in Dupuytren's disease.

Methods: The minimally invasive limited fasciotomy utilizes a small longitudinal incision (5 millimeters) centered over the pathologic central cord. After achieving adequate visualization to ensure that no tendinous or neurovascular structures are at risk, a scalpel is used to sharply divide the cord. Digital motion is begun immediately postoperatively. We retrospectively reviewed the charts of 22 consecutive patients with 39 affected joints at the long, ring, and small fingers including 20 metacarpophalangeal (MCP) and 19 proximal interphalangeal (PIP) joints. Pre-operatively, intra-operatively, and at last follow-up, we measured MCP and PIP joint contractures and recorded complications. For these 22 patients, minimum and mean follow-up was 77 and 581 days, respectively. Twelve of these 22 patients returned to clinic for repeat evaluation of contracture and to complete a questionnaire on satisfaction with their surgery. These 12 patients had a minimum and mean follow-up of 374 and 930 days, respectively.

Results: For all 22 patients, mean preoperative total flexion deformity (TFD) was 59.8 degrees at the MCP joints and 54.7 degrees at the PIP joints. Mean percentage of intraoperative angular extension gain (AEG) at the MCP joints was 99.7% and 87.2% at the PIP joints. At last follow-up, our mean percentage AEG decreased to 90.9% at the MCP joints and 37.4% at the PIP joints. Complications included two patients with subjective fingertip numbness with intact static 2-point discrimination, four patients with minor skin disruptions, and one patient with a superficial skin infection. All complications were treated non-operatively.

Extended follow-up data were obtained from a subset of 12 of the 22 patients representing 11 MCP and 9 PIP joints. Amongst these patients, preoperative mean TFD was 56.4 degrees at the MCP and 56.7 degrees at the PIP. Intraoperatively, mean AEG in this cohort was 100% at the MCP and 79.1% at the PIP. At last follow-up mean percentage AEG was 83.9% at the MCP joints and 19.4% at the PIP joints. Seven of 10 patients would elect for the limited fasciotomy on another joint if needed.

Summary:

- The limited fasciotomy is safe and provides immediate release of MCP and PIP contractures
- Follow-up data suggests good maintenance of correction at the MCP, but a high risk of recurrent contracture at the PIP.
- A majority of patients would elect to repeat the procedure, if needed.

◆ Nothing of financial value to disclose

AM E-POSTER 76: A Proposal of a Method to Make a Disease-Specific Instrument Based on Region-Specific Instrument

Category: Evaluation/Diagnosis/Clinical Treatment

Keyword: Other

Not a clinical study

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- ◆ Shigeru Kurimoto, MD
- ◆ Masahiro Tatebe, MD
- ◆ Takaaki Shinohara, MD
- ◆ Hitoshi Hirata, MD

Hypothesis: The tools to rate patient disability are indispensable for establishing clinical evidence. Unfortunately, composing a validated disability tool is always an enormous task which requires a lot of time, money and people, and is seldom accomplished without patience and luck. Disability assessment instruments are classified into 3 categories, i.e. region-, joint-, and disease-specific, depending on intended area or disease targets. There is a general notion that increase in targets tends to deteriorate validity and responsiveness. In this study, we tried to make a disease-specific instrument by choosing items included in a region-specific instrument while improving statistical indices with the use of the concept-based method and the equidiscriminative item-total correlation (EITC) method, and tested its usefulness by applying to another patient population^{1,2}.

Methods: Hand20 is a validated upper-extremity disability assessment tool, comprising 20 short and easy-to-understand questions³. Our previous study demonstrated moderate responsiveness for CTS, standardized response mean (SRM) was 0.60. The spearman-Brown “prophecy” formula showed that seven items are required to retain the internal consistency coefficient (Cronbach’s alpha) of 0.90. We analyzed Hand20 score of 56 patients who underwent carpal tunnel release and followed up for more than one year to form a CTS specific instrument comprising 7 items (Hand-CTS). Five items were chosen based on factor loadings and SRM, and the other 2 items referring to hand specialists’ opinion. Validity and responsiveness of Hand-CTS was tested by applying to another group of surgically treated patients.

Results: Hand-CTS includes four concepts of Hand20, i.e. physical functioning, role physical, mental health and symptom. Among the first 56 patients, the change of the score for Hand-CTS and Hand20 between pre- and post-operation was -21.9 ± 20.4 and -18.3 ± 20.0 , and SRM was 1.07 and 0.92 at one year, 0.61 and 0.53 at 6 months. The responsiveness of Hand-CTS was better than Hand20. On other 16 patients population, the change of score was -18.1 ± 22.9 and -16.5 ± 23.8 , SRM was 0.79 and 0.69 at 6 months. On the population, Hand-CTS was similarly more responsive.

Summary: We propose a method to make a disease-specific instrument based on region-specific instrument for wider targets. The development process appears to be applicable to other instruments, which may significantly ease the instrument creation.

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◆ Nothing of financial value to disclose

AM E-POSTER 77: Terrible Triad Injuries; Who Needs the Coronoid Fixed?

Category: Fractures and Dislocations

Keyword: Elbow

Level 4 Evidence

◆ Loukia K. Papatheodorou, MD

◆ James H. Rubright, MD

◆ Robert W. Weiser, MPAs,PA-C

● Dean G. Sotereanos, MD

Hypothesis: Elbow dislocation combined with fractures of both the radial head and the ulnar coronoid process (“terrible triad” (TT) injuries) are complex injuries with variable outcomes. We reviewed the results of 14 patients with TT injuries in which Regan-Morrey type I and type II coronoid process fractures were not repaired.

Methods: Fourteen patients (6 male and 8 female) with an acute TT injury were included in this study. Mean patient age was 52 years (range, 32- 58). The fourteen coronoid fractures included two Regan-Morrey type I fractures and twelve Regan-Morrey type II fractures. Associated radial head fractures were managed with ORIF in three patients, and with prosthetic radial head replacement in eleven patients. All patients were managed with anatomic repair of the lateral ulnar collateral ligament (LUCL) using suture anchors. Intraoperative clinical stability was restored in all patients without fixation of the small or highly comminuted coronoid fracture fragments. Prior to definitive closure, concentric reduction of the ulnohumeral joint was confirmed with fluoroscopic examination through a range of 20° to 130° of flexion-extension in all patients. No subluxation was noted. The elbow was immobilized in a long posterior splint and motion was initiated within one week in all patients with a hinged brace. At follow-up each patient was evaluated with physical and radiographic examination.

Results: The minimum follow-up was twenty-four months (range, 24-56 months). The mean arc of ulnohumeral motion was 122° (range, 75° to 140°) and mean forearm rotation was 135° (range, 40-170°). None of the patients demonstrated instability post-operatively. The average Broberg and Morrey score was 90 (range, 70 to 100) and the average of DASH score was 14 (range, 0 to 38). There were no complications at final follow-up. No patient developed clinically symptomatic heterotopic ossification. Radiographs revealed mild arthritic changes in one patient.

Summary: The primary goal of surgical fixation of TT injuries of the elbow is to restore stability sufficient to permit early motion. Our results suggest that TT injuries can be successfully managed without fixation of type I and II coronoid fractures in the setting of clinical intra-operative stability following surgical repair of the LUCL and repair or replacement of the

radial head. Based on our findings we challenge the accepted belief that the coronoid must be fixed in all TT patients.

References:

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- Royalties/Honoraria received from: Wright Medical
- Consulting Fees (e.g. advisory boards) received from: Arthrex, Integra, Zimmer, AxoGen
- ◆ Nothing of financial value to disclose

AM E-POSTER 78: Prospective Randomized Repair of the Pronator Quadratus Following Volar Plate Fixation of Distal Radius Fractures

Category: Fractures and Dislocations

Keyword: Wrist

Level 2 Evidence

◆ Rick Tosti, MD

◆ Asif Ilyas, MD

Hypothesis: Volar plate fixation of distal radius fractures is becoming more common. Application of the plate requires exposure and elevation of the pronator quadratus (PQ). Repair of the PQ following plate fixation has been purported to improve wrist motion, grip strength, and prevent against iatrogenic flexor tendon injury. To better understand the value of repairing the PQ a prospective randomized trial was undertaken with the null hypothesis being that repair of the PQ will result in no clinical difference.

Methods: From January 2011 to December 2011, all consecutive distal radius fractures treated operatively with a volar plate were randomized to either repair of the PQ or not, upon closure following fixation of the plate. Randomization was not blinded and based upon the patient's birth year. Surgical exposure, reduction, and the post-operative rehabilitation were identical in both groups. Clinical outcomes with a minimum follow-up of 12 months were compared between each group including motion; grip strength; DASH scores; and VAS scores.

Results: Sixty consecutive distal radius fractures were treated operatively with a locking volar plate. Two patients were lost to follow-up, and one was excluded for an ipsilateral elbow fracture-dislocation. Full follow up data was available for 33 patients in the PQ Repair group and 24 patients in the control group. The mean DASH score was 7.78 for the repair group and 4.86 for the control group ($p = 0.28$). VAS in the repair group averaged 0.35 in the repair group and 0.18 for the control group ($p = 0.37$). Range of motion assessed in flexion, extension, supination, pronation, radial deviation, and ulnar deviation was also not significantly different between groups. Additionally, no significant differences were found in any of the parameters at the 2,6, or 12-week intervals except a greater grip strength and flexion was observed in the repair group at 6 weeks. Reoperation was required in 4 patients in the repair group (3 carpal tunnel release, 1 removal of hardware for extensor tenosynovitis) and in 1 patient in the control group (1 removal of hardware for extensor tenosynovitis).

Summary:

- PQ repair was not found to significantly improve range of motion, grip strength, or DASH and VAS scores.
- The rate of reoperation between groups were not significantly different.

- We do not recommend routine repair of the PQ following volar plate fixation of distal radius fractures.

◆ Nothing of financial value to disclose

AM E-POSTER 79: Arthroscopically Assisted Screw Fixation of Nondisplaced Scaphoid Waist Fractures – A Randomized Study with 6 Years Follow up.

Category: Fractures and Dislocations

Keyword: Wrist

Level 2 Evidence

- ◆ Martin Clementson, MD
- ◆ Peter Jørgsholm, MD
- ◆ Jack Besjakov, MD, PhD
- ◆ Niels Thomsen, MD, PhD
- ◆ Anders Björkman, MD, PhD

Hypothesis: There are no differences in outcome between nondisplaced scaphoid waist fractures treated by arthroscopically assisted percutaneous screw fixation or conservative treatment in a cast.

Methods: Consecutive patients with nondisplaced scaphoid waist fractures were prospectively, randomized to either conservative or surgical treatment. All patients were screened using x-ray and MRI. Conservative treatment consisted of below elbow cast until signs of radiological healing. Surgical treatment consisted of wrist arthroscopy and percutaneous fracture fixation with a compression screw in proximal to distal direction. If complete (Geissler 4) scapholunate ligament rupture was encountered during arthroscopy percutaneous pinning of the scapholunar interval was performed. Patients were followed according to a study protocol with CT and clinical examination at defined intervals. Statistical chi-test, t-test and non-parametric (Mann-Whitney) test were used.

Results: 300 wrists in 296 patients (18 to 65 yr) were screened for scaphoid fracture. We identified 45 nondisplaced waist fractures of which 42 were included and followed until one year post-surgery. Of these, 39 patients were available for follow up after median 6 (4-8) years. 24 patients were treated conservatively in a cast (mean age 30yr, 4 female). 18 patients had arthroscopically guided screw fixation (mean age 37yr, 4 female). Four of these patients underwent additional K-wire pinning due to scapholunate instability.

There were no differences in healing time between the two groups (median 6 weeks) and all fractures healed. No clinically relevant differences in wrist range of motion or grip strength could be demonstrated at any time point. Also when the pinned patients were excluded from calculations, the results remained. At 6 yrs follow-up, positive Watson test was more frequent in the conservatively treated group (5/21) than for the surgically treated patients (2/18).

Radiological signs of osteoarthritis in the radio-scaphoid joint, (diminished joint space or

subcondral sclerosis), were more common in the surgically treated group (6/18) compared to the conservatively treated patients (2/21). Two patients had their fixation screw removed.

Summary:

- No difference regarding range of motion or grip strength between conservative and surgically treated patients.
- A higher frequency of clinically detectable SL instability was observed in the conservatively treated group indicating possible associated ligamentous injury.
- Radiological signs of osteoarthritis in the radio-scaphoid joint were more common in the surgically treated group.
- All scaphoid fractures healed and healing time was equal for both groups.

◆ Nothing of financial value to disclose

AM E-POSTER 80: MRI Findings in Acute Elbow Dislocation: Insight into Mechanism

Category: Fractures and Dislocations

Keyword: Elbow

Level 4 Evidence

◆ Joseph J. Schreiber, MD

◆ Russell F. Warren, MD

◆ Hollis G. Potter, MD

● Robert N. Hotchkiss, MD

◆ Aaron Daluiski, MD

Hypothesis: The disruptive forces and mechanism of elbow dislocation are not entirely understood. Both the sequence and location of ligament injury are still in question[1-3]. The purpose of this study was to identify the location of ligament injury - medial and/or lateral, and severity of ligament injury – partial or full; using MRI studies performed after acute elbow dislocation. Based on the observation that many elbow dislocations arise from an initial acute valgus load[3], we hypothesized that all patients would have a high-grade medial injury, but not all would demonstrate injury of the lateral ligament.

Methods: Patients with documented elbow dislocations were included in the study. Post-dislocation standardized elbow MRI images were scanned at a single MRI center. The medial and lateral collateral ligaments were subdivided into anterior and posterior (AMCL) and posterior (PMCL) bands of the anterior bundle[4], the lateral ulnar collateral ligament (LUCL) and the radial collateral ligament (RCL). Distinction was made between normal morphology and signal, low-grade partial tear (50%) and full thickness disruption. The site of disruption was also characterized. Chi-squared test assessed the association between location and severity and Fisher's exact test compared injury frequency across sites.

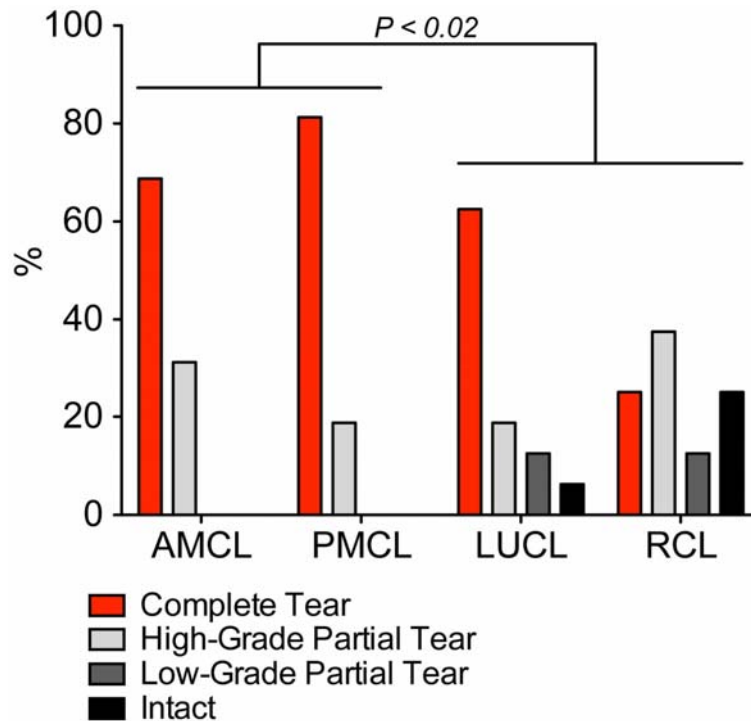
Results: Sixteen patients were included (mean 37.8 years) with an acute MRI evaluation (mean 16 days post-dislocation). On the medial side, there were no low-grade partial tears or intact evaluations of either the AMCL or PMCL, with the majority demonstrating complete tears (11/16, 13/16 respectively, $p < 0.001$) (Figure 1). On the lateral side, the LUCL most frequently showed complete disruption (10/16, $p < 0.006$), but was occasionally found to be either intact or with a low-grade partial tear. The RCL showed the most heterogeneity with complete disruption in only 4/16 studies. Complete tears involving the medial side (AMCL/PMCL) were more common ($p < 0.02$) than complete tears involving the lateral side (LUCL/RCL). Injury locations are summarized in Figure 2.

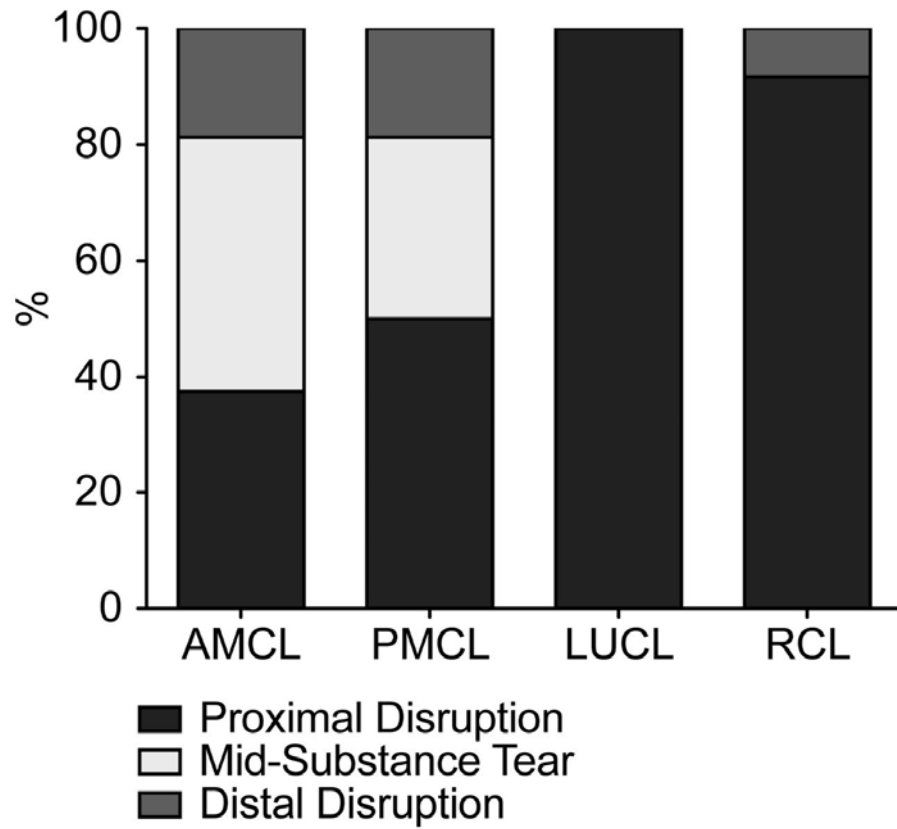
Summary:

- Complete ligamentous tears are more common on the medial side as compared to the lateral side of the elbow following dislocation.
- While no MRI studies showed an intact AMCL or PMCL, both the LUCL and the RCL were occasionally found to be intact following dislocation.
- These data support that complete ligamentous disruption of the lateral side is not always present.
- Information on elbow ligamentous injuries is important for directing post-dislocation rehabilitation, as various protocols and positions can selectively protect or stress different ligaments[5].

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- Contracted Research with: Auxilium
- ◆ Nothing of financial value to disclose

AM E-POSTER 81: Isometric Pronation and Supination Torque After Open Reduction and Internal Fixation of Distal Radius Fractures

Category: Fractures and Dislocations

Keyword: Wrist

Level 3 Evidence

◆ Jason Strelzow, MD

◆ Thomas J. Goetz, MD, FRCSC

◆ Henry M. Broekhuysen, MD, FRCSC

Hypothesis: The goals of this study were to establish the effect of ORIF using volar plating on isometric pronation and supination torque and to determine if values were influenced by secondary measurements of reduction and demographic variables. We hypothesized that post ORIF pronation torque would be diminished on the operative wrist compared to the contralateral side.

Methods: Data was collected prospectively using the Vancouver General Hospital (VGH) Trauma database. 104 patients were recruited with surgically treated distal radius fractures. Using a previously validated custom isometric torque measurement apparatus, maximal pronation and supination torque values were evaluated at pre-determined follow-up points and recorded along with patient demographics. Objective outcome measures included wrist ROM, radiographic measures of injury displacement, AO/ASIF fracture classification, as well as final reduction measurements. Subjective outcome measurements were collected using the DASH and SF-36 scores. Outcomes were recorded at baseline, three, six and twelve months following injury. Ethics Board approval was obtained.

Unpaired two-tailed Student's T tests with equal variance (alpha 0.05 with associated confidence intervals of 95%) were used to evaluate for a significant difference between maximal isometric supination and pronation torques on the injured and uninjured sides.

Results: Overall isometric pronation torque was significantly diminished at all testing points compared to the uninjured side (one year mean 0.55Nm persistent reduction std. 2.89). Isometric supination torque was also significantly diminished at all time points (one year mean 0.57Nm persistent reduction std. 3.03)

No relationship was found between pronation/supination torque deficit and clinical outcomes with the DASH, SF-36, ROM or radiological fracture outcomes.

Summary:

- Isometric pronation and supination torque are reduced after volar plate fixation of unstable distal radius fractures and do not recover at one year.

- No evidence demonstrating that volar approach with surgical release of the pronator quadratus had any increased effect on loss of pronation torque compared to supination torque.

References:

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	No.	%
TOTAL	92	
Males	23	25.00%
Females	69	75.00%
AGE		
Average Age	57.4	
Min-Max	18-92	
HAND DOMINANCE		
Right Dominance	82	89.13%
Left Dominance	10	10.87%
RADIOGRAPHIC VARIABLES		
Ulnar Styloid	42	45.65%
Ulnar Variance	0.69	±2.53
Radial Inclination	21.53	±4.78

Table 1. Patient demographics and radiographic findings at 12 months post open reduction internal fixation of distal radius fracture

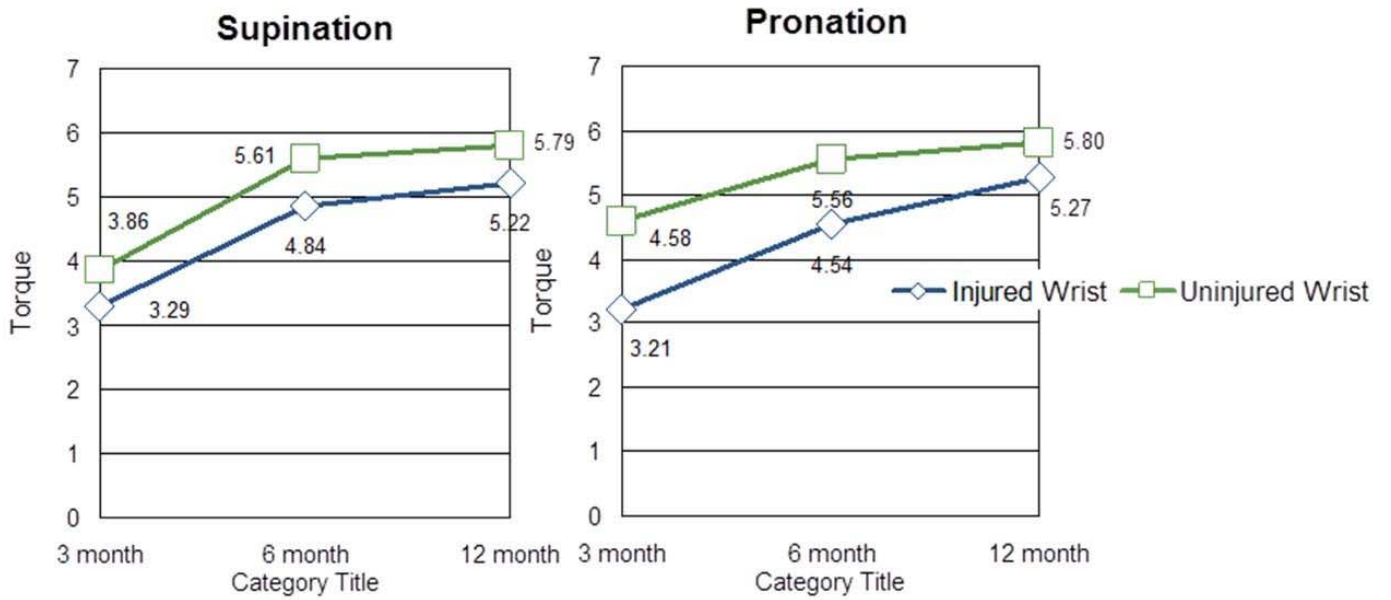


Figure 1. Comparison of mean values for isometric supination and pronation torque between the injured and uninjured wrists at 3 months, 6 months and 12 months.

◆ Nothing of financial value to disclose

AM E-POSTER 82: Range of Motion After Removal of Dorsal Spanning Plate Fixation of Distal Radius Fractures.

Category: Fractures and Dislocations

Keyword: Wrist

Level 4 Evidence

◆ Karim Bakri, MD

◆ Bret C. Peterson, MD

◆ Jerry I. Huang, MD

Hypothesis: Patients undergoing spanning internal fixation of the wrist for the treatment of distal radius fractures require prolonged rehabilitation and experience delayed recovery of wrist flexion/extension following plate removal.

Methods: After institutional review board approval, a retrospective chart review was undertaken to identify patients who underwent skeletal stabilization of a distal radius fracture with a 2.4/2.7 mm Synthes dorsal spanning bridge plate. The medical records were reviewed to obtain demographic data, time to plate removal, length of followup, number of hand therapy visits, and range of wrist motion at final followup.

Results: Of 132 consecutive patients who underwent bridge plate fixation, we identified 26 cases (18 male, 8 female) with well-documented followup greater than 3 months from the date of plate removal. Average time to plate removal was 14.4 weeks, and average followup of these patients was 8 months thereafter (11.3 months post injury). All patients underwent formal hand therapy, with an average of 22 visits. Final pain score was 2.1, and the average arc of motion at final followup was 50 degrees of wrist flexion, and 41 degrees of extension, with 81 degrees forearm pronation and 68 degrees supination.

Summary: Dorsal spanning plate fixation has been advocated for the treatment of comminuted distal radius fractures as well as distal radius fractures in multiply injured patients as it allows them the opportunity to actively participate in intensive rehabilitation of lower extremity, pelvic and spine injuries, often requiring them to weight bear through the injured upper extremity. Recovery of wrist motion has not previously been studied after spanning plate removal. The results of this retrospective chart review suggests that while the majority of patients regain a functional arc of motion after spanning plate removal, their range of flexion/extension is still significantly diminished at final followup despite extensive hand therapy.

◆ Nothing of financial value to disclose

AM E-POSTER 83: Factors Influencing Infection Rates after Open Fractures of the Diaphysis of the Radius and/or Ulna

Category: Fractures and Dislocations

Keyword: Forearm

Level 4 Evidence

- ◆ Justin Zumsteg, MD
- ◆ Cesar S. Molina, MD
- Donald H. Lee, MD
- ◆ Shannon Mathis, PhD
- ◆ Nicholas Pappas, MD

Hypothesis: The purpose of this study is to determine which factors influence the rates of infection following open fractures of the diaphysis of the radius and/or ulna. We hypothesize that earlier administration of antibiotics and earlier time to debridement will be associated with lower infection rates.

Methods: A CPT search for the period of January 1, 2005 to June 1, 2012 revealed 160 patients with open diaphyseal fractures of the radius and/or ulna. Of these patients, 107 had at least 6-month follow up and were included in this study. The following variables were examined for each patient: time from injury to antibiotic administration, time from injury to operative debridement, Gustilo-Anderson classification, type of antibiotic received, and host characteristics such as age, diabetes, and tobacco use. Outcome parameters included the presence of deep infection and fracture union. Statistical analysis was performed using Fisher's exact and chi-square tests.

Results: Based on the Gustilo-Anderson classification, 23 (21.5%) of the injuries were type 1, 22 (20.6%) were type 2, and 62 (57.9%) were type 3 injuries. The overall rate of deep infection was 5.6% (6/107) and the rate of non-union was 17.0% (16/94). No type 1 or 2 fractures (0/45) developed deep infection. In contrast, 9.7% (6/62) of type 3 injuries developed such infection. This demonstrated a trend towards a higher rate of deep infection in type 3 injuries than in type 1 or 2s combined ($p=0.08$). Similarly, the rate of non-union was higher among type 3s, with 22.4% (13/58) of type 3s progressing to non-union versus only 8.3% (3/36) of type 1s and 2s combined ($p=0.14$). 21 patients both received antibiotics in under 3 hours and underwent debridement in less than 6 hours from time of injury; however, they did not have a lower risk of either infection or non-union than those who either received antibiotics and/or debridement after those time frames.

Summary:

- Factors such as time to antibiotics and time to operative debridement did not predict the development of either deep infection or non-union in open diaphyseal fractures of the radius and/or ulna.
- Receiving antibiotics within 3 hours and undergoing operative debridement within 6 hours did not lower the rates of either deep infection or non-union.
- The “type” of fracture as outlined by the Gustilo-Anderson classification played the most substantial role in predicting both infection and non-union.

References:

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- Royalties/Honoraria received from: Biomet, Elsevier
- ◆ Nothing of financial value to disclose

AM E-POSTER 84: The Use of BMP-2 and Screw Exchange in the Treatment of Scaphoid Fracture Non-Union

Category: Fractures and Dislocations

Keyword: Wrist

Level 4 Evidence

◆ ▲ Robert Harold Alove, MD

Hypothesis: Persistent scaphoid non-union, particularly following internal fixation, is a vexing problem. We hypothesize that Bone Morphogenetic Protein-2 (BMP-2) increases the union rate in treatment of scaphoid non-unions that have failed initial open reduction and internal fixation.

Methods: A retrospective review was conducted analyzing the outcome of 4 patients who failed initial open reduction and internal fixation of scaphoid fractures. These patients were identified via a retrospective chart review of all patients surgically treated for scaphoid non-union who had failed initial open reduction and internal fixation treated by a single surgeon from 2003 to 2013. They represent the entire cohort treated with BMP-2. All patients were initially fixed with headless compression screws and had clear radiographic confirmation of non-union. Three fractures were located in the waist and the fourth in the proximal pole. After being informed and consented regarding the off-label use of BMP-2, all patients underwent screw exchange and BMP-2 sponge placement with a dose of 0.53 mg at the non-union site. There was no additional bone grafting. Patients were immobilized for four weeks and followed with serial radiographs in all cases and CT scans in 3 cases.

Results: All four patients demonstrated evidence of solid bony union at an average of 53 days from surgery and ultimately returned to pain-free full activity. There were no complications.

Summary:

- BMP-2 and screw exchange yielded a 100% union rate in patients with established scaphoid non-union.
- While this retrospective study represents a small number of patients and clearly requires further investigation, it presents a promising technique for managing a difficult clinical problem.

References:

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▲ This presentation will discuss Infuse by Medtronic

◆ Nothing of financial value to disclose

AM E-POSTER 85: The Incidence of Scapholunate and Lunotriquetral Ligament Tears in Distal Radius Fractures: The Effect of Wrist Position and Forearm Rotation During a Fall onto an Outstretched Hand

Category: Fractures and Dislocations

Keyword: Wrist

Not a clinical study

- Elizabeth A. Ouellette, MD, MBA
- ◆ Razvan Nicolescu, BS
- ◆ Check C. Kam, MD
- ◆ Prasad J. Sawardeker, MD
- ◆ Paul Clifford, MD
- ◆ Loren Latta, PhD

Hypothesis: Hand positions (neutral, ulnar or radial deviation) and forearm rotation (no rotation, internal or external) during a fall can influence whether a SL or LT tear occurs in association with a distal radius fracture.

Methods: Baseline fluoroscopic images, MRI scans, and DEXA bone mineral density measurements of the wrist were obtained for two sets of 24 fresh frozen cadaveric arms. All of the arms were transected 18 cm proximal to Lister's tubercle and then mounted at 80 degrees of wrist extension and full pronation. In the first set of 24 arms, eight were mounted perpendicular to the MTS table top, eight were radially deviated 10-15 degrees, and eight were ulnarly deviated 10-15 degrees. In the second set of 24 arms, twelve underwent 5 N-m of external forearm rotation, with six of the arms perpendicular to the MTS table top and the other six ulnarly deviated 10-15 degrees. The last twelve arms underwent 5 N-m of internal forearm rotation, with six of the arms perpendicular to the MTS table top and the other six radially deviated 10-15 degrees. The arms were then loaded on an MTS machine and axially displaced 2.5 cm at a compression rate of 5 cm/sec. Post injury fluoroscopic images and MRI scans of the wrist were obtained and analyzed.

Results: All arms sustained a distal radius fracture. Post-stress MRI revealed that 17 (35%) of the arms sustained a SL ligament tear, and 16 (33%) sustained a LT ligament tear. Of the 24 arms that did not undergo a rotational force, 5 (21%) sustained a SL or LT ligament tear. In contrast, of the 24 arms subjected to a rotational force, 18 (75%) were found to have either a SL or LT tear.

Summary:

- SL and LT ligament tears were associated with distal radius fractures in 75% of arms subjected to a rotational force.
 - SL and LT ligament tears were associated with distal radius fractures in only 21% of the arms with a static forearm displayed such an injury.
 - Hand position during a fall may influence the ligament tear distribution but further investigation with a greater number of specimens is needed to evaluate this.
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- Royalties/Honoraria received from: Auxillium
 - Consulting Fees (e.g. advisory boards) received from: Stryker, Synthes
 - ◆ Nothing of financial value to disclose

AM E-POSTER 86: Acute Proximal Pole Fractures of the Scaphoid Treated Non-Operatively

Category: Fractures and Dislocations

Keyword: Wrist

Not a clinical study

◆ Kristina H. Lutz, MD

◆ Nina Suh, MD

◆ Joy C. MacDermid, MSc, PhD

◆ Ruby Grewal, MD, MSc

Hypothesis: We hypothesize that by using serial computed tomography (CT) scans, we can more accurately predict the natural history of acute isolated proximal pole fractures treated non-operatively and identify risk factors which may lead to non-union and delayed union.

Methods: A radiology database at a tertiary care centre was used to identify all proximal pole scaphoid fractures between 2006 and 2012. Inclusion criteria included acute fractures with CT scans performed within 6 weeks of injury. Exclusion criteria included associated perilunate dislocations or scapholunate ligament injuries and fractures treated with acute surgical management. A retrospective chart review was performed collecting demographic, injury, and treatment characteristics. CT images were reviewed to assess for fracture orientation, displacement (translation between fragments and/or humpback deformity), comminution, cysts, and sclerosis. The association between imaging characteristics and risk of non-union was determined using odds ratios and time to union using a student's t-test.

Results: There were 40 patients identified with isolated acute proximal pole fractures treated non-operatively. Two patients were lost to follow-up, leaving 38 analyzable patients (mean age 27.3 years, 84.2% male). Based on initial CT scan, there were 9/38 (23.7%) displaced fractures, 7/38 (18.4%) comminuted fractures, 3/38 (7.9%) with sclerosis present, and 10/38 (26.3%) with cystic changes present. All 38 patients were treated non-operatively with a short arm thumb spica cast. The overall union rate of proximal pole fractures in this cohort was 84.2% (32/38, SD 0.37) and the mean overall time to union (defined as 50% union based on CT scan) was 14.1 weeks. Of the 6 fractures that were considered non-unions, one patient was non-compliant with casting and is awaiting further management, 1 patient declined further surgical intervention, and 4 patients healed successfully after ORIF with bone grafting. We were unable to identify any factors that increased the risk of non-union based on initial CT scan (see Table 1). However, presence of comminution and displacement were found to be significant factors contributing to delayed union (See Table 2).

Summary:

- In a cohort of isolated, acute proximal pole scaphoid fractures treated with casting, based on serial CT scans, we confirmed that the mean union time for casting was 14.1 weeks and the overall union rate was 84.2%. This is a much higher union rate than the previous literature reports.
- There were no radiographic characteristics identified that could be used to predict development of a non-union. However, comminuted and displaced fractures were found to significantly increase time to union.

References:

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Table 1. Union Rate based on Fracture Characteristics

Union Rate				
	Yes	No	Odds Ratio (95% CI interval)	p-value
Displacement	89% (8/9)	86% (24/28)	1.7 (0.2-16.5)	0.7
Comminution	86% (6/7)	84% (26/31)	1.2 (0.1-11.8)	0.9
Sclerosis	100% (3/3)	83% (29/35)	1.5 (0.07-33.6)	0.8
Cysts	80% (8/10)	86% (24/28)	0.7 (0.1-4.4)	0.7

Table 2. Fracture and Patient Characteristics and Time required to Achieve Union

Time to Union - Weeks (\pm SD)			
	Yes	No	p value
Displacement*	24.1 \pm 18.4	10.3 \pm 10.8	0.01
Comminution*	27.7 \pm 20.0	10.6 \pm 10.5	0.05
Sclerosis	16 \pm 7.6	13.6 \pm 14.7	0.8
Cysts	11.3 \pm 7.3	14.5 \pm 15.8	0.6

◆ Nothing of financial value to disclose

AM E-POSTER 87: Complication Rates in the Management of Distal Radius Fractures as a Function of Sub-Specialty Training

Category: Fractures and Dislocations

Keyword: Wrist

Level 4 Evidence

- ◆ Tobias Mann, MD, MSc
- ◆ Taylor Buckley, MD
- ◆ Peter M. Murray, MD
- ◆ Warren C. Hammert, MD
- ◆ John Elfar, MD

Hypothesis: Hand and trauma fellowship trained orthopaedic surgeons are confronted with complex distal radius fractures (DRF) often referred by other surgeons. We hypothesized that hand and trauma subspecialists would treat the most complex DRFs in greater number and that complication rates would reflect the complexity of this difference from non-hand or trauma surgeons.

Methods: We queried the American Board of Orthopaedic Surgery (ABOS) database for complication and case log information submitted for part II of the board examination. Queries for all codes involved with DRF management were combined with associated codes for complications. Data from surgeons with hand or trauma subspecialty trained surgeons were included in the same group and compared to those completing other fellowships and non-fellowship trained orthopaedists. Fisher's exact two-tailed test and the Chi-square two-tailed were used to determine if a statistical significant difference existed. All tests were performed after review with a statistician.

Results: From 2007–2011 there were 15433 DRFs treated by 2317 surgeons tested by the ABOS. Of these, 10975 underwent open treatment balanced with: 3617 extra-articular, 2881 simple-intra-articular and 4477 multifragmented intra-articular fractures. The total DRFs treated, per surgeon, for hand and trauma subspecialists was 11.85 vs. 4.83 for non-hand and trauma trained surgeons. For multifragmented intra-articular DRFs these numbers were 4.46 vs. 1.04 respectively. Orthopaedic hand and trauma surgeons treat a larger proportion of multifragmented intra-articular DRFs (44.9% vs. 35.8%, $p<0.0001$) than do non-hand or trauma surgeons. For the treatment of intra-articular DRFs, the operative complication rate is higher for hand and trauma fellowship trained surgeons. This was the only difference in complication rates, which was statistically significant. The difference in complication rates was most significant in multifragmented intra-articular fractures (12.8% vs. 10.6%, $p=0.0266$) and less significant in partial intra-articular (10.9% vs. 8.6%, $p=0.0449$).

Summary:

- On average, orthopaedic surgeons subspecializing in hand or trauma treat approximately 2.5 times as many DRFs as their non-hand or trauma subspecialized counterparts.
- Focusing on multifragmented intra-articular DRFs, orthopaedic hand and trauma surgeons treat over 4 times as many fractures as their non-hand or trauma subspecialized counterparts.
- Of the DRFs treated by orthopaedic hand and trauma surgeons, almost half (45%) are multifragmented intra-articular fractures.
- Despite greater experience and presumably more training, the reported complication rate for surgeons treating distal radius fractures is highest among hand and trauma subspecialists.
- The role of reporting of complications as opposed to systematic differences in complexity cannot be dissected in our analysis

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◆ Nothing of financial value to disclose

AM E-POSTER 88: When Do Distal Radius Fractures Most Likely Displace and When Do They Stop Moving: Long-Term Follow-Up of Closed Reduction and Casting

Category: Fractures and Dislocations

Keyword: Wrist

Level 4 Evidence

◆ Joey A LaMartina, MD

● Paul Tornetta, III, MD

◆ Andrew Jawa, MD

Hypothesis: The position of distal radius fractures treated nonoperatively in a cast continues to change over a longer time period than the duration of standard immobilization.

Methods: We prospectively screened 546 consecutive distal radius fractures. We excluded patients with $<10^\circ$ of dorsal tilt upon presentation leaving 275 fractures of which 168 were treated nonoperatively with closed reduction and casting. Patients were managed with short arm casts and seen every other week in the clinic by an attending orthopaedic trauma surgeon until 6 weeks and then at clinically appropriate times. Patients were recasted for any shift in fracture position or if the cast became loose. We excluded patients with less than 150 days of follow-up. Radial height and volar tilt were measured at presentation, post-reduction, and all subsequent follow-up visits. A PhD statistician performed a regression analysis to determine the best fit curve for 96 measurements for each parameter. Based on this function, we calculated the number of days when 50%, 75% and 95% of change occurred relative to one-year, when full healing is presumed. We also determined the percentage loss for each parameter at 6 weeks, when the cast is typically removed.

Results: Using regression analysis, we placed a best fit curve and determined the function for both radial height and volar tilt. Based on this function, we found a logarithmic curve in which 50% of the radial height is lost in approximately the first 19 days after reduction, 75% is lost in the first 82 days, and 95% is lost by day 278. Similarly, for volar tilt, 50% loss in reduction is seen in the first 18 days, 75% is lost in the first 81 days, and 95% is lost by day 263. Additionally, at 6 weeks, approximately 64% of both height and volar tilt are lost.

Summary:

- 50% of the primary reduction parameters of radial height and volar tilt are lost in approximately the first 3 weeks after reduction.
- 64% of the primary reduction parameters of radial height and volar tilt are lost by 6 weeks.
- Reduction continues to shift for nearly one year from treatment.

- Royalties/Honoraria received from: Smith & Nephew; Wolters Kluwer Health – Lippincott, Williams & Wilkins
- Other Financial/Material Support received from: Journal of Orthopaedic Trauma
- ◆ Nothing of financial value to disclose

AM E-POSTER 89: Open Fractures Of The Proximal Ulna Have Similar Injury Patterns And Outcomes As Closed Fractures

Category: Fractures and Dislocations

Keyword: Elbow

Level 3 Evidence

- ◆ Paul H. Yi, BA
- ◆ Sangmin Ryan Shin, MD
- ◆ Alexander Weening, MD
- Paul Tornetta, III, MD
- David C. Ring, MD, PhD
- ◆ Andrew Jawa, MD

Hypothesis: Although proximal ulna fractures are common, there is a paucity of evidence to guide management of open fractures of the proximal ulna. We hypothesized that 1) Open fractures have more complex injury patterns than closed fractures of the proximal ulna; 2) Most open fractures present as Gustilo and Anderson type I and II injuries; 3) Open fractures have higher overall complication rates; and 4) Immediate open reduction and internal fixation (ORIF) is a safe treatment option for open fractures of the proximal ulna.

Methods: Fifty-five consecutive adult open fractures of the proximal ulna treated between 2002 and 2010 at three level-1 trauma centers (8.1% incidence) were identified and compared in a retrospective case-control study to an age-, sex, and institution-matched group of 55 closed fractures to test the null hypothesis that open and closed fractures have similar injury patterns using McNemar's test. Secondary study questions addressed differences in final range-of-motion (ROM), union, and postoperative complication rates at an average follow-up of 10 months using McNemar's test and paired t-tests, as appropriate.

Results: The majority of open fractures of the proximal ulna were intra-articular injuries (45; 73.8%) with Gustilo-Anderson type I and II wounds (53; 86.7%). Though there were more anterior transolecranon dislocations in the open group (14.5% vs. 1.8%; $p < 0.001$) and more posterior Monteggia fractures in the closed group (36.4% vs. 10.9%; $p < 0.001$), the open injuries overall did not have more complex bony injury patterns. Final ROM was greater in the closed group (121 vs. 110 degrees, $p = 0.01$), but all of the fractures in both groups healed. There was no significant difference in the incidence of wound infections (14.6% vs. 12.7%, open and closed, respectively; $p = 0.76$) or secondary procedure rate (38.2% vs. 34.6%, open and closed, respectively; $p = 1$) even with immediate bony fixation.

Summary:

- Open fractures of the proximal ulna are more common than the literature suggests with fractures that are mostly intra-articular with mainly Gustilo-Anderson type I and type II injuries.
- Although the final ROM was slightly less for the open fractures, overall injury patterns, postoperative complications, and outcomes are similar for both groups.
- Immediate bony fixation in the open fractures did not lead to a higher incidence of wound infection.

References:

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- Royalties/Honoraria received from: Smith & Nephew; Wolters Kluwer Health - Lippincott Williams & Wilkins (Tornetta); AO North America, AO International, Wright Medical, Medartis (Ring)
- Other Financial/Material Support received from: Journal of Orthopaedic Trauma (Ring, Tornetta); Journal of Hand Surgery, Journal of Shoulder and Elbow Surgery (Ring)
- Contracted Research with: Skeletal Dynamics (Ring)
- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Illuminos (Ring)
- Consulting Fees (e.g. advisory boards) received from: Wright Medical, Skeletal Dynamics (Ring)
- ◆ Nothing of financial value to disclose

AM E-POSTER 90: Diabetes and Inpatient Status Increase Risk for Re-Admission After Open Reduction and Internal Fixation of Distal Radius Fractures

Category: Fractures and Dislocations

Keyword: Wrist

Level 3 Evidence

- ◆ Madeleine J. Gust, MD
- ◆ David W. Grant, MASC
- ◆ Alexei S. Mlodinow, BA
- ◆ Seokchun Lim, BSE
- ◆ John Y.S. Kim, MD

Hypothesis: The Affordable Care Act has provisions for penalizing hospitals and healthcare providers for re-admission. A paucity of data exists regarding re-admissions following fixation of distal radius fractures. We hypothesized that readmission after ORIF distal radius fractures is a rare phenomenon.

Methods: An analysis was performed of all open reduction internal fixations for distal radius fractures in the prospectively maintained National Surgical Quality Improvement Database (NSQIP) in the year 2011. Demographic, comorbidity and re-admission within 30-days data was collected. A binomial logistic regression analysis was used to determine which patient characteristics increased risk of unplanned readmission.

Results: A total of 829 cases meeting inclusion criteria were analyzed. There were 11 (1.3%) unplanned re-admissions. Initial in-patient status and a history of diabetes mellitus were found to be significant predictors of unplanned re-admission. In-patient status was found to have an odds ratio of 8.0 (95% CI 2.1-30.7), and a history of diabetes was found to have an odds ratio of 4.3 (95% CI 1.1-17).

Summary: This multi-institutional analysis of ORIF of distal radius fractures showed that unplanned re-admission was very rare. The few occurrences were associated with inpatient status and a history of diabetes. These findings will help guide surgeon and patient education and bolster the institutional perspective that these procedures can be efficaciously performed in an outpatient setting.

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◆ Nothing of financial value to disclose

AM E-POSTER 91: Dorsally Angulated Tension Failure Greenstick Fracture is Risk Factor for the Increase of Angulation in the Conservative Treatment of the Pediatric Distal Radius Fractures Without Manipulation

Category: Fractures and Dislocations

Keyword: Forearm

Level 4 Evidence

- ◆ Souichi Ohta, MD, PhD
- ◆ Ryosuke Kakinoki, MD, PhD
- ◆ Takashi Noguchi, MD
- ◆ Yukitoshi Kaizawa, MD
- ◆ Shuichi Matsuda, MD, PhD

Hypothesis: Distal third of the radius fractures in children are very frequent injuries. Because of the excellent remodeling potential, pediatric distal radial fracture with minimal angulation at initial consultation was often decided to be treated with a cast or splint without manipulation. Considering to the pain and the cost of sedation during manipulation, the reduction of the angulation within the limit of spontaneous correction is supposed to be unnecessary. However, the increase of angulation within the cast was infrequently seen during the first week post-injury. We retrospectively investigated the risk factor for the increase of angulation in the conservative treatment of pediatric distal radius fractures without manipulation.

Methods: From January 2005 to December 2009, we treated 97 children with distal radius fractures. 90 children were conservatively treated with a cast or splint and 81 were treated without manipulation at initial consultation. Within them, 6 children (4 males, 2 females; range 4-14y, mean 8.5y) got increase of angulation over 10 degrees within 1 week after initial consultation. The injuries occurred in the right (dominant) hand in 2 and in the left (nondominant) in 4.

Results: All cases were treated in an above-elbow cast with the elbow at 90 degrees and neutral forearm position. Four fractures were isolated fractures and 2 were with greenstick fractures of the distal ulna. Five cases were angled dorsally and 1 case was angled volarly. In all 5 dorsally angled cases, the fracture site was proximal end of distal metaphysis. Four of the dorsally angled 5 cases were tension failure greenstick fractures in which the dorsal cortex were plastically deformed and the volar cortex were completely separated. Volarly angled one was complete fracture with dorsal displacement. In 2 of dorsally angled cases, the angulation increased more than 25 degrees and manipulation was performed two weeks after the initial consultation.

Summary: Dorsally angulated tension failure greenstick fractures tend to be more unstable than its initial impression from plain X-ray. Even if the angulation was minimal at initial consultation, special attention would be needed in the treatment of this type of fractures without manipulation.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 92: The Effect of Osteoporosis on Outcomes of Distal Radius Fractures Treated with Volar Locking Plate

Category: Fractures and Dislocations

Keyword: Wrist

Level 3 Evidence

◆ Kwang-Hyun Lee, MD

◆ Chang-Hun Lee, MD

◆ Hyun-Soo Park, MD

◆ Il-Hoon Sung, MD

◆ Wan-Sun Choi, MD

Hypothesis: Previous studies showed adverse effect of osteoporosis even after plate fixation for the fracture of distal radius. However, locking plate has improved fixation strength in osteoporotic fractures. This prospective cohort study was undertaken to explore the hypothesis that osteoporosis does not have a negative effect on the radiologic and functional outcomes in patients with distal radius fracture treated with volar locking plate.

Methods: A total of 94 consecutive patients who were female with age of 50 years or older and were treated by volar locking plate fixation for the fracture of the distal radius were enrolled. Bone mineral density was checked in the proximal femur and lumbar spine using DEXA. The cohort of 94 patients was classified into osteoporosis group (T-score ≤ -2.5) or non-osteoporosis group (T-score > -2.5). Volar tilt, radial inclination, and ulnar variance were measured after the index operation and at last follow up. DASH and Mayo wrist score were assessed at last follow up to address the functional outcome. The two cohorts were analyzed for difference of each parameter using Wilcoxon rank sum test, Chi-square test and Fisher's exact test. Logistic regression analysis was used to identify factors related to poor functional outcome. Pearson correlation coefficient was calculated to address the relationship between bone mineral density and final outcome.

Results: Osteoporosis was founded in 44 patients and mean T-score was -3.0. Non-osteoporosis group was consisted of 50 patients with mean T-score of -1.6. Dominant hand, AO classification, radiologic parameters (volar tilt, radial inclination, and ulnar variance), DASH score and Mayo wrist score were not differed significantly between two groups. Logistic regression analyses showed that any factors involving T-score were not significantly related to functional outcome. Pearson correlation analysis could not find a relationship between bone mineral density and the outcome.

Summary: In our study, osteoporosis does not have any adverse effect on radiologic and functional outcomes after volar locking plate fixation for the fracture of distal radius.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 93: Modified Pull-In Suture in Mallet Finger (Technical Note)

Category: Fractures and Dislocations

Keyword: Hand

Level 4 Evidence

◆ Jin-Rok Oh, MD, PhD

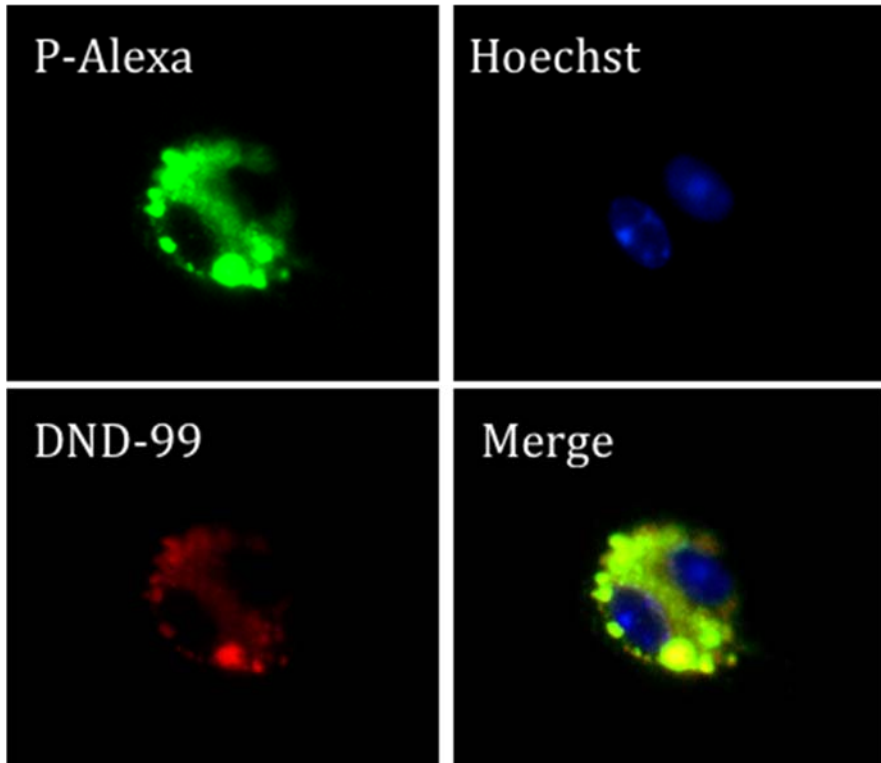
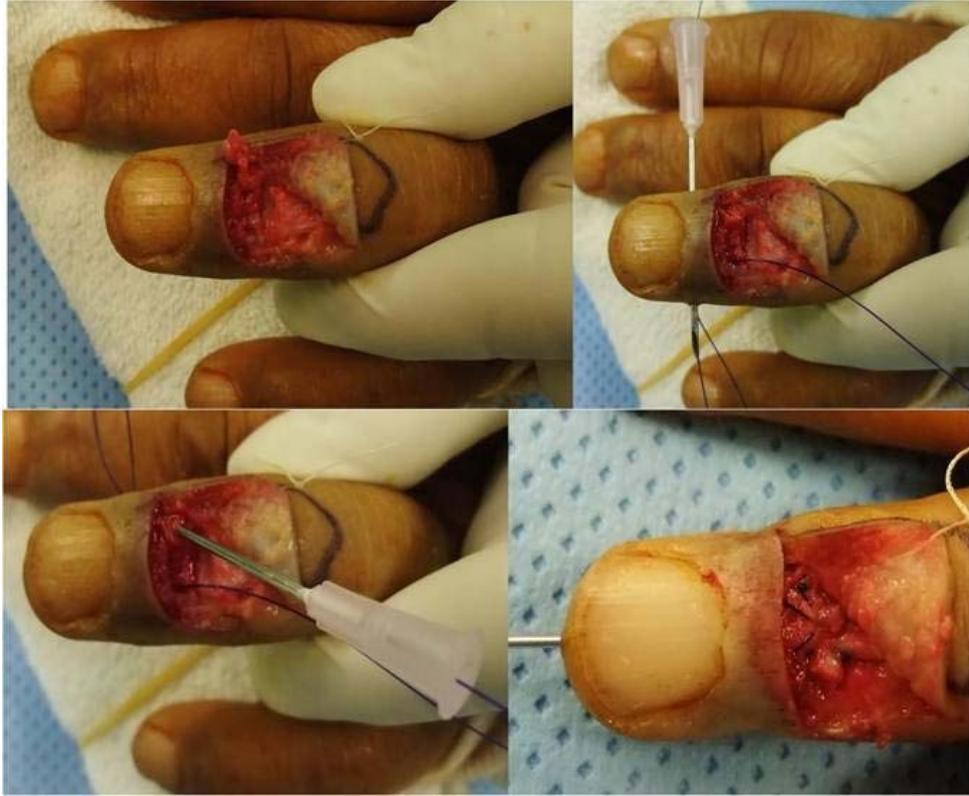
◆ Sung-Min Kwon, MD

Hypothesis: For treating mallet finger surgically, Pull-out suture may cause complications. Here, the authors introduce a new technique called modified pull-in suture for treating mallet finger.

Methods: Modified pull-in suture and Kirschner wire fixation was performed to 17 patients who had been admitted to Wonju Christian Hospital from March, 2008 to February, 2011. Those with closed bony mallet finger that closed reduction cannot be achieved, bony mallet with minute bony fragment, and open or closed tendinous mallet finger were selected for the procedure. In a total of 17 cases, 12 cases were male, and 5 were female. Age distribution was from 16 to 60 years old. Direct injury was 6 cases, and indirect injury was found in 11 cases. Time taken from injury to surgery was 6.5 days on average. (1 to 14 day) All had follow-ups at every 2 weeks postoperatively. Open reduction was first performed, and suture was begun at proximal part of ruptured extensor tendon. The suture was circled around distal phalanx using 18 gauge needle to complete the repair. Finally, K-wire was used to fixate distal interphalangeal joint (picture 1). Immediately after the surgery, active ROM exercise was initiated to proximal interphalangeal and metacarpophalangeal joints. K-wire was removed 6 weeks after the surgery, and active ROM exercise was also initiated to distal phalangeal joint. After 1 week, the exercise continued without any limitation, and evaluation was made by measuring joint range with goniometer, radiologic result, and patient satisfaction.

Result: Mean follow-up time was 25 weeks. (8 to 42 week). All 17 patients returned to their daily activities. Mean distal phalangeal extension angle was 4 degrees (0 to 8 degree), and mean distal phalangeal flexion angle was 75 degrees (57 to 90 degree). Crawford's evaluation criteria yielded 12 excellent, 4 good, and 1 fair satisfaction results.

Summary: Modified pull-in suture does not cause skin necrosis or ulceration and require any special modalities such as mini screw, mini external fixator or mini bone anchor system. Also the surgery is performed under direct view, not requiring C-arm. Although this method requires delicate technique, modified pull-in suture technique with its more successful result and higher patient satisfaction is considered an effective method to treat mallet finger



◆ Nothing of financial value to disclose

AM E-POSTER 94: Reconstruction of Severe Cartilage Defect After Intra-Articular Fracture of the Distal Radius with the Pedicle Pisiform Transfer

Category: Fractures and Dislocations

Keyword: Wrist

Level 4 Evidence

- ◆ Hisao Ishii, MD
- ◆ Masahiro Tatebe, MD
- ◆ Michiro Yamamoto, MD
- ◆ Takaaki Shinohara, MD
- ◆ Hitoshi Hirata, MD

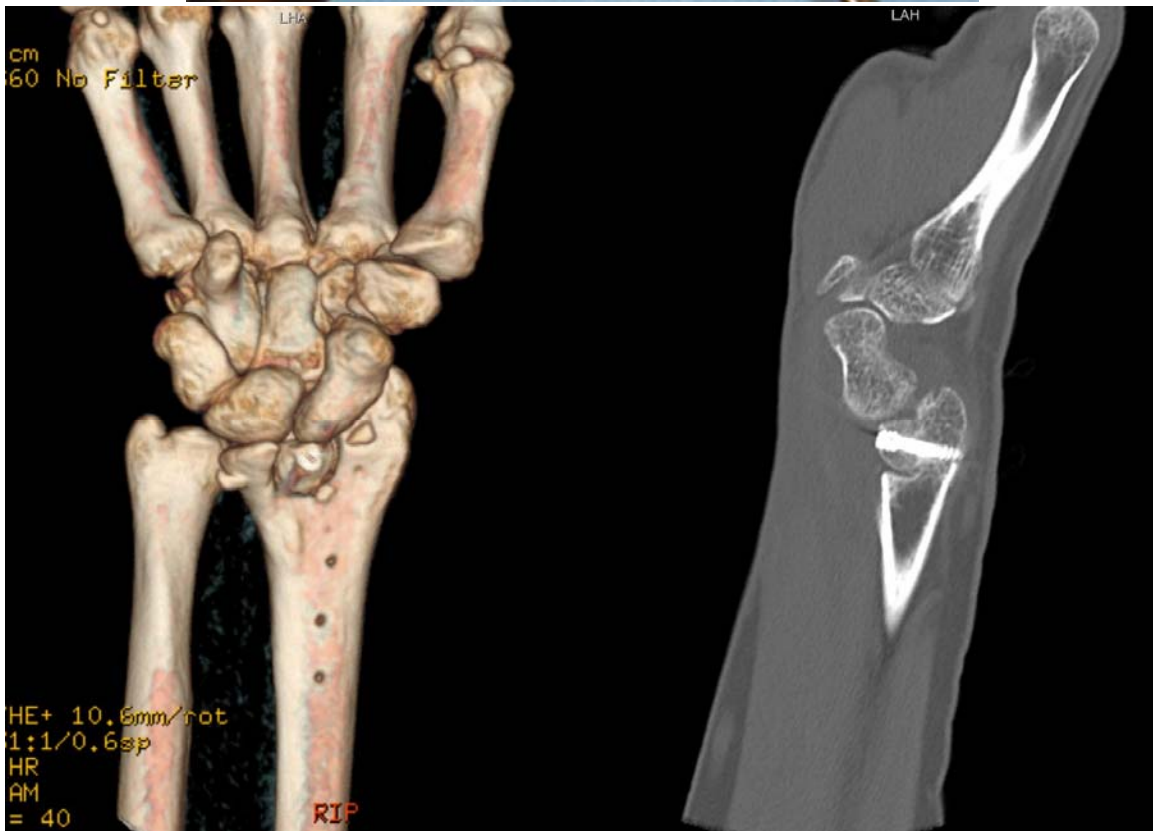
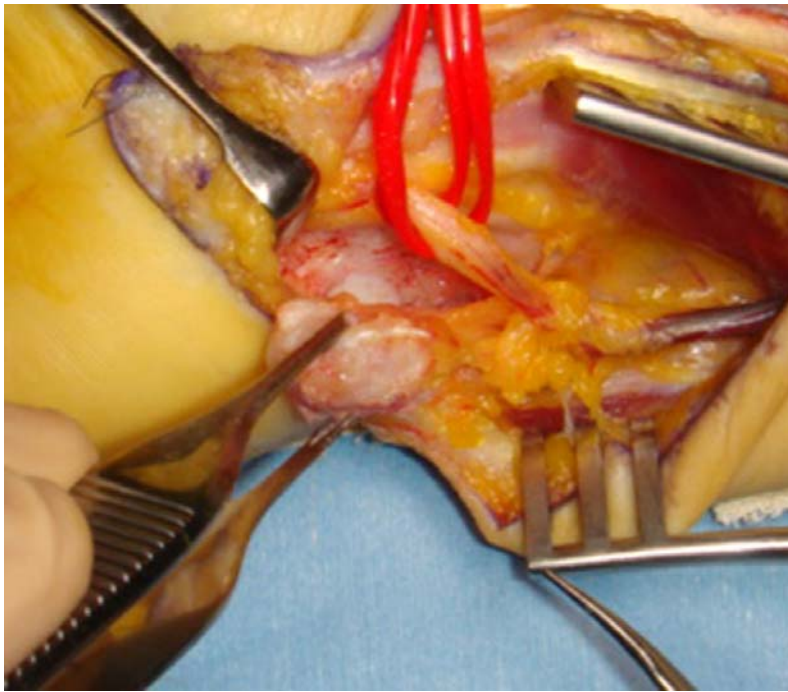
Hypothesis: Severe articular cartilage defect in the distal radius poses a significant challenge to hand surgeons. For prevention of secondary degenerative arthritis, restoration of articular surface is preferable. Pedicle pisiform transfer has several advantages; easily accessed through the volar incision, easy to raise due to its discrete supplying vasculatures, expendable source of osteochondral graft, has long reach especially on the extended pedicle, etc. It has been reported as a useful treatment option for Kienböck disease. Although the relatively small cartilage area is a disadvantage, we hypothesized that it can be a promising reconstructive procedure for partial articular cartilage defect in the radius.

Methods: We performed 2 vascularized pisiform transfers for severe cartilage defect after intra-articular distal radius fracture.

Surgical procedure is as follows: A longitudinal palmar incision was made along the flexor carpi ulnaris (FCU) tendon to the wrist crease and extended distally in a zigzag fashion. Comminuted fragments of the lunate fossa were resected. Pisiform is supplied by two independent vessels; radial branches and dorsal vessels from the ulnar artery. Therefore, there are several options for pedicle selections. We raised pisiform on the dorsal branches in both cases. The pisiform was freed from its muscular attachments, pisohamate ligament and the FCU while preserving the ulnar loose connective tissue. The vessels were passed behind the FCU and were freed up to the ulnar artery. The pedicle obtained was 4cm or longer. The pisiform was inserted into the defect with its cartilage surface directly opposing the lunate. In one case, the minimum Darrach procedure was added to increase forearm rotation. The pisiform was fixed with K wire and a cannulated double barrel screw.

Results: Follow-up 3DCT shows good restoration of radiolunate articulation and solid bony union.

Summary: Vascularized pisiform transfer could be one of the treatment options for restoration of articular cartilage after severe intra-articular distal radius fracture.



◆ Nothing of financial value to disclose

AM E-POSTER 95: Does Low Bone Mineral Density Increase the Risk of Distal Radius Fracture Malunion?

Category: Fractures and Dislocations

Keyword: Wrist

Level 2 Evidence

◆ Isam Atroshi, MD, PhD

◆ Elisabeth Brogren, MD

◆ Michael Petranek, MD

Hypothesis: Osteoporosis is a strong predictor of distal radius fracture. We hypothesized that osteoporosis is also associated with increased risk of fracture malunion.

Methods: Patients older than 40 years with distal radius fracture treated with cast or closed reduction and cast attended a 1-year follow-up examination; 130 patients (84% women) participated (Table). Calcaneal bone mineral density (BMD) was measured with a DXA heel scanner and T-scores were estimated (osteopenia defined as T-score -1.0 – -2.5 and osteoporosis as T-score ≤ -2.5 and ulnar variance ≤ 3 mm) and the T-scores compared.

Results: Of the 130 patients, 14 had normal BMD, 71 had osteopenia and 45 had osteoporosis. BMD correlated significantly with the change in volar tilt ($r=0.26$, $p=0.003$) but not ulnar variance ($r=0.15$, $p=0.11$). Patients with osteopenia or osteoporosis had significantly greater worsening in volar tilt than patients with normal BMD; adjusted mean difference -5.5 (95% CI -9.6 – -1.4 , $p=0.009$) and -5.6 (95% CI -9.5 – -1.6 , $p=0.006$), respectively. The mean difference in change in ulnar variance between osteopenia and normal BMD was 0.65 (95% CI -0.61 – 1.9 , $p=0.31$) and between osteoporosis and normal BMD was 0.67 (95% CI -0.67 – 2.0 , $p=0.32$). No significant differences were found between osteopenic and osteoporotic patients. The mean T-score for patients with ≤ -2.5 worsening ($n=41$) was -2.5 (SD 0.6) ($p \leq 3$ mm worsening ($n=41$) was -2.2 (SD 1.0) ($p=0.42$).

Summary:

- In patients with distal radius fracture treated with cast or closed reduction and cast osteopenia and osteoporosis were associated with significantly higher risk of worsening volar tilt after treatment but no difference with normal BMD regarding ulnar variance worsening.
- Because the majority of radius fracture patients are osteopenic or osteoporotic and these two groups did not differ regarding effect of low BMD on risk of fracture malunion, the value of BMD measurement in deciding treatment or predicting prognosis is limited.

Table. Patient characteristics

	Study patients N=130	Excluded patients [*] N=7
Age (yrs)	66 (11)	73 (9)
BMD (g/cm ²)	0.35 (0.08)	0.30 (0.06)
T-score	-2.1 (0.9)	-2.6 (0.8) [†]
Volar tilt (degrees) at baseline [‡]	0.4 (9.5)	-
Volar tilt (degrees) at 1 year	-5.9 (10.4)	-
Ulnar variance (mm) at baseline [‡]	0.6 (1.9)	-
Ulnar variance (mm) at 1 year	2.4 (2.9)	-

Values are mean (SD)

^{*} Initially treated with closed reduction and cast but after re-evaluation 7-10 days after fracture were operated on with external fixation because of fracture redisplacement.

[†] 4 patients had osteoporosis and 3 had osteopenia

[‡] Initial radiographs (patients treated with cast only) or post-reduction radiographs (patients treated with closed reduction and cast). Four patients had missing data for baseline ulnar variance.

◆ Nothing of financial value to disclose

AM E-POSTER 96: Dubberley Type 3 Capitellar and Trochlear Coronal Fractures

Category: Fractures and Dislocations

Keyword: Elbow

Level 4 Evidence

- ◆ Gerardo L. Gallucci, MD
- ◆ Jorge Boretto, MD
- ◆ Verónica A. Alfie, MD
- ◆ Ruben E. Paoletta, MD
- ◆ Jose I. Albergo, MD
- ◆ Pablo De Carli, MD

Hypothesis: Capitellar and trochlear are uncommon fractures of the distal part of the humerus. Dubberley described a classification for these fractures and the type 3 consisted on a coronal shear capitellar and trochlea fractures with separated fragments. The objective of this paper is to retrospectively evaluate the functional outcomes of patients who were treated with open reduction and internal fixation in Type 3 Dubberley's fracture

Methods: Twelve type 3 fractures were included in this study. The average age was 57 years old. Eleven patients were women. Nine patients had a type 3A and 3 a type 3B fracture. Associated lesions were present in 8 patients and included: 2 humeral shaft fractures, 7 epicondilar fractures and one olecranon fracture. All such lesions were treated at the same time. Lateral approach was used in 6 cases, posterior in 4 and a combined lateral and medial approach was used in 2 cases. All capitellar and trochlea fractures were treated with screws and pins. The use of a plate was not necessary in any of the cases. Average follow-up was 26 months. Table 1 Patient outcomes were assessed with physical and radiographic examinations, range-of-motion measurements, strength testing, and self-reported questionnaires (Mayo Elbow Performance Index, Short Form-36, and DASH score).

Results: Ten out of 12 patients had a complete healing of the fracture. The average flexo-extension was 125-26° and the average pronosupination was 78-76°. The average arc of motion was 100°. The grip strength was 85% of the contralateral side. Pain was 1. The DASH score was 15 and the SF-36 was 77. According to the Mayo Elbow Performance Index, 5 outcomes were excellent, 5 good and 2 fair. Six patients required reoperations: 3 needed implant removals, one evidenced a condylar nonunion, one developed a ulnar neuropathy and finally one of the patients with a not healing of a comminuted fracture required conversion to a total elbow arthroplasty. (Table 2)

Summary: Type 3 Dubberley capitellar and trochlear fractures are uncommon. Although these fractures create entirely articular fragments with little or no soft-tissue attachments, problems with fracture-healing and osteonecrosis were very uncommon in our series. Open reduction and internal fixation can offer good results, although a high number of complications may appear.

References:

1. Bryan RS, Morrey BF. Fractures of the distal humerus. In Morrey BF, editor. The elbow and its disorders. Philadelphia: WB Saunders; 1985. p:325-33.
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3. Ghawabi MH. Fracture of the medial condyle of the humerus. J Bone Joint Surg Am 1975;57:677-80.
4. Ring D, Jupiter JB, Gulotta L. Articular fractures of the distal part of the humerus. J Bone Joint Surg Am 2003;85:232-8.

Table 1

Nº	Age	Sex	Dubberley Type	<u>Associated Lesions</u>	Approach	Treatment of <u>associated lesion</u>	F up (months)
1	56	F	3 A	No	Posterior	No	74
2	62	F	3 A	No	Lateral	No	13
3	57	F	3 A	Olecranon + <u>humerus shaft fracture</u>	Posterior	<u>Tension band + Endomedular nail</u>	12
4	71	F	3 A	<u>Epicondilar + humerus shaft fracture</u>	Posterior	<u>Tension Band + Endomedular nail</u>	48
5	50	F	3 A	<u>Epicondilar fracture</u>	<u>Posteror</u>	ORIF	79
6	27	M	3B	No	Lateral	No	16
7	59	F	3B	No	Lateral	No	15
8	71	F	3 A	<u>Epicondilar fracture</u>	Lateral	<u>Tension Band</u>	10
9	48	F	3 A	<u>Epicondilar fracture</u>	Lateral	ORIF	7
10	62	F	3 A	<u>Epicondilar fracture</u>	Lateral	ORIF	11
11	54	F	3 A	<u>Epicondilar fracture</u>	<u>Lat/medial</u>	ORIF	13
12	73	F	3B	<u>Epincodilar fracture</u>	<u>Lat/medial</u>	ORIF	9

Table 2

Nº	<u>Motion</u>				<u>Grip</u>		<u>Complication</u>	EVA	DASH	SF 36	<u>Mayo Clinic</u>
	<u>Flex°</u>	<u>Ext°</u>	<u>Pro°</u>	<u>Sup°</u>	<u>Injured</u>	Contra lateral					
1	125	45	70	70	32	30	<u>Ulnar neuropathy</u> <u>remove implant</u>	0	7	70	<u>Good</u>
2	140	15	90	90	20	20	<u>remove implant</u>	0	9	81	<u>Excellent</u>
3	130	25	70	80	20	22	<u>remove implant</u>	1	14	81	<u>Good</u>
4	130	20	80	80	18	20	No	0	2	---- --	<u>Excellent</u>
5	125	25	90	90	8	14	<u>condillar nonunion</u>	0	3	77	<u>Excellent</u>
6	120	30	90	70	41	45	No	2	4	85	<u>Good</u>
7	120	30	90	70	15	25	No	3	32	76	Regular
8	130	30	90	70	16	17	No	0	1	80	<u>Excellent</u>
9	130	20	90	90	23	25	No	0	12	80	<u>Excellent</u>
10	125	15	70	60	11	14	-	2	18	85	<u>Good</u>
11	125	20	60	80	15	14	<u>remove implant</u>	1	21	80	<u>Good</u>
12	100	40	50	60	3	5	Converse TEA	7	56	54	Poor

◆ Nothing of financial value to disclose

AM E-POSTER 97: Prospective Comparative Study Between Volar Locking Plate and Intramedullary Nail for Unstable Distal Radius Fractures

Category: Fractures and Dislocations

Keyword: Wrist

Level 3 Evidence

◆ Ryotaro Fujitani, MD

◆ Shohei Omokawa, MD

◆ Yoshinobu Uchihara, MD

◆ Yasuhito Tanaka, MD

Hypothesis: The purpose of this comparative study was to investigate whether intramedullary nail (IMN) or volar locking plating (VLP) allows for good clinical and radiological results for unstable extra-articular distal radius fractures. We hypothesized the patients using volar locking plate may have better functional outcome due to satisfactory anatomical restoration for unstable distal radius fractures.

Methods: Inclusion criteria were unstable Type A3 and C1 fractures according to AO/ASIF system. Since 2005 to 2007, 47 consecutive wrists were treated with VLP. Since 2008 to 2010, 16 consecutive wrists were treated with IMN. The wrists treated with the 47 VLP wrists were matched to 16 IMN wrists on the basis of gender, age, mechanism of injury and type of fracture. Functional outcomes of the both groups, including the Disabilities of the Arm, Shoulder, and Hand (DASH), the range of flexion-extension motion (ROM) of the wrist, and grip strength, were evaluated at 3, 6, and 12 months postoperatively. Radiographic outcomes including the ulnar variance (UV), radial inclination (RI), volar tilt (VT) and the correction loss in UV, RI and VT, during the postoperative course until bone union, were evaluated when the bone union was achieved. These outcome measures were compared between the patients with the VLP and the IMN fixation. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS). A p value of <0.05 was considered significant.

Results: There were no significant differences between these two matched cohorts with respect to gender, age, mechanism of injury and type of fracture. The overall postoperative correction loss in UV postoperatively was 0.4mm in the patients with VLP group, and 1.1mm in the patients with IMN group, and these differences was statistically significant. There were no significant differences in the other radiological parameters between the two groups.

At 3 months postoperatively, the average DASH score (VLP:48 and IMN:32), the average %grip strength (VLP:53% and IMN:65%) and the ROM (VLP:69% and IMN 88%) were significant differences between the two groups ($p=0.04$ each). At 6 and 12 months postoperatively, there was no significant difference between the two groups regarding the DASH, the grip strength, and the ROM, respectively.

Summary:

- The current results indicate that both procedures are highly effective in maintaining fracture reductions, except postoperative UV, which was better in the VLP group than the IMN group.
- The IMN fixation may provide earlier recovery of the wrist and upper extremity function in the early postoperative period.

References:

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2. Nishiwaki M, Tazaki K, Shimizu H, Ilyas AM. Prospective study of distal radial fractures treated with an intramedullary nail. J Bone Joint Surg 2011; 93A:1436-1441.
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Table 1 Summary of Patient Characteristics and Radiographic outcome

		VLP(n=16)	IMN (n=16)	p-value
Age(years)		64 (59-88)	73 (55-84)	
Gender		F15:M1	F16	
Mechanism of injury		High:6 Low:10	High:6 Low:10	
AO classification		A3: 10 C1: 6	A3: 12 C1: 4	
Postoperative	UV	0.12	-0.35	0.64
	RI	19	23	0.11
	VT	8.7	5.3	0.2
Correction loss in	UV	0.4	1.1	0.02 *
	RI	0	2	0.07
	VT	1.5	2.3	0.45

Abbreviations

Correction loss in UV, RI and VT: the amount of change in UV, RI and VT postoperatively

* : statistically significant

Table 2 Comparison of Functional outcomes between VLP and IMN

	VLP	IMN	p-value
% ROM			
3months	69	88	0.04 *
6months	78	87	0.45
12months	95	98	0.16
% GS			
3months	53	65	0.04*
6months	73	80	0.07
12months	85	88	0.35
DASH			
3months	48	32	0.04 *
6months	20	18	0.18
12months	14	8	0.36

Abbreviations %ROM: % Flexion+% Extension

%ROM, %GS: Percentage of one of the injured wrist compared to the contralateral wrist

* : statistically significant

◆ Nothing of financial value to disclose

AM E-POSTER 98: Inpatient Status and Ethnicity: Risk Factors for Surgical Complications Following Open Reduction Internal Fixation of Distal Radius Fractures

Category: Fractures and Dislocations

Keyword: Wrist

Level 4 Evidence

- ◆ Madeleine J. Gust, MD
- ◆ David W. Grant, MASc
- ◆ Alexei S. Mlodinow, BA
- ◆ Seokchun Lim, BSE
- ◆ John Y.S. Kim, MD

Hypothesis: We hypothesized that surgical complications after open reduction and internal fixation (ORIF) of distal radius fractures (DRF) were rare.

Methods: A retrospective analysis was performed of all ORIFs for distal radius fractures in the National Surgical Quality Improvement Database (NSQIP) from 2005-2011. Demographic and comorbidity data was collected. Variables tracked included ethnicity, gender, inpatient versus outpatient status, current wound infections and systemic inflammatory response syndrome criteria, and a variety of comorbid conditions. A binomial logistic regression analysis was used to determine which patient characteristics increased risk for these surgical complications: superficial surgical site infection (SSI), deep SSI, organ-space SSI, wound dehiscence, and return to the operating room.

Results: A total of 1,923 cases met inclusion criteria. There were 29 surgical complications (1.5%). 76% of DRFs were managed in outpatient settings. Initial in-patient status was found to be a significant predictor of surgical complications with an odds ratio of 3.5 (95% CI 1.5-8.1). African American ethnicity was also found to be a significant predictor of surgical complications. The odds ratio for African American ethnicity was 5.0 (95% CI 1.5-16.3). A history of smoking, ethanol use, steroid use, diabetes, pulmonary disease, or cardiovascular disease did not show an increased risk of surgical complications.

Summary: This multi-institutional study shows that surgical complications after ORIF of distal radius fractures are rare. We found that inpatient status and African American ethnicity significantly increased the risk of complications.

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◆ Nothing of financial value to disclose

AM E-POSTER 99: The Post-Traumatic Stiffness of the Wrist Following Intra-Articular Distal Radius Fractures : Correlation With Decreased Carpal Motion

Category: Fractures and Dislocations

Keyword: Wrist

Level 4 Evidence

- ◆ Yoshihiro Dohi, PhD
- ◆ Kenji Kasubuchi, OT
- ◆ Hiroshi Ono, MD
- ◆ Shohei Omokawa, MD, PhD
- ◆ Yasuhito Tanaka, MD, PhD

Hypothesis: Intra-articular distal radius fractures often cause posttraumatic contracture of the radiocarpal joint¹). The radiocarpal joint moves simultaneously during wrist flexion-extension motion²), and the midcarpal joint moves isolatedly during the dart-throwing motion³). So we hypothesized that goniometric measurements of the flexion-extension and dart-throwing motion in the posttraumatic stiff wrist would predict contracture at radiocarpal or midcarpal joint.

Methods: Twenty cases of the intra-articular distal radius fractures treated with a volar locking plate were prospectively enrolled in this study. The patients included six men and 14 women with an average age of 61 years old (ranged from 37 to 78). Two patients had AO type B fracture, and 18 had AO type C fracture. The dart-throwing motion (DTM) was defined as a movement from radiodorsal to ulnopalmar and oblique to the sagittal plane,^{2),3}) and the arc of the DTM plane was measured using a custom-made goniometer (figure1) at 1, 3, 6 and 12 postoperative months. The flexion-extension motion (FEM) was measured with a standard goniometer as well. At each visit, the radiolunate angle (RLA) and capitulate angle (CLA) were measured in the lateral view radiographs during maximum wrist extension and flexion, and dynamic changes of these parameters were calculated. All the parameters of percent range of motion were calculated by using the contralateral wrist. One-way analysis of variance (ANOVA) and post hoc Bonferroni correction were used to demonstrate significant differences between each measurement during the postoperative course (SPSS, version12). The correlations between each of the goniometric parameters and each of the radiographic parameters were analyzed by Pearson's correlation. The contributions of each of the radiographic parameters with respect to a goniometric parameter were analyzed by partial regression coefficient in a multiple regression model.

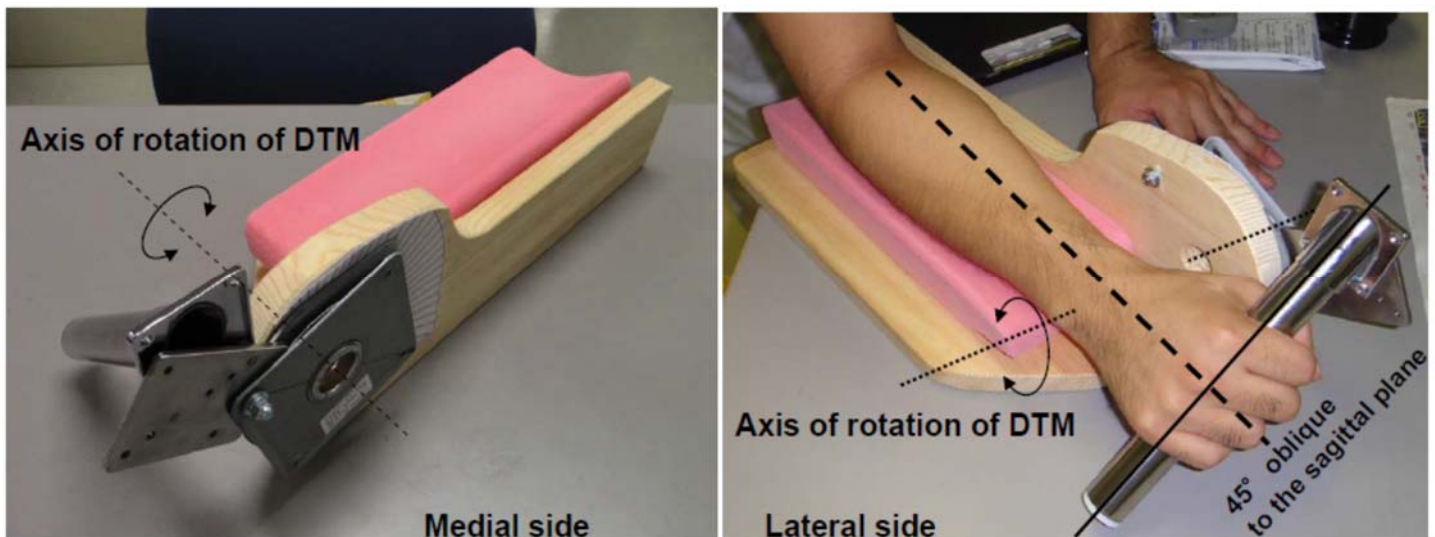
Results: The arcs of the DTM after 3 postoperative months, the arcs of the FEM after 6 postoperative months, and the arc of the CLA at 12 postoperative months were significant

increasing than that at 1 month (figure 2). The arc of FEM was correlated with that of RLM and CLM ($r=-0.52$, $p<0.001$; $r=0.36$, $p=0.28$, respectively). The partial regression coefficient of RLM and CLM with respect to EFM were 0.49 ($p<0.01$) and 0.19 ($p=0.01$), respectively.

Summary: The DTM recovered in the early period but the FEM was recovered later than the DTM. The RLA was not recovered throughout the period. According to the multiple regression analysis, the decreased FEM was more associated with the dysfunction of RLM than that of CLM.

References:

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2. In vivo three-dimensional kinematics of the midcarpal joint of the wrist. Moritomo H, Murase T, Goto A, Oka K, Sugamoto K, Yoshikawa H. *J Bone Joint Surg Am*. 2006 Mar; 88: 611-21
3. In vivo radiocarpal kinematics and the dart thrower's motion. Crisco JJ, Coburn JC, Moore DC, Akelman E, Weiss AP, Wolfe SW. *J Bone Joint Surg Am*. 2005 Dec; 87: 2729-40.



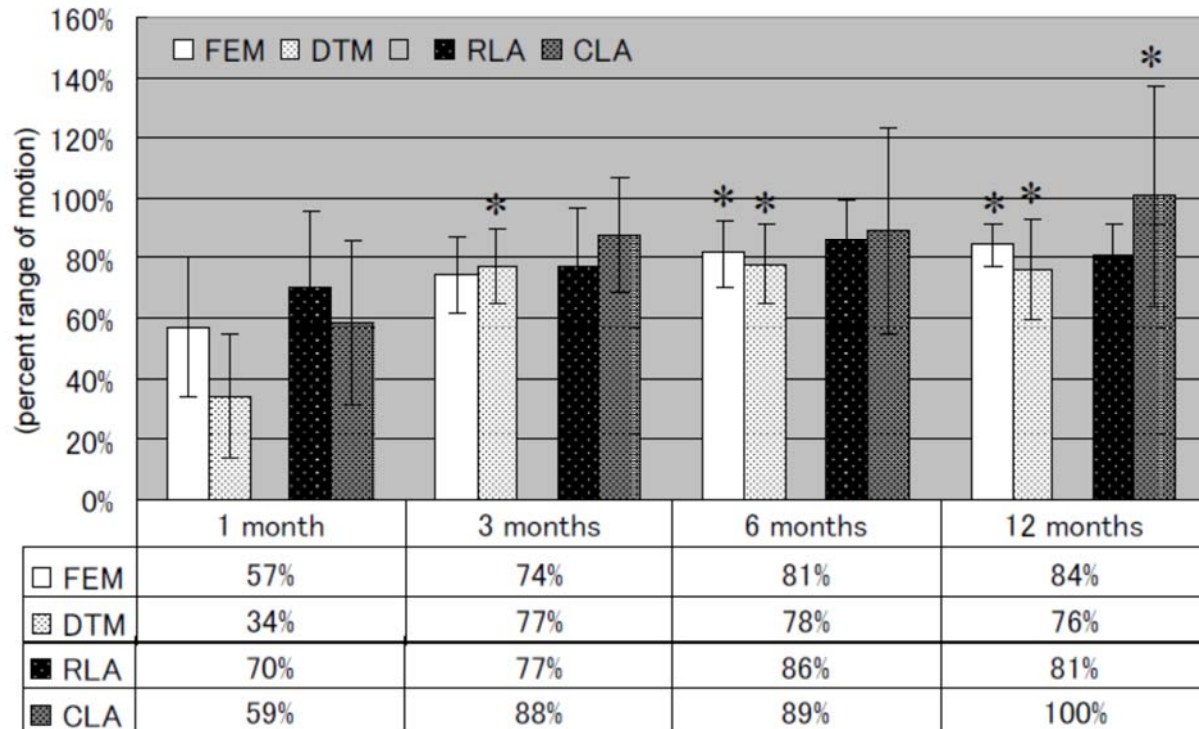


Figure 2 : The dart-throwing motion (DTM), The flexion-extension motion (FEM), the radiolunate angle (RLA) , capitulum angle (CLA) , at 1, 3, 6 and 12 postoperative months.

*: Significant increasing than the percentage at 1 postoperative month ($p \leq 0.05$)

◆ Nothing of financial value to disclose

AM E-POSTER 100: Arthroscopically Diagnosed SL Ligament Injuries in Distal Radial Fractures. A 13-15-year Clinical and Radiographical Follow-Up

Category: Fractures and Dislocations

Keyword: Wrist

Level 2 Evidence

- ◆ Ante Mrkonjic, MD
- ◆ Tommy Lindau, MD, PhD
- ◆ Mats Geijer, MD, PhD
- ◆ Magnus Tägil, MD, PhD

Hypothesis: A high rate of ligament injury has been reported in distal radial fractures. The purpose of this study was to evaluate the long-term results and the natural course of untreated scapho-lunate ligament (SLIL) tear, associated with distal radius fracture

Methods: Between 1995 and 1997, 51 consecutive young (<60 years) individuals with a distal radius fracture [24 men and 27 women, median age 41 years (range 20-49)], were treated according to a standard fracture protocol. Within the first week, the patients had a diagnostic wrist arthroscopy to map the soft tissue and cartilage injuries associated with a distal radial fracture. 32 of 51 patients (63%) had a SL ligament tear. Ten patients (20%) had a total tear of the scapholunate ligament and twenty-two (43%) patients had a partial tear. These lesions were left without any treatment. In 2010, 13-15 years after the fracture all fifty-one patients were located. 47 patients were still alive and were invited for an interview, radiogram and clinical examination

Results: 38 of the 51 original patients (75%) participated in the long time clinical and. One patient was excluded due to a scaphoid fracture and four patients only responded to the questionnaire. Four patients were dead and four could not participate due to personal reasons. Nine of the 38 patients had a complete SL ligament injury, 17 a partial injury and 12 patients no tear at all. None of these patients have been operated on with secondary stabilization surgery. At the present investigation, we found laxity in five patients (positive Watson test). Two of these were unstable at the one-year follow up (one with initially total and one with partial tear). Three patients had pain at provocation without correlation to clinical laxity.

The grip strength in patients with a total SL tear was 83% of the contralateral compared to 92% ($p=0.02$) in patients without. The median DASH score was 2 (range 0-55) for total tears compared to 11.5 (range 0-70) ($p=0.69$). The type of ligament injury did not affect pain, either at rest or under load or range of motion in the injured side.. One patient had advanced arthritic changes bilaterally. None of the patients developed a SLAC wrist.

Summary: A coexisting injury of the SLIL in distal radius fractures did not appear to influence the outcome after 15-17 years.

◆ Nothing of financial value to disclose

AM E-POSTER 101: Complications Following One-Bone Forearm Surgery for Post-Traumatic Forearm and Distal Radio-Ulnar Joint Instability.

Category: Instability

Keyword: Forearm

Level 4 Evidence

◆ Abdo Bachoura, MD

◆ Sidney Jacoby, MD

◆ Randall W. Culp, MD

◆ A. Lee Osterman, MD

Hypothesis: To present the outcomes following one-bone forearm (OBF) surgery for chronic, post-traumatic forearm and distal radioulnar joint instability.

Methods: A retrospective chart review was conducted to study patients who underwent OBF surgery secondary to a traumatic etiology. Patient demographics, surgical technique, preoperative and postoperative range of motion, final grip strength, and complications were collected from the medical records. Patients were asked to complete the Quick Disabilities of the Shoulder, Arm, and Hand questionnaire, a 0-10 point pain scale, and 0-10 point treatment satisfaction scale.

Results: There were 5 male and 5 female patients, with a mean age of 32 at the time of OBF surgery (range, 17-44 years). The mean number of procedures prior to OBF surgery was 3.6 (range, 2-7); 4 patients had undergone a Darrach procedure, and 3 patients had undergone a Sauve-Kapandji procedure. The median clinical follow-up duration was 6 years (range, 1-17 years). Wrist and elbow range of motion did not change remarkably before and after surgery. Three out of 8 primary OBF surgeries resulted in nonunion. Four out of 10 patients experienced painful impingement of the remaining proximal radius on adjacent bone and soft tissue and required a total of 7 procedures following OBF surgery. The median follow-up duration for patient rated outcomes was 10 years (range, 5-21 years) (n=7). The median Quick Disabilities of the Shoulder, Arm, and Hand was 77, the median pain score was 7, and the median satisfaction score was 7.

Summary:

- In our experience, complications following OBF surgery are common for patients with a traumatic etiology.
- Although wrist and elbow range of motion were spared, pain persisted and functional outcomes were poor.
- OBF surgery is our last resort for a chronically painful and unstable forearm.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 102: Reconstruction of the Distal Oblique Bundle of the Interosseous Membrane and the Effects on Distal Radioulnar Joint Instability

Category: Instability

Keyword: Wrist

Not a clinical study

◆ Michael D. Riggensbach, MD

◆ Bryan P. Conrad, PhD

◆ Paul C. Dell, MD

● Thomas W. Wright, MD

Hypothesis: The primary purpose of this study was to create an anatomic reconstruction of the distal oblique bundle and determine the effects on distal radioulnar joint instability. The second purpose of this study was to compare this technique with the currently accepted distal radioulnar ligament reconstruction. We hypothesized that this reconstruction would provide equivalent stability to distal radioulnar ligament reconstruction and that combining the two techniques would enhance stability.

Methods: Seven fresh cadaveric upper limbs were affixed to a custom frame. Sagittal translation of the distal radioulnar joint was measured in 60° pronation, neutral, and 60° supination using an electromagnetic motion tracking system. Translation was sequentially measured with the distal radioulnar joint intact, sectioned distal radioulnar ligaments and triangular fibrocartilaginous complex, and sectioned distal oblique bundles. Reconstructions were performed on the distal radioulnar ligaments, the distal oblique bundle tensioned in both neutral and supination, and a reconstruction employing both techniques.

Results: The distal oblique bundle reconstruction tensioned in supination allowed the least amount of translation in all positions compared to the distal oblique bundle tensioned in neutral and the distal radioulnar ligament reconstruction. The distal oblique bundle reconstruction restored greater stability to the distal radioulnar joint than the innate fibers found in situ corresponding to the distal oblique bundle. Combining the two techniques did not further reduce translation.

Summary:

- The distal oblique bundle reconstruction is a novel, anatomically based reconstruction technique for distal radioulnar joint instability.
- Reconstruction of the distal oblique bundle is technically simpler than distal radioulnar ligament reconstruction described by Adams¹.

- The distal oblique bundle reconstruction tensioned in supination provided the least translation at all positions.

References:

1. Adams BD. Anatomic reconstruction of the distal radioulnar ligaments for DRUJ instability. Tech hand Upp Extrem Surg 2000; 4(3): 154-160.

- Royalties/Honoraria received from: Exactech
- Other Financial/Material Support received from: Exactech
- ◆ Nothing of financial value to disclose

AM E-POSTER 103: The Lateral Collateral Ligament Complex: A Biomechanical Analysis of Three Ligament Reconstruction Techniques

Category: Instability

Keyword: Elbow

Not a clinical study

◆ Aakash Chauhan, MD, MBA

◆ William Anderton, BEng

◆ Mark C. Miller, PhD

◆ Bradley Palmer, MD

◆ Michael Wigton, MD

◆ Mark E. Baratz, MD

Hypothesis: The stability of a double docking graft reconstruction with a palmaris longus (PL) for a disrupted lateral collateral ligament complex (LCL) will exceed that of a single docking graft reconstruction with a PL in a lasso configuration and an identical lasso configuration using only suture.

Methods: Five human cadaveric elbows were each tested with the LCL complex intact, disrupted off the origin from the lateral epicondyle, and then reconstructed sequentially using 3 different constructs in randomized order. The first construct utilized a PL graft doubled at each end and proximally docked at the isometric point on the lateral aspect of the capitellum and distally docked into a trans-osseous tunnel drilled from the distal margin of the Lateral Ulnar Collateral Ligament (LUCL) insertion through the inferior border of the ulna. A metal button was used for both docking sites. For the second and third constructs a second hole was drilled on the lateral aspect of the ulna at the proximal margin of the LUCL insertion to create an osseous bridge with the previously drilled hole. The ulna was secured with passage of either a PL graft or No. 2 braided non-absorbable suture through the osseous bridge, with the free ends of the graft doubled. The suture or doubled graft limb was passed through a single tunnel at the isometric point and docked with a metal button at the proximal exit hole creating a “lasso” configuration. Overlying soft tissues were closed in layers over each reconstruction. Elbows were mounted in a simulator so that flexion-extension was in the horizontal plane and tested under gravitational varus loads. Varus angular position was quantified with an optical tracking system. A repeated-measures ANOVA test and Tukey post-hoc analysis was used to compare the angular differences among the repair groups.

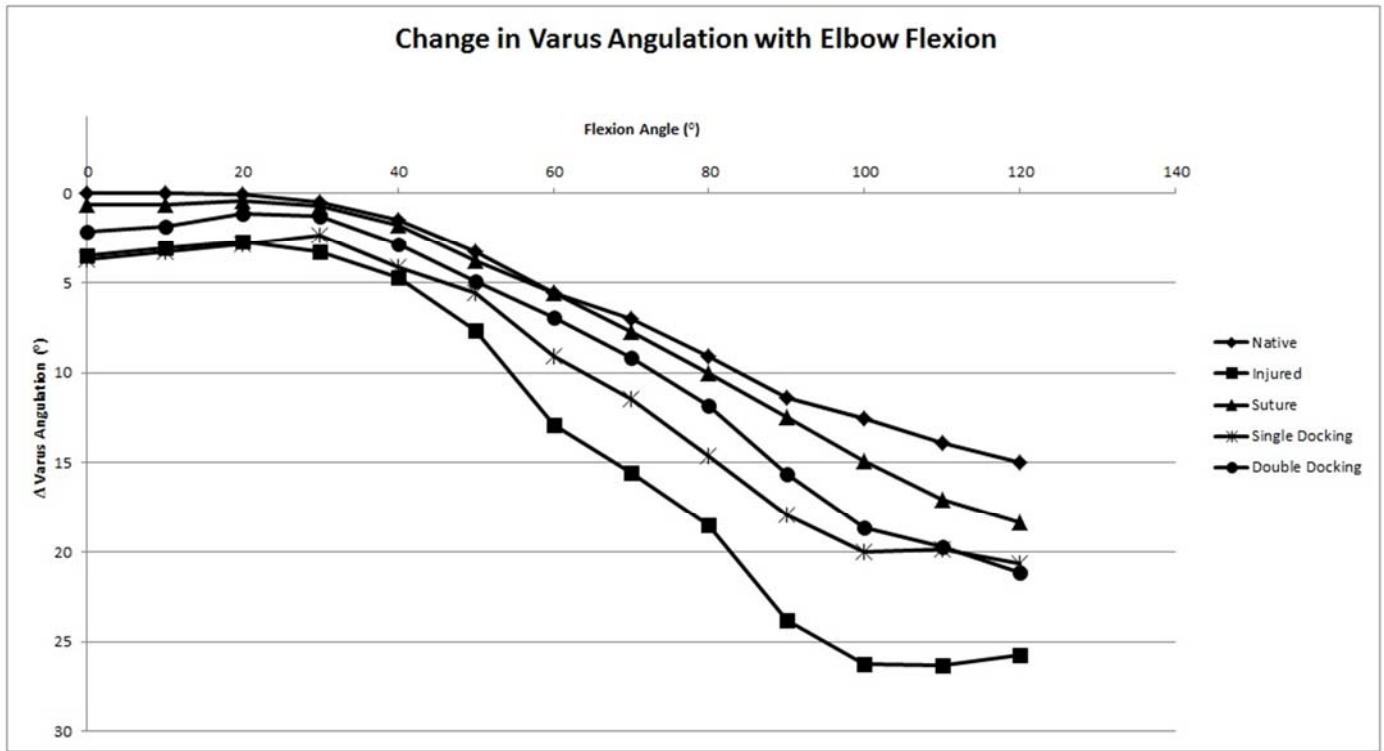
Results: Reconstruction matters, as there was a statistically significant difference from the disrupted state ($p < 0.05$). The varus angulation after the repairs showed that suture reconstruction was slightly better than the double docking reconstruction which was slightly better than the

single docking reconstruction (Figure 1). Numerically, the double docking reconstruction was an average of 2.8 degrees from the native state. The suture reconstruction was an average of 1.1 degrees from the native case.

Summary: LCL complex reconstruction improves elbow biomechanics after disruption. A suture lasso reconstruction was quantitatively superior and most similar to the native state when compared to the other reconstructions.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 104: Arthroscopically Assisted Specified Limbs Repair (AASLR) for TFCC Foveal Tear with DRUJ Instability

Category: Instability

Keyword: Hand

Level 4 Evidence

- ◆ Keiichi Murata, MD, PhD
- ◆ Shohei Omokawa, MD, PhD
- ◆ Yasunori Kobata, MD
- ◆ Takamasa Shimizu, MD
- ◆ Yasuhito Tanaka, MD, PhD

Hypothesis: Arthroscopically assisted specified limbs repair (AASLR) for triangular fibrocartilage complex (TFCC) foveal tear with distal radioulnar joint (DRUJ) instability can give good clinical results at middle term follow-up (>18 months postoperatively).

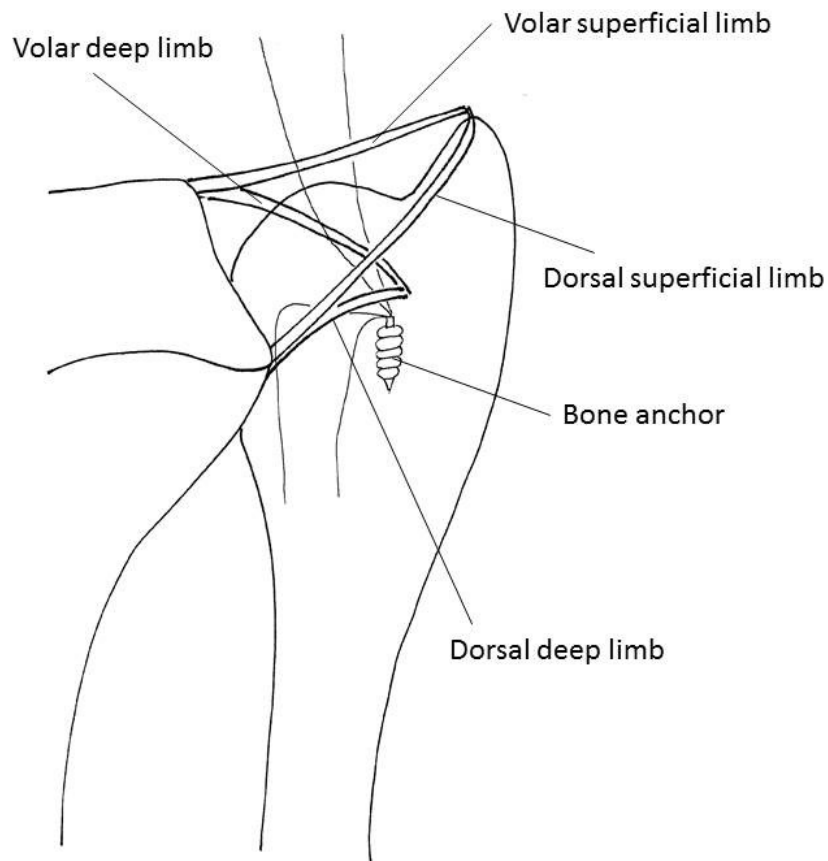
Methods: This study is a consecutive case series of 16 patients who underwent arthroscopically assisted repair for a traumatic foveal lesion of the TFCC at our institute between January 2010 and September 2011. The mean age at the time of surgery was 34 years. In all patients, ruptured dorsal and/or volar deep limbs of the TFCC were confirmed by DRUJ arthroscopic findings and preoperative manual stress test. Both dorsal and volar deep limbs of the TFCC were repaired in 13 patients, only dorsal limb in 1, and only volar limb in 2. Ruptured limbs were specifically retouched to the fovea of the ulna using a bone anchor. Through a longitudinal skin incision of 2 cm in length, a debridement of the fovea lesion and insertion of the bone anchor were performed. Proper location of sutures anchoring was confirmed by arthroscopic observation of the radiocarpal joint. The mean follow-up period was 24 months (range, 18 to 39). At the final follow-up, the DASH score, pain (Visual Analog Scale: VAS), grip strength, DRUJ instability, the Mayo Modified Wrist Score and postoperative complications were assessed in all patients and compared with preoperative values using Wilcoxon signed-rank test. Values of $P < .01$ were considered statistically significant.

Results: The preoperative DASH score was 40 ± 21 and it significantly decreased to 15 ± 15 at final follow-up. Pain (VAS) significantly improved after surgery 64 ± 19 to 11 ± 12 . Grip strength significantly improved after surgery from 68% to 92% of the unaffected side. Thirteen patients had no DRUJ instability and 3 patients had mild DRUJ instability. The mean Mayo Modified Wrist Score at final follow-up was 87 points, and the results were excellent in 7, good in 6, fair in 3. There was no postoperative complication.

Summary: AASLR for TFCC foveal tear can provide considerably reliable restoration of the DRUJ stability; satisfactory subjective and objective results can be expected without serious complications at middle term follow-up.

References:

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Results

Assessment	<i>preop.</i>	<i>final F-U</i>
Ulnocarpal stress test(+)	8/15	0/15*
Piano key sign (+)	8/15	0/15*
Fovea sign (+)	14/15	0/15**
Ulna ballottement test (point)	6.5+2.2	0.5+0.8**
Grip Power	0.68+0.26	0.92+0.11**
Modified Mayo Wrist Score	52+24	87+12**
VAS	64+19	11+12**
PRWE-J	57+18	25+22 **
DASH(JSSH ver.)	40+201	15+15**

Chi-square test / McNemar:Wilcoxon ranked test

*** p<0.01, * p<0.05*

◆ Nothing of financial value to disclose

AM E-POSTER 105: Maximizing Long-term Outcomes in Proximal Row Carpectomy; A Longitudinal Study of 144 Cases

Category: Instability

Keyword: Wrist

Level 4 Evidence

◆ Eric R. Wagner, MD

◆ Dalibel Bravo, BS

◆ Bassem T. Elhassan, MD

● Steven L. Moran, MD

Hypothesis: Although controversy regarding the indication for proximal row carpectomy (PRC) exists, there are few large, long-term studies examining these controversies. In this study, we report on the largest cohort of patients to date with long-term outcomes and factors influencing these outcomes.

Methods: We performed a longitudinal investigation of all patients who underwent proximal row carpectomy (PRC) at a single institution from 1967 to 2010 with a minimum follow up of 2 years. T-test, univariate and Kaplan-Meier survival analysis were performed to analyze wrist range of motion, pain levels, DASH, PRWE and revision surgeries.

Results: 144 patients were identified with an average follow up of 13.4 years (2.0-40.7). Postoperative wrist flexion-extension ($p<0.05$), grip strength ($p<0.05$), and pain levels ($p<0.001$) significantly improved from preoperative values. At most recent followup, 76% reported good pain relief and 72% reported satisfaction. Postoperative DASH and PRWE scores were 23.8 (+/-15) and 22.4 (+/-15), respectively. Similar to published survival rates, 17 (12%) of patients underwent a revision surgery at an average of 44.6 months (7-145) (Figure 1).

Factors that influenced the outcomes included age at the time of surgery, laborers, Kienbock's disease, concomitant PIN+/-AIN, and surgery performed after 1990. Increasing age at the time of surgery significantly all outcome measures ($p<0.03$). Additionally, patients older than 40 years had improved pain scores ($p<0.025$), pain relief and satisfaction ($p<0.02$), DASH scores ($p<0.01$), and revision surgeries ($p<0.05$) (Figure 2a). A diagnosis of Kienbock's disease (33, 23%) improved DASH scores ($p<0.05$) and decreased revision surgery ($p<0.047$). Laborers (60, 42%) had worse pain scores ($p<0.05$), overall pain relief ($p<0.01$), DASH scores ($p<0.006$), and more revisions ($p<0.05$). Patients who underwent a concomitant PIN+/-AIN had improved pain scores ($p<0.03$), pain relief and satisfaction ($p<0.04$), and DASH scores ($p<0.002$). Lastly, surgeries that occurred after 1990 had significantly improved outcomes when compared to those performed before 1990, including pain levels ($p<0.01$), pain relief and satisfaction ($p<0.03$), DASH scores ($p<0.001$), and rates of revision surgery at 5, 10, and 20 years ($p<0.01$) (Figure

2b). Of note, a higher percentage of PIN+/-AINs were performed in patients with more recent surgeries.

Summary: Proximal row carpectomy improves patient's pain, function and quality of life. Improved outcomes are seen in patients older than 40 years, non-laborers, patients with Kienbock's and those who undergo concomitant PIN and/or AIN. Additionally, those who underwent surgery after 1990 had better outcomes, likely secondary to increased usage of PIN+/-AIN amongst other factors.

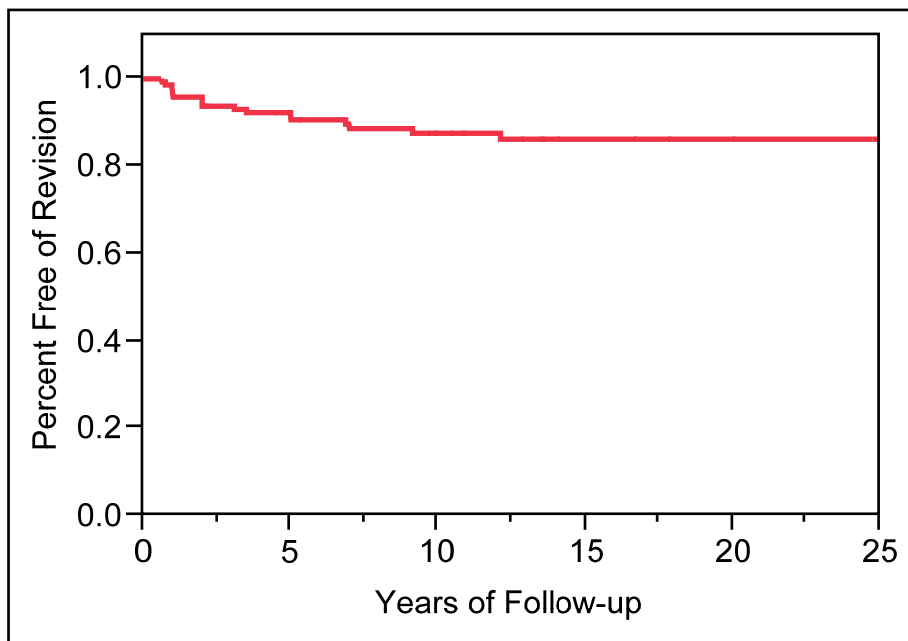


Figure 1. Kaplan Meier survival analysis of all PRCs. The 5, 10 and 20 year survival rates were 90.5%, 87.5%, and 86%, respectively.

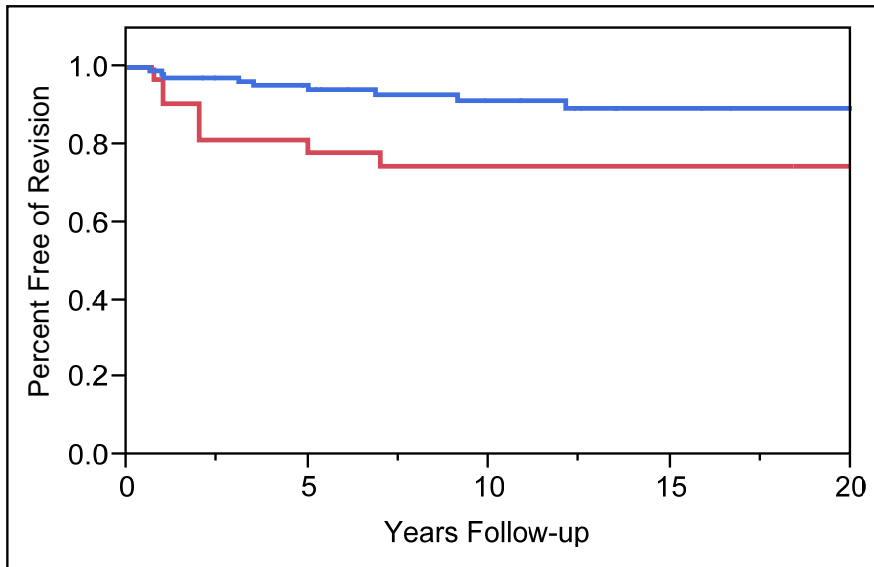


Figure 2a. Survival by time of surgery. Surgeries performed after 1990 (blue line) had significantly higher rates of revision than those performed before 1990 (red line) ($p < 0.01$).

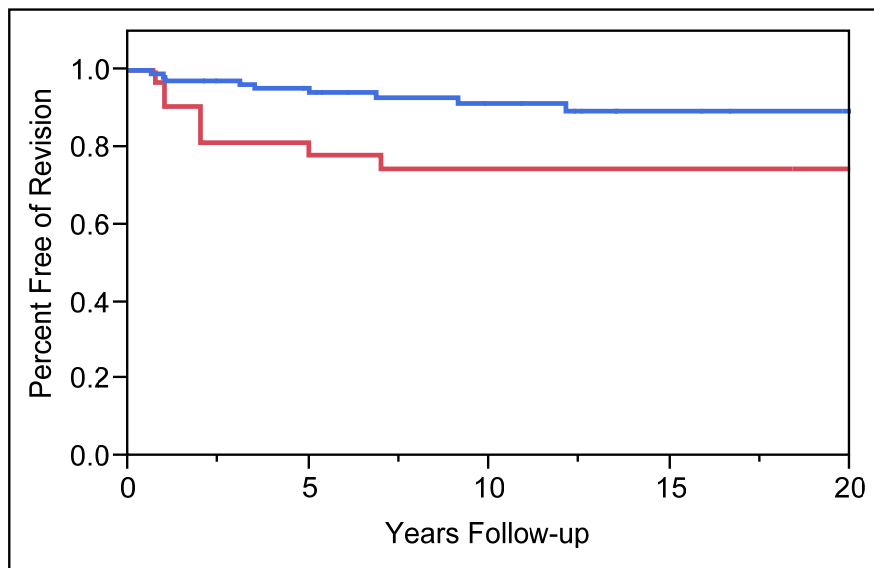


Figure 2b. Survival by age at surgery. Surgeries performed in patients older than 40 years (blue line) had significantly lower rates of revision than those performed in patients less than 40 years (red line) ($p < 0.01$).

- Other Financial/Material Support received from: Integra, Coventus
- ◆ Nothing of financial value to disclose

AM E-POSTER 106: Treatment of Scapholunate Instability with Reduction and Association of the Scaphoid and Lunate (RASL)

Category: Instability

Keyword: Wrist

Level 4 Evidence

◆ Christopher M. Jones, MD

◆ Jaehon M. Kim, MD

◆ Michael S. Murphy, MD

Hypothesis: As one of the most common types of carpal instability, scapholunate (SL) dissociation remains a challenging problem without a consistently successful solution. Without intervention, the natural history of SL ligament rupture frequently progresses to carpal instability and degenerative arthrosis. The overall goal of surgery is to preserve normal anatomic alignment of the carpus, therefore preventing progressive degenerative arthrosis. We hypothesize that the reduction and association of the scaphoid and lunate (RASL procedure) is a safe and efficacious technique for scapholunate dissociation. The objective of the study is to demonstrate an improvement in clinical outcomes between pre- and post-operative evaluations for those individuals undergoing reduction and association of the scaphoid and lunate.

Methods: Between December 2008 and February 2013, six surgeons from one practice performed 27 RASL procedures for scapholunate instability. A single cannulated screw was used to maintain anatomic reduction of the scaphoid to the lunate in this reconstruction technique. Radiographs were reviewed pre-operatively and at subsequent post-operative intervals. Patients were also evaluated using DASH and MAYO wrist score questionnaires.

Results: Of the 27 patients, 23 were available for radiographic comparison, physical examination, and questionnaires. Four patients were lost to follow-up. There were 20 males (74%) and 7 females (26%) who underwent the RASL procedure for scapholunate instability. The average age of the patients at the time of the surgery was 43.4 years (range 22-62 years). The mean follow-up for this cohort was 20.4 months (range 6-48 months). Among those patients available for physical exam, the average arc of motion was 70 degrees of flexion and extension. Post-operative measurements of grip strength showed average of 85% of the normal contralateral hand. Post-operative radiographs showed an overall maintenance of carpal alignment. The scapholunate gap was well maintained, and the average scapholunate angle was found to be 45 degrees at average of 20 months follow-up. These were both significantly improved compared to preoperative radiographic findings. There was also a statistically significant improvement in both DASH and Mayo Wrist scores.

Summary:

- The RASL procedure is a safe and efficacious technique for scapholunate instability.
- Use of this technique adequately maintains carpal alignment, preserves motion, and maintains strength.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 108: Traumatic Valgus Instability of the Elbow in a Young Active Duty Military Population—A Case Series

Category: Instability

Keyword: Elbow

Level 4 Evidence

◆ Leo T. Kroonen, MD

◆ James Harrison, MS3

Hypothesis: No consensus exists on the optimal treatment for acute traumatic avulsions of the medial collateral ligament of the elbow. The traditional approach has been non-operative^{1,2}. More recently, some have advocated early surgical repair³. The purpose of this case series was to describe the clinical course of a series of active duty military patients with acute injury of the MCL. Our hypothesis was that, in a young, active population, patients would ultimately require surgical reconstruction in order to return to the demands of military lifestyle.

Methods: A retrospective review was performed on a consecutive series of patients with traumatic valgus elbow instability treated by a single surgeon between September 2009 and December 2011. All patients were initially given a trial of non-operative treatment with a hinged range of motion brace and activity modification. If after a period of protection, patients were still symptomatic, then they were offered surgical reconstruction. Charts were reviewed for demographic data, imaging studies, and pre- and post- treatment symptoms and range of motion. Outcomes included time to full active duty status, range of motion, complications, and overall patient satisfaction.

Results: Four patients were evaluated and treated for traumatic elbow instability in the specified interval. All patients remained reduced through a full arc of flexion and extension, but had clinical evidence of valgus instability with a valgus stress test, and a positive milking maneuver. All patients also had MRI evidence of MCL rupture (Figure 1). Each patient continued with symptoms of instability that resulted in an inability to perform their job in the military despite bracing and activity modification. All subsequently were treated with reconstruction of the MCL. One patient was lost to followup due to separation from the military for non-medical reasons. The other three patients returned to full active duty and expressed satisfaction with their outcome. Final clinical outcomes are presented in Table 1.

Summary:

- There is no consensus on optimal management for traumatic valgus instability of the elbow.
- In this small series, non-operative treatment did not allow for return to a physically demanding military job in a timely fashion.

- Young, active patients with traumatic valgus instability might benefit from earlier surgical intervention to allow for direct repair.
- Clinical outcomes of MCL reconstruction in a young, active population are reliably good.
- Similar outcomes might be achieved within a shorter time if direct repair is undertaken soon after injury.

References:

- 1) Kenter K, Behr CT, Warren RF, O'Brien SJ, Bames R. Acute elbow injuries in the National Football League. J Shoulder Elbow Surg. 2000;9:1-5.
- 2) Norwood LA, Shook JA, Andrews JR. Acute medial elbow ruptures. Am J Sports Med. 1981;9:16-9
- 3) Richard MJ, Aldridge JM, Wiesler ER and Ruch DS. J Bone Joint Surg Am. 2008;90:2416-2422



	Age	Gender	Days from Injury to Surgery	Mechanism	Preoperative Motion	Valgus Stress Test	Milking Maneuver	Postoperative Motion	Duration for return to Full Duty
Patient 1	22	F	112 days	Obstacle course	0-140	positive	Positive Pain	3H-140	128 days
Patient 2	35	M	30 days	Soccer Injury	0-130	positive	Positive Pain	0-140	40 days
Patient 3	37	M	58 days	Dirt bike injury	0-130/25-110	positive	Positive Pain	0-135	130 days

◆ Nothing of financial value to disclose

AM E-POSTER 109: Quantitative Three-Dimensional Articular Facet Suitability Assessment of Osteochondral Autografts for the Reconstruction of the Coronoid Process

Category: Multiple Trauma

Keyword: Elbow

Not a clinical study

- ◆ Toshiyuki Kataoka, MD
- ◆ Hisao Moritomo, MD, PhD
- ◆ Yohei Kawanishi, MD
- Shinsuke Omori, MD
- ◆ Hiroyuki Tanaka, MD, PhD
- Tsuyoshi Murase, MD, PhD

Hypothesis: Osteochondral autografts including the olecranon graft, side radial head graft, and top radial head graft for the reconstruction of the coronoid process have been reported. It is unclear as to which of these osteochondral autografts are most similar to the coronoid articular configuration. We hypothesized that these three osteochondral autografts had different morphological suitabilities for the reconstruction of the coronoid process.

Methods: We performed three-dimensional computed tomography on 20 elbows to compare the coronoid process with the olecranon tip, side radial head, and top radial head for articular facet configuration. We measured the area of the proximity region (defined as ≈ 2.0 mm) between the articular facets of the coronoid process and the olecranon, side radial head, and top radial head, respectively, and calculated the proximity rate that was defined as the ratio of proximity region among the coronoid process articular facet area (Fig. 1). To investigate the location of the proximity region, we measured the distance between the proximity region center and the coronoid tip. In addition, we measured the percentage of the ulnohumeral articular surface facet occupied by the resected olecranon articular surface facet.

Results: Proximity rates in the olecranon, side radial head, and top radial head grafts were $89.2\% \pm 6.2\%$, $80.3\% \pm 11.1\%$, $81.5\% \pm 11.0\%$, respectively (Fig. 2). The proximity rate in the olecranon graft was significantly greater than that in radial head grafts. The location of the proximity region of the top radial head graft existed significantly medially in comparison with those of the olecranon and side radial head grafts. Further, 13.8% of the ulnohumeral articular surface facet was occupied by the resected olecranon articular facet.

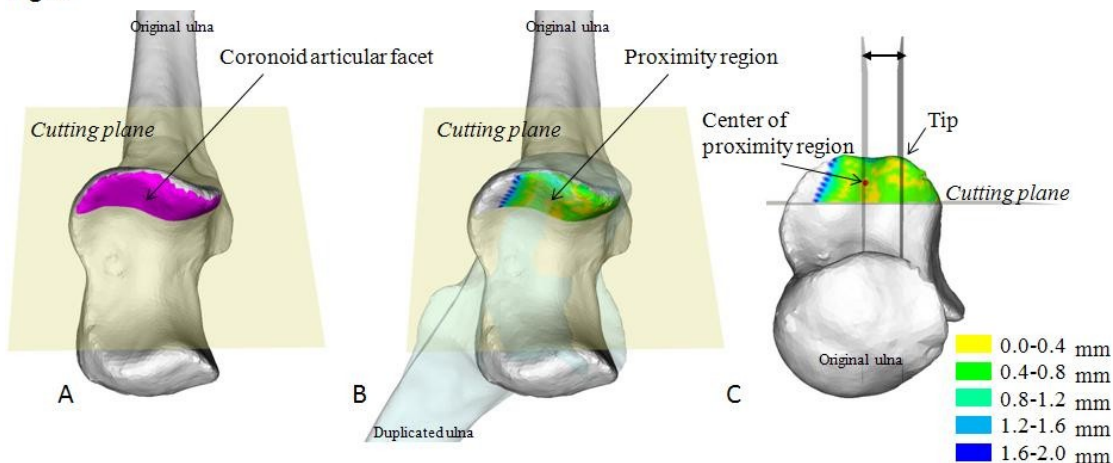
Summary:

- The olecranon graft provided the best match of the articular facet configuration with the coronoid process including the tip.
- The top radial head graft provided the match of the more medial articular facet configuration with the coronoid process.
- The percentage of the ulnohumeral articular surface facet occupied by the resected olecranon articular facet was 13.8 %; therefore, resection of olecranon for the reconstruction of the coronoid process would not result in gross elbow instability as per some biomechanical studies.
- Our data may be helpful in selecting osteochondral autograft for the reconstruction of the coronoid process.

References:

- 1) Reconstruction of the coronoid for chronic dislocation of the elbow. Use of a graft from the olecranon in two cases. Moritomo H, Tada K, Yoshida T, Kawatsu N. J Bone Joint Surg Br. 1998;80(3):490-492.
- 2) Use of osteochondral bone graft in coronoid fractures. van Riet RP, Morrey BF, O'Driscoll SW. J Shoulder Elbow Surg. 2005;14(5):519-523.
- 3) Reconstruction of the coronoid process using a fragment of discarded radial head. Ring D, Guss D, Jupiter JB. J Hand Surg Am. 2012;37(3):570-574.
- 4) The effect of partial removal of proximal ulna on elbow constraint. An KN, Morrey BF, Chao EY. Clin Orthop Relat Res. 1986(209):270-279.
- 5) Contribution of the olecranon to elbow stability: an in vitro biomechanical study. Bell TH, Ferreira LM, McDonald CP, Johnson JA, King GJ. J Bone Joint Surg Am. 2010;92(4):949-957.

Fig. 1



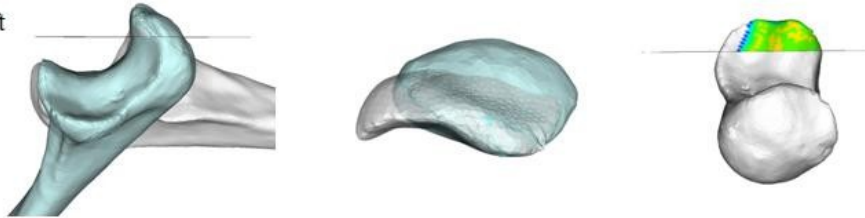
(A) 3D bone model of the original ulna viewed from the anteroproximal side is shown. Coronoid area (red-purple) was defined as the anterior part of ulnohumeral articular surface area of the original ulna divided by the *Cutting plane*.

(B) 3D bone models of the original ulna (white) and duplicated ulna (transparent light blue), of which the olecranon tip was superimposed on the coronoid process of the original ulna, viewed from the anteroproximal side. Proximity region (five different colored) was defined as the anterior part of the proximity region, where their proximity between the articular surface areas of the original and duplicated ulnae is ≤ 2.0 mm, divided by the *Cutting plane*.

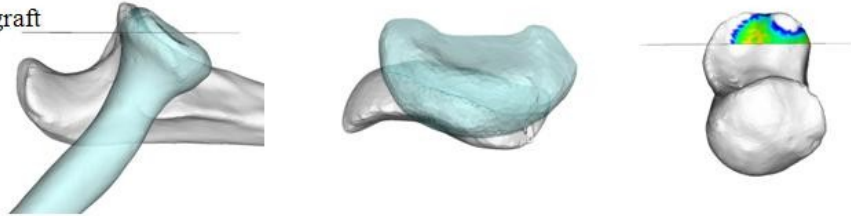
(C) 3D bone model of the original ulna viewed from the proximal side. The distance between the tip of the coronoid process and the center of proximity area (red point) along the line perpendicular to the long ulnar axis in the *Cutting plane* was measured.

Fig. 2

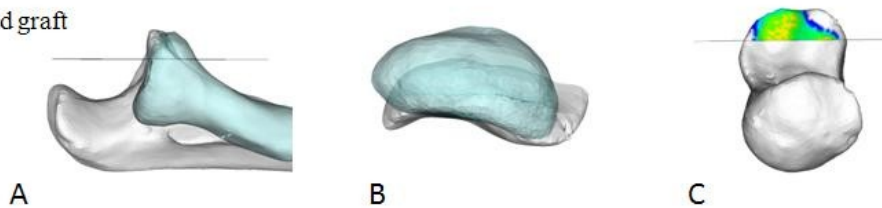
Olecranon graft



Side radial head graft



Top radial head graft



3D models of original ulna (white), duplicated ulna (transparent light blue), and radius (transparent light blue) viewed from lateral (A) and anterior (B) sides after the olecranon tip of the duplicated ulna model (top), the side radial head (middle), and the top radial head (bottom) was semiautomatically superimposed on the corresponding part of the coronoid process of the original ulna model, respectively. (C) Proximity area on the original ulna model viewed from the proximal side was shown. Note that proximity area in olecranon tip graft was located more medially than that in top radial head graft.

- Other Financial/Material Support received from: the Japan Science and Technology Agency (Omori, Murase)
- Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Orthree Co., Ltd. (Murase)
- ◆ Nothing of financial value to disclose

AM E-POSTER 110: Dorsal Spanning Plate Fixation for Distal Radius Fractures in Poly-Trauma Patients

Category: Multiple Trauma

Keyword: Wrist

Level 4 Evidence

◆ Alem Yacob, MD, MSc

◆ Ameya V. Save, BS

● Seth D. Dodds, MD

Hypothesis: The presence of a multi-fragmentary distal radius fracture in a poly-trauma patient with concomitant lower extremity injuries can pose a challenge with respect to early mobilization. We evaluated our experience with the use of a dorsal spanning plate in multiply injured patients with the goal of providing definitive operative fixation for the distal radius fracture as well as for providing a construct to allow weight-bearing through the injured wrist for rehabilitative purposes.

Methods: This was a retrospective review of poly-trauma patients with a distal radius fracture treated with a dorsal spanning plate by the senior author over a 6 year period from 2006 to 2012. Only those patients who had returned for removal of the implant were included. Medical records were reviewed to evaluate functional and radiographic outcomes as well as complications associated with the procedure.

Results: A total of 33 patients were identified, 20 male and 13 female. The mean age of the patients was 52 years, with a range of 23 – 79 years. The mechanism of injury was a motor vehicle accident in 9 patients, a mechanical fall in 6 patients, and a fall from height in 18 patients. There were 5 patients who had sustained bilateral distal radius fractures. The median time from injury to operative fixation was 3 days. Patients returned to the operating room for removal of the plate at a median interval of 4.3 months, with a range of 2.5 to 15.9 months. Only 5 of the patients retained the implant for more than 7 months. There were no cases of tendon rupture or infection. Implant failure was noted in 3 patients, however, these patients had retained their plate for a mean interval of 13.4 months. Average functional outcomes at a mean of 5.8 months following removal of the plate were 48 degrees of flexion, 47 degrees of extension, 78 degrees of pronation, 72 degrees of supination, 14 degrees of radial deviation, and 20 degrees of ulnar deviation. Mean radiographic outcomes were radial inclination of 19.2 degrees, radial length of 10.2 mm, ulnar variance of -0.16 mm, and a palmar tilt of 5.8 degrees.

Summary: A preliminary analysis of our experience with the procedure is encouraging. Functional and radiographic outcomes are comparable to values reported in the literature for

patients with similar high energy injuries who were treated with spanning external fixation or volar plating.

- Royalties/Honoraria received from: Medartis, Integra, and TriMed
- ◆ Nothing of financial value to disclose

AM E-POSTER 111: Does the Extent of Cubital Tunnel Release Contribute to Ulnar Nerve Subluxation?

Category: Nerve/Neuromuscular

Keyword: Elbow

Not a clinical study

◆ Andrew P. Hurvitz, MD

◆ Leo T. Kroonen, MD

◆ Brian Fitzgerald, MD

Hypothesis: There is no consensus regarding the extent to which the ulnar nerve should be released during an in situ decompression. Our hypothesis is that the risk of ulnar nerve subluxation will increase with the extent of decompression.

Methods: Sixteen cadaveric elbows were examined for nerve instability following in situ ulnar nerve decompression. A release of the ulnar nerve was performed through the cubital tunnel, and extended 7cm distal to a point centered between the medial epicondyle and olecranon. The nerve was then released proximally over a distance of 10 cm in 2 cm increments. Elbows were ranged from full extension to full flexion to observe for nerve subluxation following each 2 cm interval of release. The presence of subluxation to a point at which the nerve broke the plane of the most superficial portion of the medial epicondyle was recorded.

Results: A statistically significant trend of instability was noted as the level decompression was advanced proximally ($p < 0.05$). Overall, eight of the sixteen elbows (50%) ultimately displayed instability of the ulnar nerve following in situ decompression. The highest rate of instability occurred at the interval between 4 and 6 cm of release, although this finding was not significantly different from other intervals of release.

Summary:

- Our study reveals that in situ decompression with a considerable proximal release may result in subsequent instability of the ulnar nerve.
- We recommend limiting decompression to the cubital tunnel if clinical and electrodiagnostic studies indicate the cubital tunnel is the source of compression.
- Further proximal decompression beyond 4cm might lead to frank instability which could be a source of ongoing nerve symptoms or require additional surgical procedures.

References:

- 1) Bartels RH, Verhagen WI, van der Wilt GJ, Meulstee J, van Rossum LG, Grotenhaus JA. Prospective randomized controlled study comparing simple decompression versus

anterior subcutaneous transposition for idiopathic neuropathy of the ulnar nerve at the elbow: part 1. *Neurosurgery* 2005;56:522–530.

- 2) Biggs M, Curtis JA. Randomized, prospective study comparing ulnar neurolysis in situ with submuscular transposition. *Neurosurgery* 2006;58:296–304.
- 3) Gellman H. Compression of the ulnar nerve at the elbow: cubital tunnel syndrome. *Instr Course Lect.* 2008;57:187-97. Review.
- 4) Nabhan A, Ahlhelm F, Kelm J, Reith W, Schwerdtfeger K, Steudel WI. Simple decompression or subcutaneous anterior transposition of the ulnar nerve for cubital tunnel syndrome. *J Hand Surg* 2005;30B: 521–524.
- 5) Osborne G. Surgical treatment of tardy ulnar neuritis. *J Bone and Joint Surg* 1957;39B:7824.
- 6) Zlowodzki M, Chan S, Bhandari M, Kalliainen L, Schubert W. Anterior transposition compared with simple decompression for treatment of cubital tunnel syndrome: a meta-analysis of randomized, controlled trails. *J Bone Joint Surg* 2007;89A:2591–2598.

◆ Nothing of financial value to disclose

AM E-POSTER 112: Multiplanar Wrist Joint Proprioception: The Effect of Anesthetic Blockade of the Posterior Interosseous Nerve or Skin Envelope Surrounding the Joint

Category: Nerve/Neuromuscular

Keyword: Wrist

Not a clinical study

- ◆ Kenneth Taylor, MD
- ◆ Michael B. Lustik
- ◆ Laurel Beth Smith, OTR
- ◆ Vanessa M. Meyer, OTR
- ◆ Robert J. Lachky, MD

Hypothesis: We hypothesized that in isolation, the posterior interosseous nerve (PIN) and the skin surrounding the joint do not contribute significantly to multiplanar wrist joint proprioception.

Methods: A multiplanar testing device secured the forearm in neutral rotation with the wrist free to move throughout all planes. A splint held the index finger from proximal to the metacarpophalangeal joint to the fingertip. From a neutral start position, the subject pointed to specific hours on an analogue clock face hidden from view. One repetition for each hour mark was assigned randomly for each of three cycles. This process was repeated for the opposite wrist. Subjects were randomly assigned to two treatment groups. In one group, subjects underwent anesthetic lidocaine blockade of the PIN within the fourth dorsal wrist compartment. The opposite placebo control wrist underwent injection with sterile saline. In the second group, subjects underwent circumferential topical anesthetic lidocaine gel blockade of the superficial cutaneous nerves about the treatment wrist while the opposite side received the placebo inert ultrasound gel. The subjects repeated testing. Differences from the true value were calculated for each observation rounded to the closest six degrees. The outcome measure of acceptable precision was defined as being within ± 18 degrees of the true value. A conditional logistic regression analysis was used to estimate odds ratios and 95% confidence intervals for pre/post-treatment differences in acceptable precision.

Results: Eighty consecutive subjects, 45 male and 35 female, mean age 33 years (range, 19 to 64 years), completed testing. The overall accuracy and precision were generally good regardless of treatment, with approximately 90% of measurements falling within ± 18 degrees of the true value. Accuracy differed significantly across degrees. In particular, participants were much less accurate when trying to hit 210° than other points (Figure). Using an acceptable range of within ± 18 degrees, the percent of measurements falling outside the range did not differ between baseline and post-treatment for the treated wrists and the control wrists (OR=1.15, 95% CI: 0.92,

1.45 for skin blockade, $p=0.22$; OR=1.14, 95% CI: 0.85, 1.51 for PIN blockade, $p=0.38$; OR=1.04, 95% CI: 0.87, 1.25, $p=0.65$).

Summary: We found no significant difference in position sense when independently blocking the contribution of the PIN or skin envelope surrounding the wrist. Wrist proprioception is therefore likely to be a multifactorial phenomenon. We believe surgeons may sacrifice the PIN without concern for effect on joint proprioception.

References:

- 1) Hagert E, Persson JKE. Desensitizing the posterior interosseous nerve alters wrist proprioceptive reflexes. *J Hand Surg.* 2010; 35A(7):1059-1066.
- 2) Moberg E. The role of cutaneous afferents in position sense, kinaesthesia, and motor function of the hand. *Brain.* 1983;106:1-19.
- 3) Wycherley AS, Helliwell PS, Bird HA. A novel device for the measurement of proprioception in the hand. *Rheumatology.* 2005;44(5):638-641.
- 4) Patterson RW, Van Niel M, Shimko P, Pace C, Seitz WH. Proprioception of the wrist following posterior interosseous sensory neurectomy. *J Hand Surg.* 2010;35A(1):52-56.
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- 6) Swanik CB, Lephart SM, Rubash HE. Proprioception, kinesthesia, and balance after total knee arthroplasty with cruciate-retaining and posterior stabilized prostheses. *J Bone Joint Surg.* 2004;86A(2):328-334.
- 7) Wassinger CA, Myers JB, Gatti JM, Conley KM, Lephart SM. Proprioception and throwing accuracy in the dominant shoulder after cryotherapy. *J Athl Train.* 2007;42(1):84-89.
- 8) Weinstein LP, Berger RA. Analgesic benefit, functional outcome, and patient satisfaction after partial wrist denervation. *J Hand Surg.* 2002;27A(5):833-839.
- 9) Hagert E. Proprioception of the wrist joint: A review of current concepts and possible implications on the rehabilitation of the wrist. *J Hand Ther.* 2010;23(1):2-16.
- 10) Dellon AL. Commentary: Desensitizing the posterior interosseous nerve alters wrist proprioceptive reflexes: It is OK to lose your nerve. *J Hand Surg.* 2010;35A(7):1067-1069.

Table. Effect of age, sex, hand dominance and target on accuracy and precision (control observations only).

		N	Pre-treatment Difference from Target			Post-treatment Difference from Target		
			Mean (°)	Std (°)	% >±18°	Mean (°)	Std (°)	% >±18°
All		80	3.3	4.0	9.2	3.0	4.4	9.6
Age	19-29	32	3.7	4.5	9.2	2.6	4.8	9.2
	30-39	31	3.1	3.6	9.7	3.4	4.4	9.9
	40-49	13	3.0	3.9	9.4	2.5	3.8	9.0
	50-64	4	2.3	3.7	5.6	3.7	3.5	12.5
Sex	Male	45	3.5	3.8	8.5	2.9	3.8	7.4
	Female	35	3.0	4.2	10.2	3.0	5.1	12.5 ††
Dominant	Yes	40	2.4	3.5	6.0	2.3	4.1	6.8
	No	40	4.2 †	4.2	12.4 ††	3.6	4.6	12.4 ††
Degree ††	30	80	5.9	7.9	8.3	5.4	10.0	12.1
	60	80	0.2	8.2	6.7	-0.8	8.7	5.8
	90	80	-1.2	7.5	3.3	-1.2	7.6	4.6
	120	80	5.1	11.0	13.8	2.9	11.5	15.0
	150	80	1.5	9.6	10.4	-0.1	10.0	10.0
	180	80	4.4	7.9	7.5	4.0	8.0	7.1
	210	80	12.2	9.9	26.3	12.1	10.5	27.1
	240	80	4.2	9.9	12.1	5.4	9.6	11.3
	270	80	3.7	7.2	3.8	4.8	6.6	2.1
	300	80	5.4	9.3	10.0	6.0	8.9	10.4
	330	80	-2.1	8.5	7.1	-2.5	8.8	7.1
	360	80	0.3	6.9	1.7	-0.6	7.3	2.5

† $0.01 \leq p \leq 0.05$; †† $p < 0.01$

◆ Nothing of financial value to disclose

AM E-POSTER 113: Release the Superior Transverse Scapular Ligament During Spinal Accessory Nerve Transfer to Suprascapular Nerve: Should it be Done?

Category: Nerve/Neuromuscular

Keyword: Shoulder

Level 2 Evidence

◆ Ashraf N. Moharram, MD, FRCSEd

Hypothesis: Release the superior transverse scapular ligament during spinal accessory nerve transfer to suprascapular nerve improves functional outcome of the procedure

Methods: Between 2006 and 2010, we have routinely used spinal accessory nerve transfer to suprascapular nerve to restore shoulder abduction & external rotation in 38 patients with traumatic brachial plexus palsy through a standard anterior approach. This was used in upper plexus lesions C5 & C6 as well as C5, C6 & C7 lesions and total plexus lesions. They were all males with an average age of 26 years. The mean timing of surgery was 19 weeks (ranging from 10 to 30 weeks). Patients were randomized into 2 groups. Eighteen patients had release of the superior transverse scapular ligament during the nerve transfer procedure while the remaining 20 patients the ligament was not released. Associated axillary nerve lesions were managed with either nerve transfer from nerve to medial head of triceps or nerve grafting from rupture C5 or contralateral C7 in case of total plexus avulsion to posterior division of upper trunk. Mean follow up duration was 22 months ranging from 18 to 26 months. They were assessed clinically for active range of abduction and external rotation and muscle strength according to the Medical Research Council (MRC) scale¹. The outcome for the spinal accessory nerve transfer was graded as good, fair, or poor using the peripheral nerve injury (PNI) unit scale². Electromyography was used to detect signs of reinnervation of the infraspinatus muscle after the fourth postoperative month.

Results: In the release group, 17 out of our 18 patients (94%) were graded as good using the peripheral nerve injury (PNI) unit scale while in the other group only 13 patients (65%) were graded as good. The first electromyographic signs of reinnervation of the infraspinatus muscle in the release group was at 28 (+/- 5) weeks, compared with 33 (+/-4) weeks in the non-release group.

Summary: We concluded that the release of the superior transverse scapular ligament improves the results of spinal accessory nerve transfer to suprascapular nerve.

References:

- 1) Medical Research Council. Aids to the investigation of peripheral nerve injuries. 2nd edition. London:Her Majesty's Stationery Office; 1943.quoted from Colbert, S.H.& Mackinnon, S.E. (2008): Nerve Transfers for Brachial Plexus Reconstruction, *Hand Clin* 24 (2008) 341–361
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◆ Nothing of financial value to disclose

AM E-POSTER 114: Long Term Outcome After Ulnar Nerve Decompression and Vascularized Submuscular Transposition for Primary Entrapment at the Elbow

Category: Nerve/Neuromuscular

Keyword: Elbow

Level 4 Evidence

- ◆ Ryan Michael Zimmerman, MD
- Jesse B. Jupiter, MD
- ◆ Juan Gonzalez del Pino, MD

Hypothesis: This study evaluated retrospectively the outcomes of a vascularized anterior submuscular ulnar nerve transposition for primary entrapment at the elbow with a minimum follow-up of 6 years using both physician and patient-rated instruments. We hypothesized that patient outcomes would be positive with low complication and recurrence rates.

Methods: From 1992-2010, 110 patients were treated surgically for primary ulnar neuropathy at the elbow by two senior surgeons using a standardized operative technique. Meticulous attention was paid to preserving the extrinsic vascular pedicle of the ulnar nerve in all patients. Eighty-two elbows in 76 patients, 47.8 ± 13.5 years of age at surgery, were followed for an average of 8.3 ± 2.2 (maximum 16.1) years, all with minimum 6-year follow-up. Thirty-two were male and the dominant limb was involved in 49 with average symptom duration of 24.7 ± 45.1 months. Clinical records were reviewed, sensory (S0-2) and motor (M0-5) testing was performed. Dellon's Scores were determined and VAS (rest, activity, frequency), modified Novak et al. and Kleinman and Bishop questionnaires were completed. Preoperatively, 48 elbows were Dellon's Grade III and 33 were Grade II. Results were analyzed using the Wilcoxon signed ranks, Chi-square and Student's t-tests.

Results: There were clinically and statistically significant improvements in both patient and surgeon-reported data regardless of the preoperative clinical stage. VAS pain, sensory and motor function all showed marked improvements. Sensory scale measurements improved from 1.0 ± 0.4 to 1.8 ± 0.4 ($p < 0.001$) and motor strength (M0-5) improved from 3.8 ± 0.6 to 4.7 ± 0.5 ($p < 0.001$), with at least anti-gravity strength in all subjects. Dellon Scores improved significantly, pre- to postoperatively and 38 elbows had normalized to Dellon 0. Of the 33 preoperative Grade IIIs, 15 improved to Grade II, 13 to Grade I, and 5 normalized. Of the 48 preoperative Grade IIs, 16 improved to Grade I and 32 normalized. Bishop postoperative score was 7.4 ± 1.8 , with 73/82 (89%) patients having a good or excellent outcome. There were no reoperations or deep infections.

Summary:

- Vascularized submuscular transposition can be a safe and effective long-term surgical option for primary ulnar neuropathy at the elbow.
- Good or excellent results were achieved in 89% of patients with an acceptable complication rate.
- Preservation of the vascular pedicle during ulnar nerve transposition may be associated with good long-term outcomes.

References:

- 1) Novak CBC, Mackinnon SES, Stuebe AMA. Patient self-reported outcome after ulnar nerve transposition. *Annals of plastic surgery* 2002;48(3):274–80.
- 2) Kleinman W, Bishop A. Anterior intramuscular transposition of the ulnar nerve. *J Hand Surg* 1989;14A:972–9.
- 3) Dellon AL. Review of treatment results of ulnar nerve entrapment at the elbow. *J Hand Surg* 1989;14A:688–700.

Preoperative Dellon Grade	Postoperative Dellon Grade			
	III	II	I	Normalized
II (n=48)	0	0	16	32
III (n=33)	0	15	13	5

Table 1. Pre- and postoperative Dellon Grade as a function of disease severity. Although the gross change in Dellon Grade pre- to postoperatively did not differ based on disease severity ($p=0.82$), Dellon Grade II elbows were more likely than Dellon Grade III elbows to have a lower postoperative disease severity ($p<0.001$).

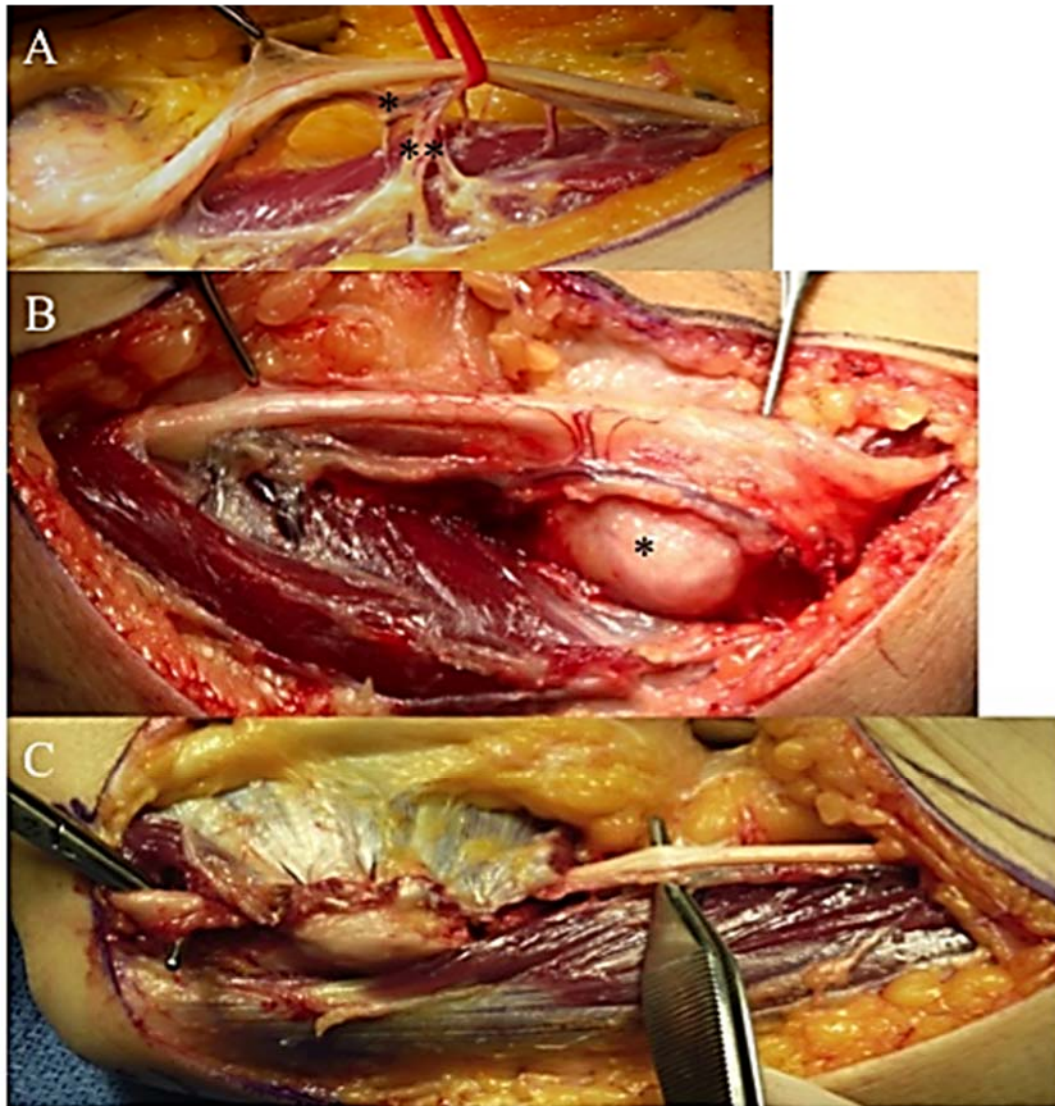


Figure 1. Intraoperative photographs of the authors' technique for vascularized submuscular transposition. (A) Careful dissection allows preservation of the extrinsic vascular supply to the ulnar nerve, including the superior ulnar collateral artery (SUCA) (*) running along the ulnar nerve, as well as branches running from the SUCA to triceps fibers (**). Proximal is on the right. (B) The anastomosis between the PURA (Posterior Ulnar Recurrent Artery) with the SUCA (Superior Ulnar Collateral Artery) around the medial epicondyle (*) can be visualized. Notice some branches arising from these vessels, running distally and proximally along the ulnar nerve. These are epineurial vessels, from which intraneural tributaries arise to perfuse the nerve fascicles. Proximal is on the left. (C) Following transposition, the central two-thirds of the flexor-pronator mass is reattached and the nerve is checked for smooth gliding and no evidence of compression. Proximal is on the right.

- Royalties/Honoraria received from: OHK
- ◆ Nothing of financial value to disclose

AM E-POSTER 115: Persistent or Progressive Median Neuropathy in Perilunate Injuries

Category: Nerve/Neuromuscular

Keyword: Wrist

Level 4 Evidence

- ◆ Neil R. Wickramasinghe, MBChB
- ◆ Andrew Duckworth, MBChB, BSc, MSc, MRCSEd
- ◆ Nicholas Clement, MRCSEd
- ◆ Michiel G.J.S. Hageman, MD
- ◆ Margaret M. McQueen, MD, FRCSEd
- David C. Ring, MD, PhD

Hypothesis: There are no independent predictors of persistent or progressive median neuropathy in perilunate injuries.

Methods: We performed a retrospective study of all patients who were diagnosed and treated for a perilunate dislocation (PLD) or a perilunate fracture-dislocation (PLFD) at two trauma centers. Using a retrospective search of a prospective trauma database, we identified all patients who had sustained a radiologically confirmed PLD or PLFD over a 10-year period.

A review of all medical records was performed. We collected demographic data including age, sex, mechanism of injury, past medical history including alcohol and smoking, type of injury and associated fractures, open or closed dislocations, the development of median neuropathy secondary to the injury, and management. Persistent or progressive median neuropathy was defined as any neurological impairment in the median nerve distribution that was precipitated by the current perilunate injury and persisted or progressed after closed reduction.

The demographic and clinical characteristics of patients were evaluated using bivariate analysis. The significance of categorical variables was assessed using chi-squared tests or two-sided Fisher's exact tests (where less than five cases occurred in a cell). The significance of continuous variables was assessed using the Student's t test, or Mann-Whitney U (MWU) test for continuous non-parametric data. Binary logistic regression was performed to predict significant categorical outcomes between the compared groups. Significance was set at $p=0.05$.

Results: Among the 77 patients treated for PLD or PLFD, persistent or progressive median neuropathy was diagnosed in 34 patients (44%). Median neuropathy was not significantly related to age, sex, medical comorbidities, mechanism of injury, associated open wound, or type of perilunate injury (PLD or PLFD).

Summary:

- We demonstrate a high incidence of acute persistent or progressive median neuropathy accompanying perilunate injuries.
 - There are no independent predictors of acute persistent or progressive median neuropathy in perilunate injuries.
 - All patients with PLD/PLFD merit equally high vigilance for persistent or progressive acute median neuropathy.
-
- Contracted Research with: Skeletal Dynamics
 - Royalties/Honoraria received from: AO North America, AO International, Wright Medical, Medartis
 - Ownership Interest (stocks, stock options, or other ownership interest excluding diversified mutual funds) with: Illuminos
 - Consulting Fees (e.g. advisory boards) received from: Wright Medical, Skeletal Dynamics
 - Other Financial/Material Support received from: Journal of Hand Surgery, Journal of Orthopaedic Trauma, Journal of Shoulder and Elbow Surgery
 - ◆ Nothing of financial value to disclose

AM E-POSTER 116: Functional Recovery of Shoulder Abduction and External Rotation Using Spinal Accessory to Suprascapular Nerve Transfer in Neonatal Brachial Plexus Palsy

Category: Nerve/Neuromuscular

Keyword: Shoulder

Level 4 Evidence

- ◆ Kevin J. Little, MD
- ◆ Emily A. Eismann, MS
- ◆ Emily Loudon, MPH
- ◆ Roger Cornwall, MD

Hypothesis: Spinal accessory (SAN) to suprascapular nerve (SSN) transfer can improve shoulder abduction/external rotation following brachial plexus injuries, although its role remains incompletely defined in neonatal brachial plexus palsy (NBPP). Classically, the transfer is performed through an anterior approach, often along with nerve grafting of the upper trunk. However, a posterior approach with neuroorrhaphy at the scapular notch allows an older age at surgery due to shorter axonal regeneration distance. This study tests the hypothesis that posterior SAN-SSN transfer restores shoulder abduction/external rotation as effectively as anterior transfer, even when performed in older children and without concomitant upper trunk grafting.

Methods: We retrospectively reviewed 50 NBPP patients with minimum 18-month follow-up after SAN-SSN transfer for shoulder abduction/external rotation weakness. Surgical approach was determined by patient age and concomitant persistent upper limb deficits requiring brachial plexus grafting. Pre- and post-operative abduction and external rotation were assessed using the Active Movement Scale (AMS) and compared for each approach using Wilcoxon signed ranks tests. Additionally, the proportion of patients in each group requiring radial-to-axillary nerve transfers or subsequent shoulder abduction/external rotation muscle transfers were compared using Fisher exact tests.

Results: Of the 50 patients, 39 underwent anterior transfer, while 11 underwent posterior transfer. Posterior approach patients were significantly older (10.8 vs. 4.8 months, $p < 0.001$) and had less severe Narakas grades ($p = 0.014$), in keeping with selection criteria. Anterior transfer significantly improved abduction (1.5 to 6, $p < 0.001$) and external rotation (0 to 6, $p < 0.001$), although concomitant C5 grafting was performed in 29/39 (74%) patients. Posterior transfer similarly improved external rotation (0 to 6, $p = 0.011$) but not abduction (4 to 6, $p = 0.11$), likely due to higher pre-operative abduction scores. Concomitant C5 grafting was not performed in any posterior transfer patients, but concomitant radial-to-axillary nerve transfer was performed in 15% (6/39) anterior and 18% (2/11) posterior transfers ($p = 1.00$). Later muscle transfers were

performed in 14 (36%) anterior transfer patients and one (9%) posterior transfer patient ($p=0.14$). In 4/11 posterior transfers, stenosis and post-stenotic dilatation were noted in the suprascapular nerve following release from the scapular notch (Figure 1).

Summary:

- SAN to SSN transfer, when performed from a posterior approach, can restore functional shoulder abduction and external rotation, even in older children, and without concomitant C5 nerve grafting.
- Release or bypass of a double crush lesion of the suprascapular nerve at the scapular notch during posterior SAN-SSN transfer could explain the relative effectiveness of this approach.

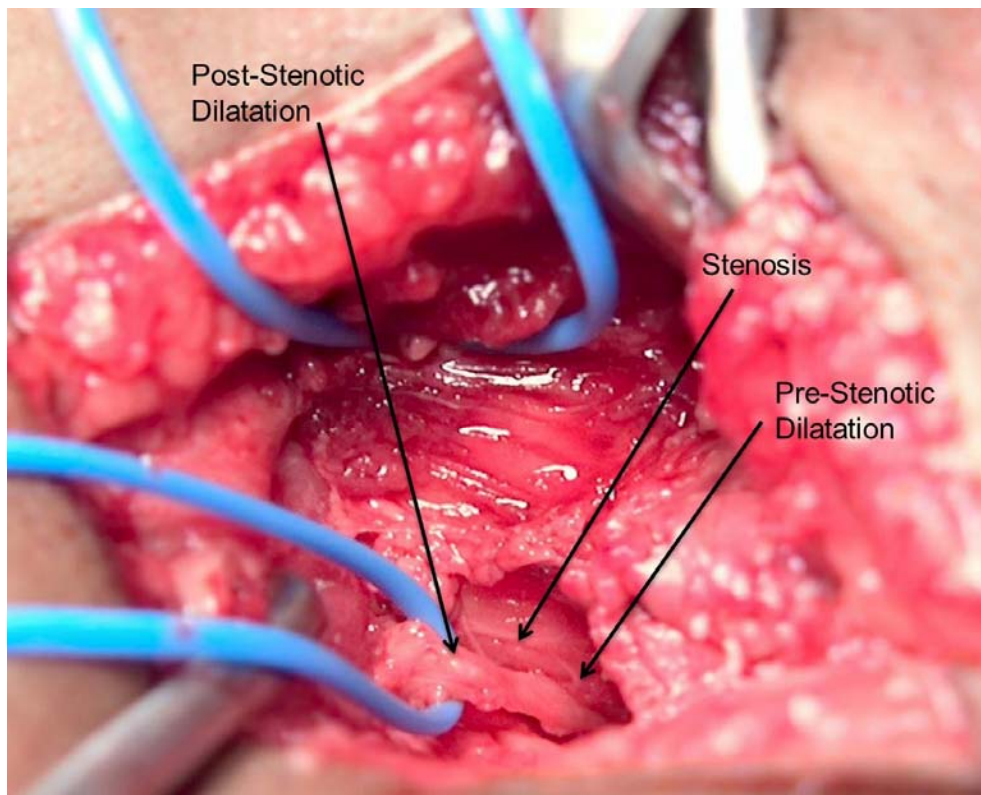


Figure 1. Suprascapular Nerve Compression at the Scapular Notch

◆ Nothing of financial value to disclose

AM E-POSTER 117: Accuracy of Carpal Tunnel Injection: A Prospective Evaluation of 756 Patients

Category: Nerve/Neuromuscular

Keyword: Wrist

Level 4 Evidence

◆ Brendan J MacKay, MD

◆ Steven J. Seiler, MD

◆ David P. Green, MD

Null Hypothesis: Carpal tunnel injection using anatomic landmarks is reproducible and safe.

Methods: Over 8 years, there were 756 attempted placements of a 25-gauge needle into the carpal tunnel in a simulated carpal tunnel injection prior to open carpal tunnel release. The needle was inserted at the wrist crease, just ulnar to palmaris longus¹. Open carpal tunnel release was subsequently performed and the position of the needle was recorded.

Results: In 572 patients (75.7%), the needle was found to be in the carpal tunnel without penetration of its contents. The needle was in the carpal tunnel but piercing the median nerve in 66 attempts (8.7%). The carpal tunnel was missed in 118 attempts (15.6%).

Summary:

- This is the largest study looking at accuracy of carpal tunnel injection using anatomic landmarks.
- Our injection accuracy (75.7%) is less than reported in previously published studies, which note 82-100% accuracy using the same injection technique^{2,3,4}. This may indicate that carpal tunnel injection is less reliable than previously thought.
- Safety of carpal tunnel injection remains an important concern. The median nerve was penetrated in 8.7% of injection attempts.

References:

- 1) Green DP. Diagnostic and therapeutic value of carpal tunnel injection. *J Hand Surg* 1984;9A:850-854
- 2) Wood WR. Hydrocortisone injections for carpal tunnel syndrome. *The Hand* 1980;12(1):62-64
- 3) Ozturk K et al. Comparison of carpal tunnel injection techniques: A cadaver study. *Scand J Plast Reconstr Surg Hand Surg* 2008; 42:300-304
- 4) MacLennan A et al. Comparison of needle position proximity to the median nerve in 2 carpal tunnel injection methods: A cadaveric study. *J Hand Surg* 2009;34A:875-879

◆ Nothing of financial value to disclose

AM E-POSTER 118: Digital Nerve Repair with Processed Nerve Allograft

Category: Nerve/Neuromuscular

Keyword: Hand

Not a clinical study

◆ Ethan W. Blackburn, MD

● ▲ Gregory Merrell, MD

◆ Jeffrey A. Greenberg, MD

Hypothesis: Meaningful recovery can be expected in severely injured digital nerves with segmental loss repaired with processed nerve allograft.

Methods: A retrospective review was conducted on digital nerve injuries repaired with processed nerve allografts from 2009 – 2012. IRB approval was obtained and standardized case report forms were used to collect utilization, safety, and follow-up data. Quantitative assessment included: MRCC scale for sensory function, 2-point discrimination (2PD), Semmes-Weinstein Monofilaments (SWMF), pain assessments, and DASH questionnaire. Demographics, outcomes, and covariate analysis were performed to further characterize the sub-groups. Meaningful recovery was defined by the MRCC scale at S3-S4 for sensory function.

Results: The population consisted of 17 males and 2 females with 24 nerve repairs. Sufficient follow-up data was available in 11 subjects with 13 digital nerve repairs. The mean follow-up period was 463 + 280 days. The average age was 52 (22-81) years. The average time to repair was 125 + 403 (0, 1460) days and the mean gap length was 20 + 8 (8, 30) mm. Saw type injuries were reported in 9 of the 13 repairs.

Meaningful recovery was reported in 11 of 13 repairs. There were two S0, one S3, seven S3+, and three S4. In repairs reporting 2-point discrimination, the mean static 2PD was 10 + 4 (5, 15) mm (n=10) and the mean moving 2-PD was 8 + 4 (4, 15) mm (n=9). Return of protective sensation was reported in 11 repairs via Semmes-Weinstein Monofilament testing. The mean reported DASH score was 18+ 15 (0.8, 43.3). There were no adverse events related to the nerve allograft.

Summary:

- We found that processed nerve allografts performed very well when used for segmental digital nerve reconstructions in the hand.
- These outcomes compared favorably to previous published results for processed nerve allograft and exceed that of nerve tube conduit.

▲ This presentation will discuss Orthomap software and Computer Tomography Navigation System by Stryker

- Consulting Fees (e.g. advisory boards) received from: Stryker power equipment division.
- Other Financial/Material Support received from: Paid Speaker and research funding from Axogen.
- ◆ Nothing of financial value to disclose

AM E-POSTER 119: Pillar Pain After Carpal Tunnel Release in Patients on Hemodialysis

Category: Nerve/Neuromuscular

Keyword: Hand

Level 3 Evidence

◆ Hiroyuki Tanaka, MD, PhD

◆ Toshiyuki Kataoka, MD

◆ Tsuyoshi Murase, MD, PhD

◆ Kozo Shimada, MD, PhD

Hypothesis: Pillar pain is one of the postoperative complications after carpal tunnel release for carpal tunnel syndrome (CTS), which etiology remains to be elucidated. Soft tissue disorders are reported to be partly associated with the pillar pain after carpal tunnel release¹. It is well known that patients with chronic kidney disease are attacked by skin disorders². We hypothesized that the characteristic of pillar pain in patients who had release for hemodialysis-associated CTS was different from that in patients with idiopathic CTS.

Methods: We retrospectively reviewed 41 hands in 33 patients with CTS who were receiving hemodialysis and 138 hands in 116 patients with idiopathic CTS. CTS was diagnosed with clinical symptoms and electrophysiologic findings. Under regional anesthesia, release of the transverse carpal ligament was performed with the limited open approach within the palm and hypertrophic tenosynovitis was removed simultaneously in all patients. Pneumatic tourniquet was not applied for patients on hemodialysis with an ipsilateral arteriovenous fistula. We defined the presence of tenderness on radial or ulnar side of the operative scar as pillar pain and evaluated the frequency of pillar pain at 1.5, 3, 6, 9 and 12 months postoperatively. In patients on hemodialysis we also estimated whether the duration of hemodialysis or the side of arteriovenous fistula influenced the occurrence of pillar pain.

Results: Pillar pain was found with the ratio of 47, 33, 11, 0 and 0% at 1.5, 3, 6, 9 and 12 months follow-up respectively in hemodialysis-associated CTS patients. These were significantly less compared to those in patients with idiopathic CTS (85, 70, 36, 30 and 19% respectively). In hemodialysis-associated CTS patients, the duration of hemodialysis or the side of arteriovenous fistula did not influence the frequency of pillar pain postoperatively.

Summary:

- The frequency of pillar pain after carpal tunnel release in hemodialysis-associated CTS patients was less than that in idiopathic CTS patients.
- Complications associated with hemodialysis or decline in the activities of daily living may affect the occurrence of pillar pain after carpal tunnel release.

References:

- 1) Pillar pain as a postoperative complication of carpal tunnel release: a review of the literature. Ludlow KS, Merla JL, Cox JA, Hurst LN. J Hand Ther. 1997;10(4):277-82.
- 2) Skin problems in chronic kidney disease. Kuypers DR. Nat Clin Pract Nephrol. 2009;5(3):157-70.

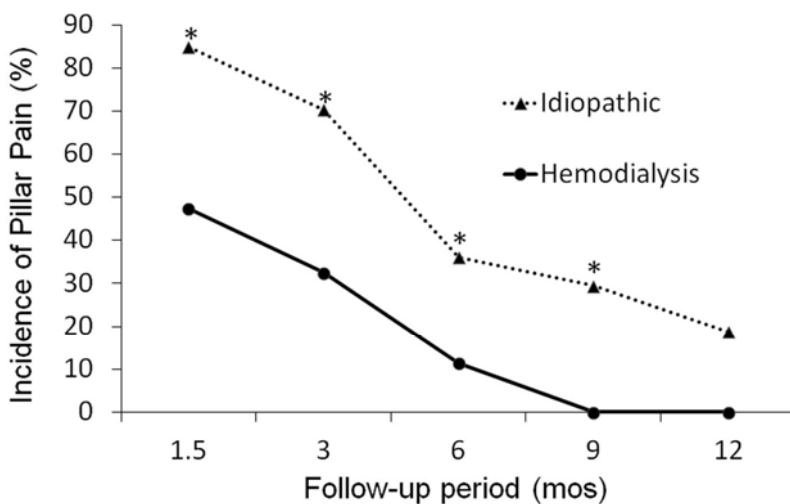


Figure 1. Each incidence of pillar pain is shown in idiopathic CTS patients and hemodialysis-associated CTS patients at 1.5, 3, 6, 9, and 12 months. Significance was determined by chi-square test. *p < 0.01.

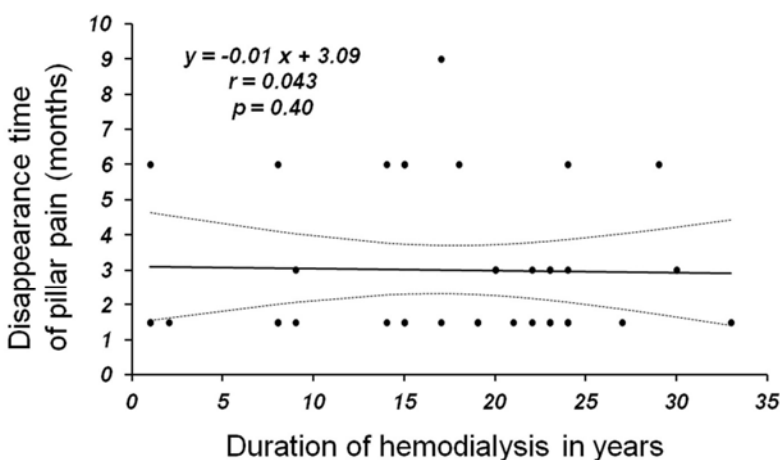


Figure 2. Correlation between duration of hemodialysis and disappearance time of pillar pain is shown. Significance was determined by Spearman's correlation.

◆ Nothing of financial value to disclose

AM E-POSTER 120: Sonography of the Carpal Tunnel in Normal, Preoperative and Post Operative Patients

Category: Nerve/Neuromuscular

Keyword: Hand

Level 3 Evidence

◆ Somesh D. Beeharry, MD

Hypothesis: This prospective study is to compare the measurements of the median nerve and the carpal tunnel (CT) in normal individuals with those found before and after surgical release in patients with carpal tunnel syndrome (CTS).

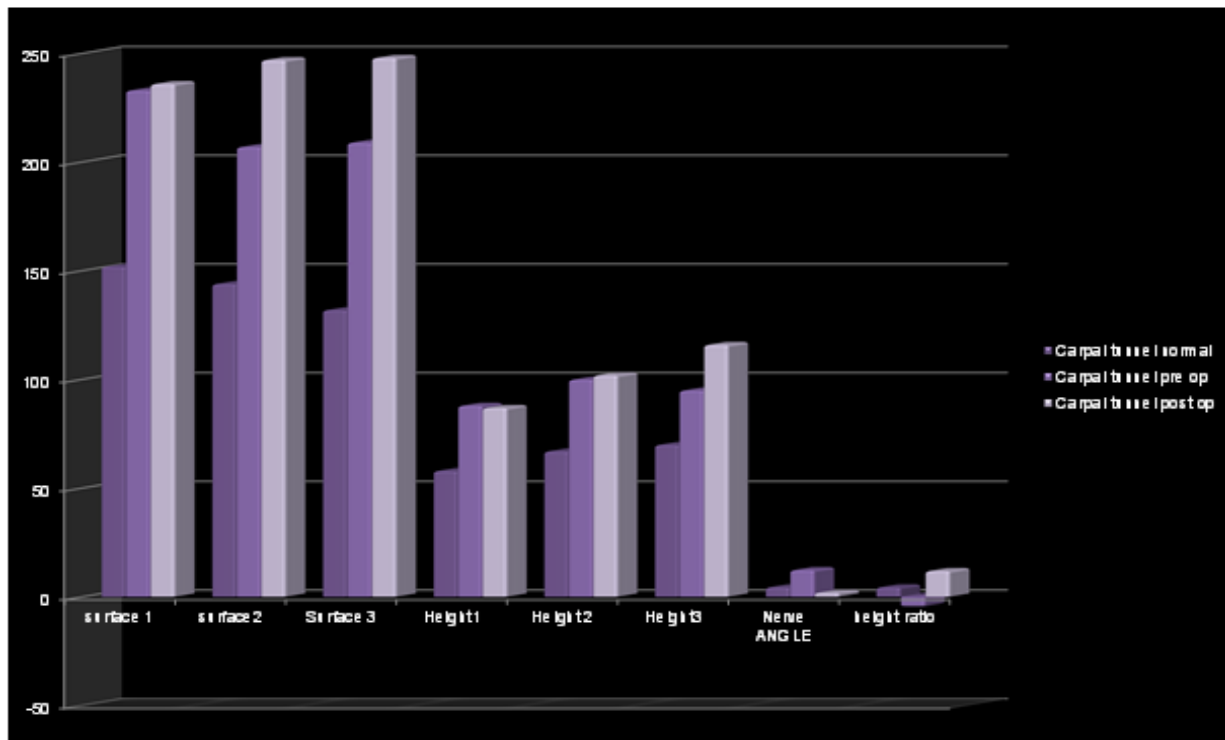
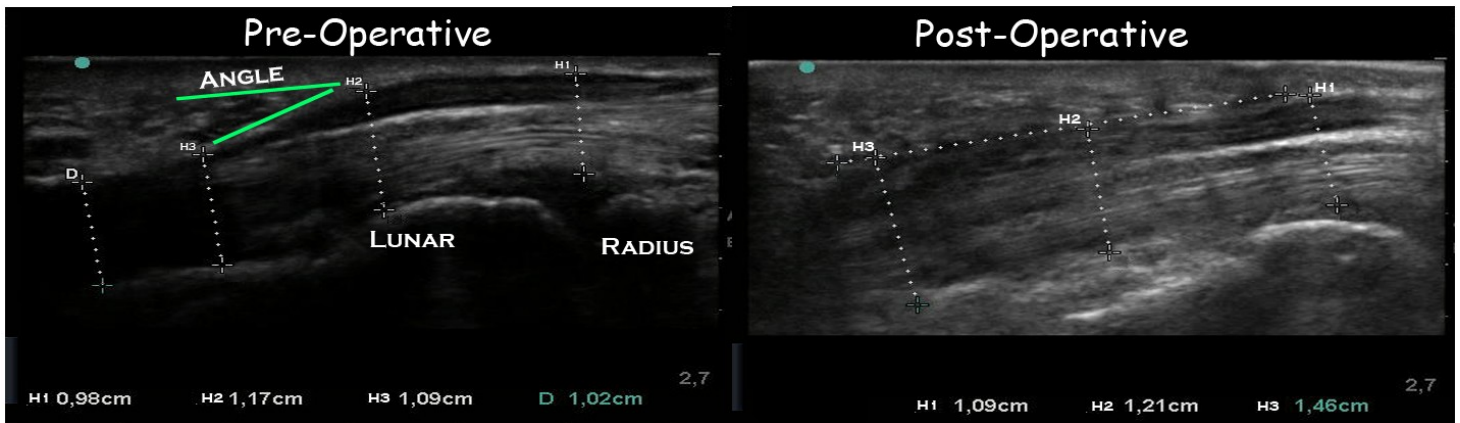
Methods: Twenty-four healthy undergraduate students (48 wrists, 10 females, mean age 21.1, range 18 to 22) and forty-eight patients scheduled for surgical release for CTS (28 females, mean age 56.3, range 25-86, 26 right wrist) had sonography of their CT by one examiner who was not blinded and patients were seen before and one month after surgery. A 5-16MHZ probe from Sonosite was used. Transverse sonograms were made at 3 levels: radiocarpal, lunocapitate, and carpometacarpal joint. Longitudinal image of the CT was captured when the nerve was seen through the tunnel. The images were analysed by 3 technicians who measured the following using direct tracing: Cross sectional area of the nerve inside (CSAi) and outside (CSAe) the hyperechoic perimeter, the nerve angle inside the CT and for the CT the surface area and height at the 3 levels named S1, S2, S3, H1, H2, H3 from proximal to distal (Figure 1). Data were transmitted for statistical analysis with Pearson's X-test and ratio calculations. We consider differences as significant in dimension and ratio between the series when $p < 0.05$

Results: The results are shown in Figure 2. The nerve angle (mean value from 14° to 2°) and the height ratio H3/H2 (mean value from -4% to + 16%) are completely corrected by surgical release and tend to normal values. The CSAi (from 12,7 to 11,3 sq mm) gets very slightly better but not normal (< 8). The flattening ratio of the nerve (from 3.28 to 3.42) and the CSAi/CSAe index -which translates nerve edema - (mean value from 1,63 to 1,71) deteriorate after release.

Summary: Thickening of the distal part of the transverse carpal ligament is the cause of Carpal Tunnel Syndrome and its transection corrects the nerve angle and the height of the distal portion of the CT. It is generally admitted that compression is the cause of CTS and in this study we demonstrate that kinking of the median nerve is main problem and its correction treats the problem. This needs reflection and can lead us to think about new conservative treatment options that can lead to nerve angle correction or TCL thinning .

References:

- 1) Phalen GS ,GardnerWJ ,La Londe AA Neuropathy of the median nerve due to compression beneath the transverse carpal ligament . J Bone Joint surg AM 1950 Jan;32 (1) 109-12
- 2) Michael S Cartwright Evidence-based guideline :Neuromuscular ultrasound for the diagnosis of carpal tunnel syndrome Muscle Nerve 46;287-293 2012
- 3) Jeffery G Jarvik Surgery versus non surgical therapy for carpal tunnel syndrome : a randomised parallel-group trial The Lancet vol 374 issue 9695 1074-1082 2009
- 4) Seang yeo Ahn Pressure measurement in Carpal Tunnel syndrome : correlation with Electrodiagnostic nd Ultrasonographic findings J korean Neurosurg soc 46;199-204 2009



◆ Nothing of financial value to disclose

AM E-POSTER 121: Carpal Tunnel Decompression in Patients with Negative Nerve Conduction Studies; A Prospective Study of Outcomes

Category: Nerve/Neuromuscular

Keyword: Hand

Level 3 Evidence

- ◆ Mr. Oliver D. Stone
- ◆ Mr. Paul J. Jenkins
- ◆ Ms. Jane E. McEachan
- ◆ Andrew Duckworth, MBChB, BSc, MSc, MRCSEd

Hypothesis: We predict that outcomes following carpal tunnel decompression (CTD) in patients with normal nerve conduction studies (NCS) will be worse than patients with positive findings on NCS.

Methods: Data was collected prospectively in all patients undergoing CTD in a single centre from 2004 to 2012. Demographics, symptoms, nerve conduction studies and Pre and post-operative Dash scores (disabilities of the Arm, Shoulder and Hand) were collected. Patients with normal nerve conduction studies that went on to have a CTD were analysed to evaluate outcomes and this group was compared to a matched cohort with positive findings on NCS.

Results:

- 1366 patients were included in the initial dataset. After excluding all patients with positive findings on NCS we had 21 suitable patients of which 20 patients had complete data (95.2%).
- The average age was 50.9 years, with a median age of 54 and a range of 26 -69 years old. The average pre-operative DASH score was 56.9 with an average DASH score of 34.9 at the 1 year review.
- The average age of the cohort with positive NCS was 55.53 with a median age of 56 and a range of 24-79 years old. Pre-operative DASH scores in the rest of the Cohort was 54.36 with the average post-operative scores at 1 year of 21.25.

Summary:

- This is the first prospective study evaluating outcomes after CTD in patients with normal NCS.
- Our results demonstrate that patients with carpal tunnel symptoms but with negative NCS gain an improvement in functional outcome at 1 year. However these patients do not experience the same degree of improvement when compared to a matched group with positive findings on NCS.

- Our study shows that patients with a good clinical history and examination findings consistent with carpal tunnel syndrome but negative NCS do worse than a matched group of patients with positive findings on NCS. Our results are a useful tool when consenting patients for CDT on a background of normal NCS.

◆ Nothing of financial value to disclose

AM E-POSTER 122: Carpal Tunnel Decompression in the Super-Elderly; a Prospective Study of Outcomes

Category: Nerve/Neuromuscular

Keyword: Hand

Level 3 Evidence

◆ Mr. Oliver D. Stone

◆ Ms. Jane E. McEachan

◆ Mr. Paul J. Jenkins

Hypothesis: We predict that outcomes following carpal tunnel decompression (CTD) in the super-elderly will lead to satisfactory results and will be comparable to younger cohorts

Methods: Data was collected prospectively in all patients undergoing CTD in a single centre from 2004 to 2012. Demographics, symptoms, nerve conduction studies and Pre and post-operative Dash scores (disabilities of the Arm, Shoulder and Hand) were collected. Patients over the age of 80 at the time of presentation were analysed to evaluate outcomes and this group was compared to younger matched group. We evaluated the Dash scores in the elderly group and compared them to a matched set of younger patients.

Results:

- 1366 patients were included in the initial dataset. After excluding all patients below the age of 80 we had 144 suitable patients of which 99 patients had complete data (68.8%).
- The average age was 83.8, with a median age of 83 and a range of 80 -96 years old. All patients in this cohort had NCS that were either moderately severe or severe except for 1 patient with mild NCS. The average pre-operative DASH score was 54.93 with an average DASH score of 25.41 at the 1 year review.
- The average age of the younger cohort was 56.0 with a median age of 56 and a range of 24-79 years old. Pre-operative DASH scores in the rest of the Cohort was 54.27 with the average post-operative scores at 1 year of 21.70.

Summary:

- This is the largest prospective study of the super-elderly population undergoing carpal tunnel decompression in a single centre to date.
- Our results show that CTD in this group gives predictable and good outcomes when compared to a younger population. Overall the elderly population present with more severe change on NCS, but comparable DASH scores. The outcome in elderly patients is similar to that of a younger cohort.

- Even with severe disability preoperatively these patients gain significant improvement and therefore we suggest that CTD is an extremely effective treatment in the super-elderly.

◆ Nothing of financial value to disclose

AM E-POSTER 123: Evaluation of Cold Sensitivity, Pain and Quality of Life after Upper Extremity Nerve Injury

Category: Nerve/Neuromuscular

Keyword: Hand

Level 4 Evidence

◆ Christine B. Novak, PT, PhD

◆ Susan E. Mackinnon, MD

Hypothesis: Cold sensitivity with severe pain has been reported following upper extremity trauma and contributes to poor outcome and quality of life (QoL). In patients with upper extremity nerve injury, we hypothesized that: 1) more severe cold sensitivity and pain would have a higher negative impact on QoL; 2) patients who select a single descriptor of “coldness” would have more pain, higher cold sensitivity scores and greater impact on QoL.

Methods: This cross sectional study included adult patients more than 6 months after an upper extremity nerve injury. As part of initial standard assessment, patients completed a Pain Evaluation Questionnaire (pain descriptors, questionnaire and visual analog scales for pain intensity, stress, coping, and impact on QoL), the Cold Intolerance Severity Scale (CISS) and the Disabilities of the Arm Shoulder and Hand (DASH). Demographic data were recorded. Statistical analyses (correlation coefficients, unpaired t-tests) were used to evaluate the relationships between the components of the Pain Evaluation Questionnaire, CISS, DASH and the independent variables.

Results: There were 72 patients (mean age 42 ± 16 years). The mean scores were: CISS 34.2 ± 24.6 ; DASH 46.5 ± 20.2 ; pain questionnaire 16.0 ± 4.2 ; pain descriptors 5.0 ± 3.5 ; pain intensity 4.9 ± 2.7 ; stress at home 5.2 ± 3.0 work 4.6 ± 3.2 ; coping at home 3.0 ± 2.2 work 2.9 ± 2.6 ; impact on QoL 6.8 ± 3.0 . Preliminary analyses revealed 24 patients selected the descriptor “coldness” on the Pain Evaluation Questionnaire. Those patients had significantly higher CISS scores ($p < .004$), pain intensity ($p < .01$) and impact on QoL ($p < .003$) compared to those that did not select “coldness”. There were strong correlations between pain with cold exposure and CISS score ($r = .78$); average pain intensity ($r = .58$); pain descriptors ($r = .49$); impact on QoL ($r = .32$); DASH ($r = .29$).

Summary:

- Pain with cold exposure is associated with higher cold sensitivity and disability scores and greater impact on QoL.
- Reporting a single pain descriptor of “coldness” was associated with more severe cold sensitivity, higher pain intensity and greater impact on QoL.

- This may have important implications for quick screening of patients with cold sensitivity.

◆ Nothing of financial value to disclose

AM E-POSTER 124: Tacit Learning Program Enhances Operability of Myoelectric Hand Prostheses.

Category: Orthotics/Prosthetics

Keyword: Forearm

Level 4 Evidence

◆ Shintaro Oyama, MD

◆ Hitoshi Hirata, MD

Hypothesis: Human beings use two different modes of learning, i.e. explicit and tacit learning, to acquire skills. The former happens with learner's awareness, while the latter takes place subliminally. Owing to tacit knowledge, one can articulate complex motions involving many muscles. Tacit Learning system^{1,2} has already been introduced to humanoid robots with some degree of self-sufficiency. We have developed a myoelectric hand prosthesis equipped with this Tacit Learning system to auto-regulate the forearm rotation in response to upper extremity movement pattern.

This study was conducted to test our hypothesis that equipping Tacit Learning system with prosthesis improves operability and reduces physical burden.

Methods: A new forearm prosthesis equipped with Tacit Learning system for forearm auto-regulation were developed.

Three forearm amputees (Table1) were fitted with Tacit Learning prosthesis and tested through a series of tasks requiring forearm rotation. Serial changes in rotation angle of the prosthesis and compensatory rotation at the shoulder were monitored.

Results:

- Compensatory angle decreased by 18 degrees on the average in the course of 40 trials, while rotation angle of the prosthesis increased in parallel and reached 13.7 degrees at the last trial. (Fig1)
- The patient described the prosthesis motion as helpful and appropriate.

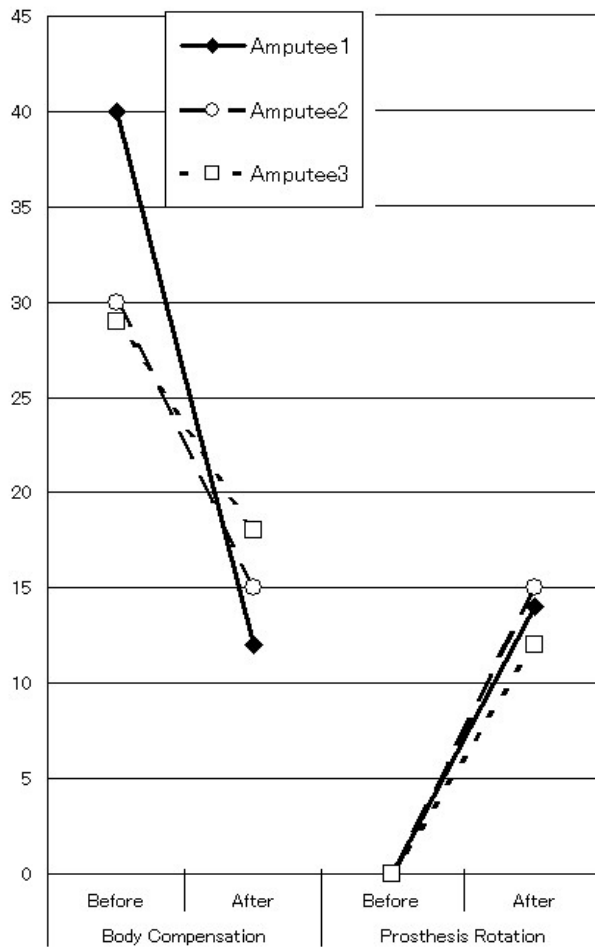
Summary: In this experimental study, we equipped a conventional 2 channel myoelectronic hand with a newly developed forearm rotation unit which is auto-regulated by the Tacit Learning program. Although the sample size is small, this study clearly demonstrated that the Tacit Learning program can gradually learn patients' compensatory movement pattern and automatically produce forearm rotation in such a way to reduce patients' physical burden. Furthermore, Tacit Learning system can be introduced into various scenes that requires biological feedback and provides proprioceptive feedback to the patients.

References:

- 1) Shimoda S, and Kimura H: "Biomimetic approach to tacit learning based on compound control.", IEEE Trans Syst Man Cybern B Cybern, 40(1), 77-90 (2010)
- 2) Shingo S, and Hidenori K: "Neural Computation Scheme of Compound Control: Tacit Learning for Bipedal Locomotion", Journal of Control, Measurement, and System Integration, 1(4), 275-283 (2008)

Amputee	Age	Sex	Laterality	Conventional Prosthesis
1	71	M	Left	Cable hook
2	43	M	Left	2Channel Myoelectric
3	39	M	Right	2Channel Meoelectric

Table1



◆ Nothing of financial value to disclose

AM E-POSTER 125: Is Multimodal Analgesia as Effective as Postoperative Patient-Controlled Analgesia Following Upper Extremity Surgery?

Category: Other
Keyword: Elbow
Level 2 Evidence

- ◆ Sang Ki Lee, PhD
- ◆ Jae Won Lee, MD
- ◆ Youn Moo Heo, MD

Hypothesis: Postoperative pain adversely affects patients' desire for and ability to undergo effective rehabilitation, and can even influence surgical outcome. The upper extremities are particularly sensitive to pain because they utilize multiple joints and require fine manipulation. The purpose of our study was to determine whether multimodal analgesia including pre-emptive analgesic can provide similar or superior analgesic effects and a lower incidence of adverse effects than postoperative PCA following upper extremity surgery.

Methods: We randomly assigned 61 patients who were to undergo upper extremity surgery into 1 of 2 analgesic groups prospectively: Group A (n = 30) received multimodal analgesia including pre-emptive analgesics (cyclooxygenase-2 inhibitor, pregabalin, and non-steroidal anti-inflammatory drugs orally), whereas group B (n = 31) received intravenous PCA postoperatively, without pre-emptive analgesics. We compared the pain scores, achievement of scheduled range of motion exercise, administration of additional pain rescue, opioid-related complication rate, and patient satisfaction between both the groups.

Results: We observed no significant differences in the resting and exercise pain scores, the administration of additional pain rescue during postoperative day (POD) 1, 2 and the achievement of rehabilitation protocol between the groups. However, the administration of additional pain rescue increased significantly after PCA removal in group B. Moreover, there was a significant difference in the incidence of opioid-related complications on operation day and POD 1 between the groups. At discharge, compared with group B, group A showed significantly greater satisfaction with their method of analgesia.

Summary: Multimodal perioperative analgesia including pre-emptive analgesics is effective for pain management following upper extremity surgery, and can be an acceptable alternative method to postoperative PCA.

- ◆ Nothing of financial value to disclose

AM E-POSTER 126: Locking Versus Non-locking Plate and Screw Fixation of Ulnar Shortening Osteotomies

Category: Other

Keyword: Forearm

Level 3 Evidence

- Frederik Verstreken, MD
- Roger P. van Riet, MD, PhD
- ◆ Jan Vermeire, MD

Hypothesis: Adding locking screws to the plate fixation of a transverse ulnar shortening osteotomy does not affect the time to healing on radiographs.

Methods: Radiographs of 54 patients who underwent a transverse ulnar shortening osteotomy for an ulnar abutment syndrome, were analyzed for time to union of the osteotomy. Patients were divided into two equal groups. The osteotomy was fixed with a 6 hole LCP small fragment plate (Synthes) plate and 6 screws in all patients. At least two locking screws, one proximal and one distal to the osteotomy were used in the first group. Time to healing was compared with a matched group in whom 6 standard 3.5 mm cortical screws were used to stabilize the osteotomy. Radiographs were evaluated at a median of 6, 12, 14 and 16 weeks postoperatively. Time until bridging callus formation and time to complete union on radiographs, was assessed by 3 experienced hand surgeons. Patients in the locking fixation group were matched to patients that had non-locking fixation, by age, using the 'nearest neighbour' method. The Mahalanobis distance was used as a measure of similarity between two individuals. Inter-observer reliability was measured using the Fleiss' kappa value. The Shapiro-Wilk test was used to assess normality. As time until bridging callus formation was not normally distributed ($p < 0.001$), the non-parametric Mann-Whitney U-test was used to evaluate this parameter. Time to complete union was normally distributed ($p = 0.723$), and was interpreted with the independent sample t-test.

Results: No loss of fixation or other radiographic problems were found in either group. Radiographs were available for all patients (27 in each group) to evaluate time until bridging callus formation. Time until bridging callus formation was seen on radiographs was 85.1 days (SD: 32.6) in the locking group, and 87.6 days (SD: 33.9) in the non-locking group ($p = 0.836$). Four patients in the locking screw group were lost to follow-up before complete union was seen on radiographs. Time to complete union of the osteotomy on radiographs was 148.0 days (SD: 43.0) in the locking group and 145.5 days (SD: 36.5) in the non-locking group ($p = 0.834$).

Summary: Adding locking screws to the plate fixation of a transverse ulnar shortening osteotomy did not affect the time until bridging callus formation, nor the time to complete union of the osteotomy.

- Consulting Fees (e.g. advisory boards) received from: Medartis, Pfizer (Verstreken); Acumed (van Riet)
- ◆ Nothing of financial value to disclose

AM E-POSTER 127: Factors Used by Program Directors to Select Hand Surgery Fellows

Category: Other

Keyword: Hand

Not a clinical study

- ◆ Matthew S. Nies, BS
- ◆ Alexander J. Bollinger, MD
- ◆ Charles Cassidy, MD
- Peter J.L. Jebson, MD

Hypothesis: There are identifiable and consistent factors and attributes preferred by Hand fellowship program directors in the selection and ranking of hand surgery fellowship applicants.

Methods: An anonymous web based questionnaire related to the selection of applicants for interview and final ranking was sent to all hand fellowship program directors in the United States. The questionnaire was designed to identify the most important criteria in; (a) granting an interview (b) sources of letters of recommendation (c) the interview process (d) highly ranking a candidate. Each criterion was ranked in importance on a 1-5 Likert scale, with a value of 1 being “not important,” and 5 being “critical.” The most important criteria for each section of the survey were determined by comparing the average Likert scores.

Results: 52 of 76 program directors responded (68%). The criteria, in order of importance, with the highest mean Likert scale scores for offering an applicant an interview were: quality of the letters of recommendation (4.33 ± 0.76), orthopaedic surgery residency training (3.83 ± 1.20), comments regarding the applicant’s technical competence (3.83 ± 0.83), applicant having an M.D. versus D.O. degree (3.77 ± 1.17), and residency program reputation (3.46 ± 0.87). The letters of recommendation on which the highest value is placed come from a Division Chief of hand surgery (4.04 ± 0.77), and other hand surgeon in division/department (3.62 ± 0.93). The most important features of the interview were: maturity of applicant (4.13 ± 0.66), ability of applicant to articulate thoughts (3.98 ± 0.70), ability to listen well (3.81 ± 0.79), degree of self-confidence (3.56 ± 0.70), and relevant questions asked (3.54 ± 0.75). Finally, the most important factors in highly ranking a candidate were: applicant integrity (4.65 ± 0.68), applicant’s commitment to hard work (4.48 ± 0.61), quality of letters of recommendation (4.31 ± 0.71), quality of the interview (4.25 ± 0.76), and ability to work well with other members of the hand surgery team (4.23 ± 0.81). The least important factors in ranking a candidate were: gender (1.21 ± 0.54), race (1.21 ± 0.54), geographic location of residency program (1.56 ± 0.87), and microsurgical experience (1.92 ± 0.93).

Summary:

- Competition for a hand surgery fellowship position is increasing with a 25% unmatched rate for appointment year 2013.
- The information gleaned in our study should be useful for medical students and residents interested in a career in hand surgery.

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- Royalties/Honoraria received from: Elsevier
- Consulting Fees (e.g. advisory boards) received from: GLG Consulting
- ◆ Nothing of financial value to disclose

AM E-POSTER 128: Distal Interphalangeal Joint Arthrodesis Using Nitinol Intramedullary Fixation Implants

Category: Other
Keyword: Hand
Level 4 Evidence

- ◆ William H. Seitz, Jr., MD
- ◆ Marko Marbella, MD

Hypothesis: Arthrodesis is a successful operative procedure for the treatment of intractable pain, instability and deformity of the distal interphalangeal joint (DIPJ) of the fingers, and the interphalangeal joint (IPJ) of the thumb. Multiple fixation techniques have been utilized in the past including Kirschner wires, tension bands, headless screws, or lag screws. Clinical results are acceptable, but complication rates have been reported to vary between 10-20%. Complications include nonunion, pain, malunion, infection, nerve injury, and protruding hardware. The authors have hypothesized that an alternative technique for arthrodesis of the DIPJ of the fingers or IPJ of the thumb using Nitinol implants for intramedullary fixation can provide a high rate of satisfactory union and improved anatomic position with a minimal complication rate.

Methods: A retrospective review was performed of 32 distal interphalangeal joints and/or thumb interphalangeal joint arthrodeses in 16 patients, between 46 and 79 years with a mean age of 62 years. All patients underwent arthrodesis using local bone graft and the X-Fuse(C) dynamic memory metal implant (Stryker, Mahwah, NJ). All procedures were performed under region anesthesia as an outpatient. In five patients, a single joint arthrodesis was performed while 11 patients underwent multiple joint arthrodesis at the same surgical procedure. All patients were treated with autologous bone graft. A bulky soft dressing with a splint was applied at surgery and kept in place for one week. PIP and MP joint motion was encourage during this phase of healing.

Results: The mean time to healing was eight weeks. By ten weeks, healing was noted in 31 of 32 digits. The one patient with delayed union after ten weeks appeared to have formed a fibrous union which was stable and non-tender. All patients described complete absence of pain and complained of no significant pain or dysfunction by three months post-operatively. There have been no hardware problems and in no case was hardware removed or surgery required.

Summary: The technique utilizes instrumentation which simplifies the surgical procedure, affords excellent apposition of bone, and intramedullary fixation of the arthrodesed joint. Variability in angle of the implants affords the surgeon the ability to place the fused joint in neutral 15 or 25 degrees of flexion as needed. The absence of any hardware related problems, lack of infection and high rate of union indicates this to be a viable and attractive option for arthrodesis of the distal joints in the hand.

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◆ Nothing of financial value to disclose

AM E-POSTER 129: Vascularized Fibular Flap in the Treatment of Upper Extremity Tissue Defects

Category: Other

Keyword: Forearm

Level 4 Evidence

◆ Mismil I. Muradov, MD, PhD

◆ Yermek A. Akhmetov, MD, PhD

◆ Timur A. Sadykov, Resident

Hypothesis: Extensive defects of the forearm bones diaphysis are the result of severe trauma, gunshot fractures, bone fragments vicious union and segmental resections in osteomyelitis or tumors, and constitute 22-24% of the total number of injuries. We tried to improve the treatment results in patients with large defects of the forearm bones, through the use of microsurgical autotransplantation of vascularized fibular flap.

Methods: From August 2007 to January 2013 we treated 25 patients with large segmental defects of one of the forearm bones, using the vascularized fibular flap. The majority of patients were young men of working age - 18 to 45 years (74%). Causes of bone tissue defects were: severe trauma - 6, osteonecrosis - 11, osteomyelitis - 2, false joints - 3, tumor - 3. Average duration of disease was 6 - 24 months.

The operation is performed simultaneously by two teams. The first one performed necrectomy, sequestrectomy of forearm tissues, osteotomy of the radius and ulna bones, blood vessels, that is, made preparations of "bed" for autotransplant. Second team performed harvesting of polycomplex tissues (skin, fascia, muscle, and a fragment of the fibula) by standard methods.

Results: In long-term period 24 patients had complete flap retention with consolidation of bone fragments, and full or partial restoration of the operated extremity function. In one case flap lysis was occurred. For evaluation of the effectiveness of treatment we used standard objective criteria: the amount of movement in three planes in adjacent joints, compared with the normal, hand dynamometry, radiological signs of retention. Functional insufficiency of the upper extremity according to the DASH questionnaire in patients before surgery was $64,25 \pm 2,64$ points, compared to patients who underwent surgery - $12,27 \pm 2,64$ points .

The use of vascularized bone grafts led to the retention of the recipient bone and autotransplant (type of primary bone callus), and restore extremity function up to $85\% \pm 3,77\%$ points. Perfused flaps, improving the biomechanics by accelerating the process of restructuring of the transplant, can significantly reduce the time of treatment.

Summary: The architecture, anatomy and structure of the fibula are ideal for forearm bones defects plastics. Another advantage of the bone flap are: the possibility of "through" inclusion of

peroneal artery into the defect of “receiving bed” artery, which increases the reliability of flap blood supply and the possibility of forming a double transplant on one vascular pedicle for the plastics of both forearm bones.

◆ Nothing of financial value to disclose

AM E-POSTER 130: Surgical Methods in Defects and Deformities of Hand Covering Tissues

Category: Other
Keyword: Hand
Level 4 Evidence

◆ Mismil I. Muradov, MD, PhD

Hypothesis: Despite the advances in modern traumatology and combustiology, 75% of patients with defects and deformities of hand covering tissue develop rough scar defects, deformities, contractures and long-time healing ulcers, which leads to serious disability. We tried to optimize the surgical treatment of deformities and defects of hand cover tissues using different plastics methods depending on the location of the lesion.

Methods: From July 2005 to February 2013 we operated 176 patients with defect or deformity of hand and fingers tissues (69 patients - with the sequelae of thermal burns, 107 - consequences of hand trauma. In 58 patients the palm deformity combined with cicatricial degeneration of interdigital spaces skin (syndactyly-type), causing finger I contracture. In 26 patients the palm located scar caused flexion contracture of fingers, palm contraction into a fist. Trophic ulcers of hand were in 12 cases (diameter - 4-5 cm). 19 patients had a post-traumatic palm tissue defects. Following methods of hand tissue damage removal were used: plastics by local tissues - 102 patients; autodermoplasty - 34 patients; plastics by flap on the supplying pedicle - 1, radial flap transplantation or transposition - 29. The choice of method was determined after excision of damaged covering tissues.

Results: All patients had engraftment of transplanted or replaced tissues within 7-12 days. In the late period (6-12 months) they had recovery of hand and fingers function. 7 (4%) patients had limitation of fingers movement in the metacarpophalangeal and interphalangeal joints, while the patients were able to exercise the capture and returned to his previous work. In all patients with hand soft tissue defects and scar contractures began the improvement of the form and function of the hand.

Summary:

- In limited scar deformation of hand covering tissues and an adequate reserve of the adjacent intact tissue the use of local tissue plastics is preferable.
- In cases of extensive lesions of covering tissues of hand and fingers dorsum, the fingers palmar surface within the skin and subcutaneous fat, the free non-vascularized split or Wolfe's graft can be used.

- In patients with deep tissue lesions, the use of transplantation or transfer of full-thickness vascularized flaps with simultaneous microsurgical reconstruction of the damaged anatomical structures is preferable.
- In the absence of the conditions to the closure of deep tissue defects by vascularized flap, the use of pedicled skin-fat flaps with simultaneous or staging recovery of injured hand anatomical structures is efficient.

◆ Nothing of financial value to disclose

AM E-POSTER 131: Osteoarthritic Elbows in Professional Baseball Pitchers: A Radiographic Study up to 13 Years' Follow-up

Category: Other
Keyword: Elbow
Level 3 Evidence

- ◆ Kazuki Sato, MD, PhD
- ◆ Takuji Iwamoto, MD, PhD
- ◆ Noboru Matsumura, MD, PhD
- ◆ Yoshiaki Toyama, MD, PhD
- ◆ Toshiyasu Nakamura, MD, PhD
- ◆ Koichi Horiuchi, MD

Hypothesis: There has been no study investigating the progression and severity of osteoarthritic changes in the elbow induced by throwing activity in the professional baseball pitchers. The purpose of this study was to analyze the relationship between the severity of osteoarthritic changes in the pitching elbow and the length of the pitcher's careers.

Methods: The subjects of this study were 40 professional baseball pitchers whose dominant elbow was retrospectively evaluated by radiographs taken at annual medical check-up. The age at the time of the initial survey ranged from 18 to 31 years, and the average professional career was 2.8 years. The average follow-up period was 7.7 years (range, 5-13 years). Pitching form was classified into three types; overarm in 22 pitchers, three-quarter in 7, and sidearm in 11. Radiographs of the elbow in both anteroposterior and lateral views were examined. The severity of osteoarthritic changes was evaluated by the number, size, and sites of bone spurs, and graded according to the following criteria: grade 0, no obvious spur formation; grade 1, one spur at least 2 mm in length; grade 2, two or more spurs in a limited area; grade 3, multiple spurs in a wide area.

The relationship between the severity of osteoarthritis and the length of the professional baseball pitchers' career was analyzed. Spearman's rank correlation coefficient was utilized to test the relationship between the severity of osteoarthritic changes and the length of the professional baseball pitchers' careers. P value of less than 0.05 was considered statistically significant.

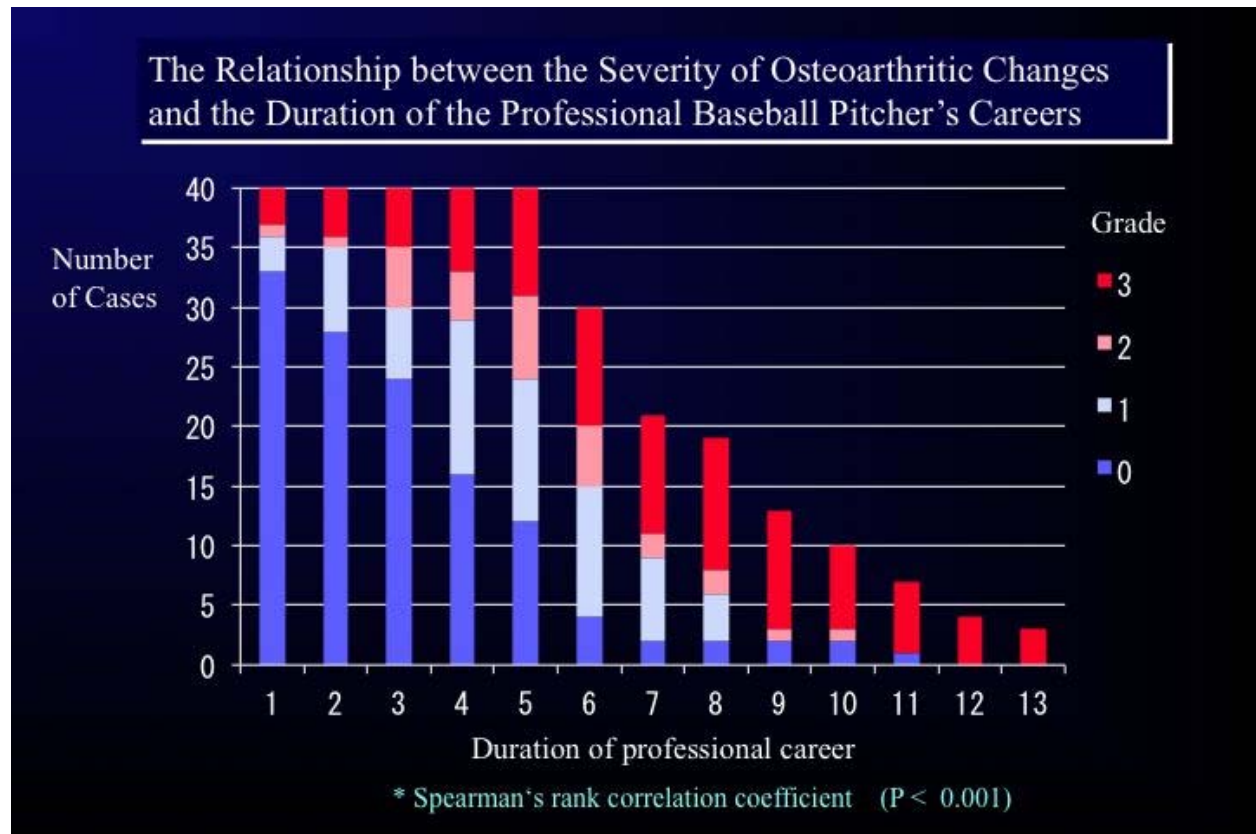
Results: The frequency of spurs was highest at the tip of the olecranon. The frequencies were also high at the medial margin of the olecranon, the tip of the coronoid process, the medial margin of the sigmoid notch, the medial margin of the trochlea, and the olecranon fossa. In contrast, there were very few pitchers with arthritic changes in the humeroradial joint. The percentage of severe arthritis (grade 3) significantly increased with the length of the professional

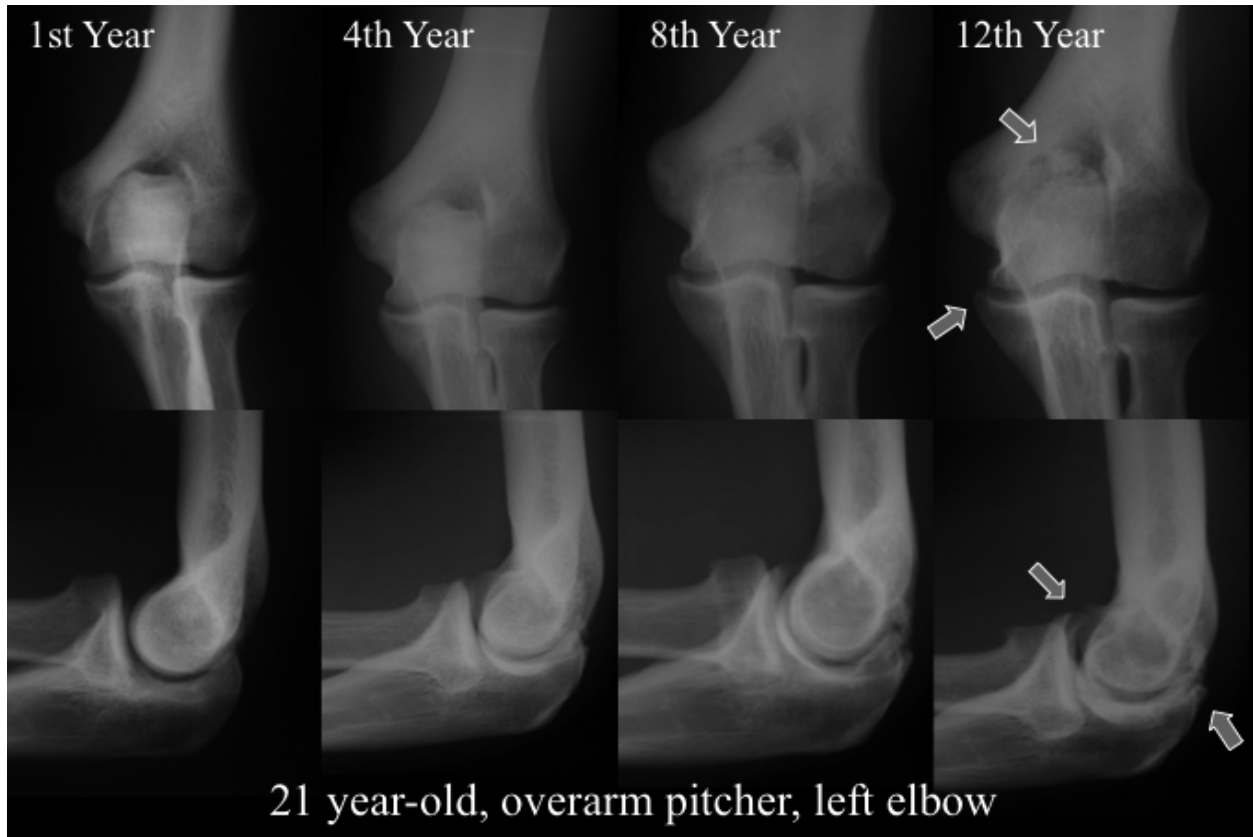
baseball pitcher's careers ($P < 0.001$) (Figure 1, 2). In overarm pitchers, large spurs were often found near the center of the joint such as the tip of the olecranon rather than medial area. On the other hand, there were no significant differences in the grades among the different pitching forms.

Summary: The severity of osteoarthritic changes in the pitching elbow significantly correlated with the length of the career as a professional pitcher.

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◆ Nothing of financial value to disclose

AM E-POSTER 132: Cost-effectiveness of Collagenase versus Fasciectomy for Dupuytren's Contracture: Case-Control Study

Category: Other
Keyword: Hand
Level 3 Evidence

- Isam Atroshi, MD, PhD
- ◆ Emelie Högberg, MS
- ◆ Anna Lauritzson, OT

Hypothesis: For Dupuytren's contracture (DC), collagenase clostridium histolyticum injection has better cost-effectiveness than fasciectomy.

Methods: Case-control study conducted at Hässeholm Hospital in Sweden. Data on collagenase were collected prospectively and data on fasciectomy extracted from medical records of patients treated before collagenase introduction. For efficacy comparison we included 49 consecutive patients treated with collagenase and had at least 6 weeks follow-up. For measuring average costs we chose two routine outpatient clinic sessions during which 5 consecutive patients were treated, each with 1 collagenase injection. Surgical controls were chosen among patients operated on with fasciectomy January 2009 through June 2011. Patients with surgery on >2 fingers, previous DC surgery, and additional procedures (e.g. amputation, skin graft) were excluded. Of 113 surgical patients a random sample of 15% was chosen by computer, yielding 18 patients; 2 were excluded (1 thumb surgery and 1 chose therapy at another location). Thus, 16 surgical controls were included. Finger range of motion was measured by hand therapists before and after treatment when therapy was completed (up to 3 months). Collagenase required 2 standard outpatient visits to a hand surgeon: injection and next-day finger extension in local anesthesia. Fasciectomy (ambulatory surgery) was done under regional or general anesthesia by hand or orthopedic surgeons. The average operating time was 63 minutes and average total time 139 minutes. Number of hospital visits to a doctor, nurse, or therapist were retrieved from the Patient Administrative System. All costs were defined and measured (2011 prices/salaries), including all medications, procedures and time of doctors and other personnel involved in care. The costs of sick leave were calculated including sick-pay, general payroll tax, vacation-pay and overhead costs according to the Swedish Social Insurance Agency and based on the average salary in Sweden 2011 (Statistics Sweden). The estimates were based on data that 20% of DC patients have employment and, on average, working fasciectomy patients require 4 weeks and 10% of working collagenase patients require 2 weeks sick-leave.

Results: Collagenase and fasciectomy resulted in similar improvement of extension deficit (Table). Collagenase required fewer hospital visits. The total treatment cost with 1 collagenase injection was 22% lower than fasciectomy. The cost was still lower if 20% of collagenase

patients would require 2 injections; with sick leave included collagenase has 40% lower cost than fasciectomy.

Summary:

- Treatment of DC with collagenase injection costs 22% less than fasciectomy with equivalent short-term efficacy regarding reduction in contracture.
- Cost estimates may vary across countries.

	Fasciectomy	Collagenase
MCP extension deficit, mean	60° ▶ 8°	60° ▶ 5°
PIP extension deficit, mean	46° ▶ 21°	36° ▶ 13°
Nurse visits, mean (median)	3 (2)	0 (0)
Therapist visits, mean (median)	5 (4)	2 (2)
Average total cost per patient *	USD 1993	USD 1560
Average total cost per patient when 20% require 2 injections *	USD 1993	USD 1843
Average total cost per patient (20% 2 inj) including sick-leave *	USD 3210	USD 1901

*** Based on 1 USD = 6.676 SEK; price Xiapex injection USD 970**

- Consulting Fees (e.g. advisory boards) received from: Pfizer
- ◆ Nothing of financial value to disclose

AM E-POSTER 133: An Assessment of Sleep Disturbance in Patients Before and After Carpal Tunnel Release

Category: Pain & Disability (chronic)

Keyword: Hand

Level 3 Evidence

◆ Eitan Melamed, MD

◆ Daniel Polatsch, MD

◆ Steven Beldner, MD

Hypothesis: This study tested the null hypothesis that there is no difference between sleep quality and night symptoms before and after carpal tunnel release (CTR). Secondary analyses addressed factors that might be associated with relief of night symptoms with carpal tunnel syndrome surgical release.

Methods: Forty-four, English-speaking adult patients requesting open CTR for electrodiagnostically confirmed carpal tunnel syndrome completed questionnaires before and after surgery. Average age was 59, 24 patients were men and 20 were women. Patient with a primary or secondary sleep disorder were excluded. Before surgery, patients completed a survey regarding demographic data, comorbidities, employment status, and the Pittsburg Sleep Quality index (PSQI). An average of 3 months after surgery, participants completed PSQI questionnaires. Onset of sleep quality improvement was specifically addressed. Differences between preoperative and postoperative sleep quality were evaluated using the paired t-test. Spearman correlations were used to assess the relationship between continuous variables.

Results: Of the 44 patients, 32 (72%) were classified as poor sleepers (PSQI>5.5) prior to surgery. At 3 months follow up, there was a significant improvement PSQI global scores (7.8 ± 5.1 vs 4 ± 3.5 , $P < 0.001$) as well as subdivisions. Daytime dysfunction secondary to sleep disturbance was improved as well (0.9 ± 0.6 vs 0.1 ± 0.3 , $P < 0.001$). Neither age, sex, number of comorbidities, diabetes mellitus, employment status or workers compensation were independent predictors of postoperative sleep quality. In all patients, onset of improvement was within 24 hours of surgery.

Summary:

- At 3 months follow-up, CTR is associated with improvement in sleep quality as measured by PSQI.
- CTR improves daytime dysfunction related to the sleep disturbance.
- There were no significant predictors of improvement of Sleep quality.
- Onset of sleep improvement is 24 hours.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 134: Comparative Study Between Botulinum Toxin and Steroid Mixed Bupivacaine for Scalene Injection in Neurogenic Thoracic Outlet Syndrome

Category: Pain & Disability (chronic)

Keyword: Other

Level 2 Evidence

◆ Jae Man Kwak, MD

◆ Young Ho Kwon, PhD

Hypothesis: The purpose of this study was to evaluate and compare the botulinum toxin (BTX) injection with steroid mixed bupivacaine injection under the ultrasound guidance in subjects with suspected neurogenic thoracic outlet syndrome (NTOS).

Methods: This study was IRB-approved and followed HIPPA guidelines. This study was conducted through randomized controlled clinical trials (RCT) using the interview on outpatient clinic or the telephone interview to survey the degree of symptom relief and complication. From January 2011 to January 2012, scalene injection were performed on 49 cases for the treatment of neurogenic thoracic outlet syndrome and were followed up for at least 12 months. 49 cases with NTOS were treated and randomly assigned to two groups: steroid mixed bupivacaine injection (n=25), BTX injection (n=24). Procedures included botulinum toxin or steroid mixed bupivacaine injections of the anterior scalene, pectoralis minor, and subclavius muscles performed under real-time ultrasound guidance. Technical success was defined as satisfactory muscle identification, intramuscular needle placement, and intramuscular delivery of medication. Follow-up was performed to determine procedure-related complications and therapy response using a Short-form McGill Pain Questionnaire (SF-MPQ) prior to and at 1, 3, 6, and 12 months post-injection.

Results: Technical success was achieved in all procedures. No complications occurred. Patients experienced substantial pain relief for 12 months following a single Botox injection. Significant pain reduction was noted for 6 months after Botox injection with respect to both sensory and VAS scores, and the total and PPI scores approximated statistical significance ($p < 0.01$). For 12 months, degree of symptom relief (% change from pre-injection state) was increased steadily. In steroid mixed bupivacaine injection group, pain relief was occurred significantly at 1 month. But after that, degree of symptom relief (% change from pre-injection state) was continually decreased. At the last follow up, all of the scores of SF-MPQ were more improved significantly in BTX injection group. ($p < 0.01$)

Summary:

- Scalene injection(Scalene block) under the ultrasound guidance is a safe and well-tolerated procedure in subjects with suspected NTOS.
- Steroid mixed bupivacaine injection seem to be an effective short-term pain reliefer.
- BTX injection is seem to be a more effective for long term symptom relief than steroid mixed bupivacaine injection in subjects with suspected NTOS.

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◆ Nothing of financial value to disclose

AM E-POSTER 135: A Novel Technique to Treat Venous Congestion in Replanted Fingers

Category: Practice Management

Keyword: Hand

Level 4 Evidence

◆ Dr. Margaret Woon Man Fok

◆ Kwok Keung Boris Fung, MD

Hypothesis: Venous congestion plays a significant role in digit replantation failures, as it was accounted for as many as 40.7% failures. We propose the use of VAC in these venous congested replanted digits as we believe the sustained suction encourages continuous bleeding from the venules of the distal stump. This in turn facilitates blood flow at the amputated part and prevents thrombosis at the venules.

Methods: Patients with replanted fingers which are prone to venous congestion are recruited in Dec 2012. Vacuum assisted dressing (VAC) was applied to each replanted finger. It was performed as follow: the wound was first dressed lightly with heparin saline gauze, and two layers of porous sponge. Suction catheter(s) was then inserted in-between the two layers of porous sponge. The surrounding skin was dried and the entire dressing was sealed by adhesive plastic dressing to achieve a vacuum environment. The catheter was connected to the wall suction with the pressure set as 120mmHg. Lamp therapy and intra-venous Dextran was also given for the initial five days. Whenever the vacuum seal was found not to be working properly, dressing was changed by either the surgeon or designated nursing staff, ranging from twelve hours to three days. A course of broad spectrum antibiotic was also given in both cases. Viability of the distal stump was determined at 2 weeks post replantation.

Results: 2 patients was treated with VAC after replantation of the fingers after crushing injuries. One patient had his left thumb amputated at the inter-phalangeal joint level while the other patient had his left index finger amputated at the distal inter-phalangeal joint level. Suction was applied immediate post-operatively. The replanted stump was well taken after suction. Stiffness of the joint involved was noted as the injury zone is at the joint level and primary arthrodesis was performed. No blood transfusion was given, despite having persistnet suction. No complication was noted.

Summary: These 2 cases suggest that VAC is a good and reliable alternative to the treatment of venous congestion. As compare with the other options including leech therapy and constant massage of nail bed to promote persistnet bleeding, VAC appears to be a safe, simple and an economical option.

References:

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◆ Nothing of financial value to disclose

AM E-POSTER 136: “Hand Surgeons Probably Don’t Starve” – Patient’s Perceptions of Physician Reimbursements for Performing a Carpal Tunnel Release

Category: Practice Management

Keyword: Wrist

Not a clinical study

◆ Kyle P. Kokko, MD, PhD

◆ April D. Davis, CHT

◆ Anthony Sapienza, MD

◆ John Capo, MD

◆ William R. Barfield, PhD

◆ Nader Paksima, DO, MPH

Hypothesis: The purpose of this study is to evaluate patient’s perceptions of physician reimbursement for the most commonly performed surgery on the hand, a carpal tunnel release.

Methods: Anonymous physician reimbursement surveys were given to patients and non-patients in the waiting rooms of orthopaedic hand physician’s offices and certified hand therapist’s offices. The short survey consisted of 13 questions. Respondents were asked what they thought a surgeon should be paid to perform a carpal tunnel release. Respondents were then asked to estimate how much they thought Medicare actually reimburses the surgeon for this common procedure. Finally, respondents were asked about how healthcare dollars should be divided amongst the surgeon, the anesthesiologist and the hospital or surgery center. Epidemiological data were obtained including age, gender, income, educational background and type of insurance the respondents have.

Results: On average, patients thought that hand surgeons should receive \$4,539 for performing a carpal tunnel release. They believe the percentage of healthcare funds should be distributed primarily to the hand surgeon (56%), followed by the anesthesiologist (24%) and then the hospital/surgery center (20%). They estimated that Medicare reimburses the hand surgeon \$3,480 for a carpal tunnel release. Most patients (91%) stated that Medicare reimbursement was “lower” or “much lower” than what it should be.

Summary:

- A carpal tunnel release is the most common hand surgery performed by hand surgeons.
- Respondents believe that, on average, a hand surgeon should be reimbursed greater than 10X the Medicare reimbursement rate of approximately \$412.

- Respondents believe physicians (surgeons and anesthesiologist) should command most (80%) of the healthcare funds allocated to this treatment.
- There is a drastic disparity between respondents' perceptions and actual physician reimbursement for a carpal tunnel release.
- There is a drastic disparity between respondents' perceptions of how healthcare dollars should be distributed between the hand surgeon, anesthesiologist and the hospital/surgery center and how healthcare dollars are actually distributed amongst these three entities.

◆ Nothing of financial value to disclose

AM E-POSTER 137: Results of a Third Corticosteroid Injections for Trigger Digits

Category: Tendon

Keyword: Hand

Level 4 Evidence

- Richard A. Bernstein, MD

Corticosteroid injections are a reliable treatment option for trigger fingers. At the 2000 ASSH, we reported a 75% cure with one injection, and 89.6% success with two injections for primary trigger fingers. At the 2012 ASSH, we reported a 62% cure rate for a new trigger finger in patients who had prior surgical treatment for another digit. A recent ASSH LISTSERV discussion regarding injections for trigger finger prompted this retrospective analysis of patients who failed two prior injections for stenosing tenosynovitis.

We retrospectively reviewed patients from 1999 to 2013 who failed two corticosteroid injections for idiopathic trigger fingers, and requested a third injection. Our treatment protocol is an injection at the first visit, reexamination at 6 weeks, reinjection if triggering continued, followup 6 weeks and surgical release after two failed injections. We identified a subgroup who declined surgery (secondary to medical comorbidities or desire to avoid surgery) and requested a third injection. Each patient was advised of the reported risks of multiple corticosteroid injections and were reevaluated six weeks after the third injection, and at final followup.

A total of 30 patients were identified, none were excluded. Average age was 56.9 years, 10 males, 18 females, 2 patients having two digits injected. Four were left-handed and 24 patients right-handed. There were seven thumbs, four index, ten long, eight ring, and one small finger. Three patients had NIDDM and three IDDM. For the entire cohort, mean length of time between symptom onset and the first, second, and third injections were 2.0, 11.6, and 14 months respectively. Of the patients who were CURED with the third injection, the interval was 3.0, 12.9 and 20.5 months. In the subgroup who had FAILED the third injection and had continued symptoms, the interval was 1.3, 6.5 and 8.6 months respectively, overall symptoms and recurrence occurred TWICE as fast in the failure cohort. Overall, 40% of patients were cured after a third corticosteroid injection but 60% of patients had continued triggering. No diabetic responded successfully to a third injection. There were no tendon ruptures or other complications.

In a select group of patients in whom surgery may be contraindicated, a third corticosteroid injection demonstrated a 40% cure rate except in diabetics. Though there are risks of multiple injections, in this limited study, there were no adverse complications. When the subgroups were further evaluated, those patients who had a quicker recurrence of symptoms were significantly less likely to respond to the third injection.

- Consulting Fees (e.g. advisory boards) received from: Biomet, Tornier

AM E-POSTER 138: Morphological Alteration of the Tendon on Ultrasound After Intrasynovial Injection of Betamethasone for Trigger Digits

Category: Tendon

Keyword: Hand

Level 4 Evidence

- ◆ Mitsuhiko Takahashi, MD
- ◆ Ichiro Tonogai, MD
- ◆ Natsuo Yasui, MD

Hypothesis: Though corticosteroid injection is a reliable treatment modality for symptomatic trigger digits, post-injective changes have not been fully investigated. The purpose of this study was to investigate whether degradation of tendon matrix occur after the injection, which leads to devastating tendon rupture.

Methods: Fifteen digits (4 thumbs, 5 middle and 6 ring fingers) of 13 patients (average 66 ± 11 y, 6 males and 7 females) with trigger digit were managed with betamethasone (2.0 mg) injection. Axial view of high-resolution ultrasonography (US) (EUB-7500; Hitachi Medical Corporation) was obtained from volar aspect at the metacarpophalangeal joint. The probe was placed perpendicular to the tendon while the tendon was characterized by hyperechoic fibrillar pattern and where fluid distension was maximal. US examinations were performed before the betamethasone injection and 31 ± 11 days after the injection by one author (MT, year of experience; 5 years). Long and short axes and cross-sectional area of the tendon, and thickness of the sheath were measured on the both examinations on ImageJ software (ver. 1.46r, NIH, USA) by the other author (IT) who did not have any clinical information. Data are expressed as mean \pm standard deviation and statistical analysis was performed using paired t-test for comparison of two examinations.

Results: At least one grade of improvement was achieved in all the cases at the second US examination (pre-injection grades ranged between 2 and 4). Long axis of the cross-section and cross-sectional area of the tendon significantly decreased from 6.27 ± 1.01 mm to 5.90 ± 0.96 mm ($p = 0.014$) and from 22.3 ± 7.2 mm² to 19.9 ± 5.8 mm² ($p = 0.019$), respectively. Short axis of the cross-section and thickness of the sheath decreased from 4.62 ± 0.82 mm to 4.37 ± 0.59 mm ($p = 0.074$) and from 0.90 ± 0.49 mm to 0.84 ± 0.30 mm ($p = 0.461$), respectively, but none of these were significant.

Summary:

- Despite single injection for a symptomatic tendon, parameters for tendon cross-section showed tendency to decrease approximately one month after the injection.
- It could be not only alleviation from pathological swelling of the tendon but also acceleration of degradation or loss of catabolism of tendon matrix.
- These results may be related with delayed tendon rupture after steroid injection reported in the literature.

References:

1. The "dark tendon sign" (DTS): a sonographic indicator for idiopathic trigger finger. Gruber H, Peer S, Loizides A. *Ultrasound Med Biol*. 2011 May;37(5):688-92.
2. Ultrasonographic assessment of clinically diagnosed trigger fingers. Kim HR, Lee SH. *Rheumatol Int*. 2010 Sep;30(11):1455-8.
3. Stiffness of the first annular pulley in normal and trigger fingers. Miyamoto H, Miura T, Isayama H, Masuzaki R, Koike K, Ohe T. *J Hand Surg Am*. 2011 Sep;36(9):1486-91.
4. Delayed flexor digitorum superficialis and profundus ruptures in a trigger finger after a steroid injection: a case report. Fitzgerald BT, Hofmeister EP, Fan RA, Thompson MA. *J Hand Surg Am*. 2005 May;30(3):479-82.

◆ Nothing of financial value to disclose

AM E-POSTER 139: Impact of Collagenase Clostridium Histolyticum on Dupuytren's Contracture Treatment Patterns

Category: Tendon

Keyword: Hand

Level 4 Evidence

- James R. Verheyden, MD
- James Tursi, MD
- Eric Dickinson, MS, MBA

Hypothesis: Collagenase clostridium histolyticum (CCH) for treatment of adult patients with Dupuytren's contracture with a palpable cord offers an alternative to surgical interventions. We examined claims data to evaluate whether the US approval of CCH in February 2010 was associated with a change in the distribution of surgical interventions (fasciectomy or fasciotomy) or needle aponeurotomy (NA).

Methods: Data regarding diagnoses and surgical procedure/NA procedure trends were derived from procedure totals reported in the IMS/SDI integrated data warehouse through November 2012. CCH usage trends data were derived from the Auxilium CCH data warehouse. CCH procedure frequency was calculated based on actual vial sales divided by 1.1 vials per procedure (based on a recent clinical effectiveness study); this was done in order to equalize CCH vial sales into the same/similar units as surgery and NA. Data reported between February 2009 and November 2012 were analyzed. Quarterly procedure trends were summarized.

Results: The average monthly diagnosed Dupuytren's contracture patients increased from approximately 15,000 in early 2009 to 20,000 in late 2012; most (86.5%) were white, 58% were male, and 49% were aged 65 or older. The average quarterly number of total procedures from 2009-2012 fluctuated between 12,000-17,000, with an overall trend showing a slight increase (Figure 1). Between 2009 and 2010, the percentage of NA ranged between 10%-20%, with surgical interventions accounting for the remainder of procedures. Since the approval of CCH, the use of CCH has increased from about 5% of all DC procedures in early 2010 to about 30% in late 2012. This coincides with a decrease in the percentage of surgical procedures from about 80% to about 60% during the same period; the percentage of NA was relatively steady at approximately 10% during this time (Figure 2).

Summary:

- CCH use steadily increased since its introduction.
- The increase in CCH use seems to correlate with the decrease in surgery. From about the time CCH was introduced in 2010 to 2012, surgery declined steadily from ~80% to ~60% of all DC procedures.

- The lack of an exact correlation between decline of surgery and increase of CCH may be a result of CCH, as a minimally invasive procedure, now being used in patients who otherwise might be managed with a “wait and see” approach; although this cannot be confirmed from the data presented.
- The percentage of NA procedures remained steady as CCH use increased over the same period.

Figure 1. Patients Diagnosed With Dupuytren’s Contracture and Total Procedures by Quarter

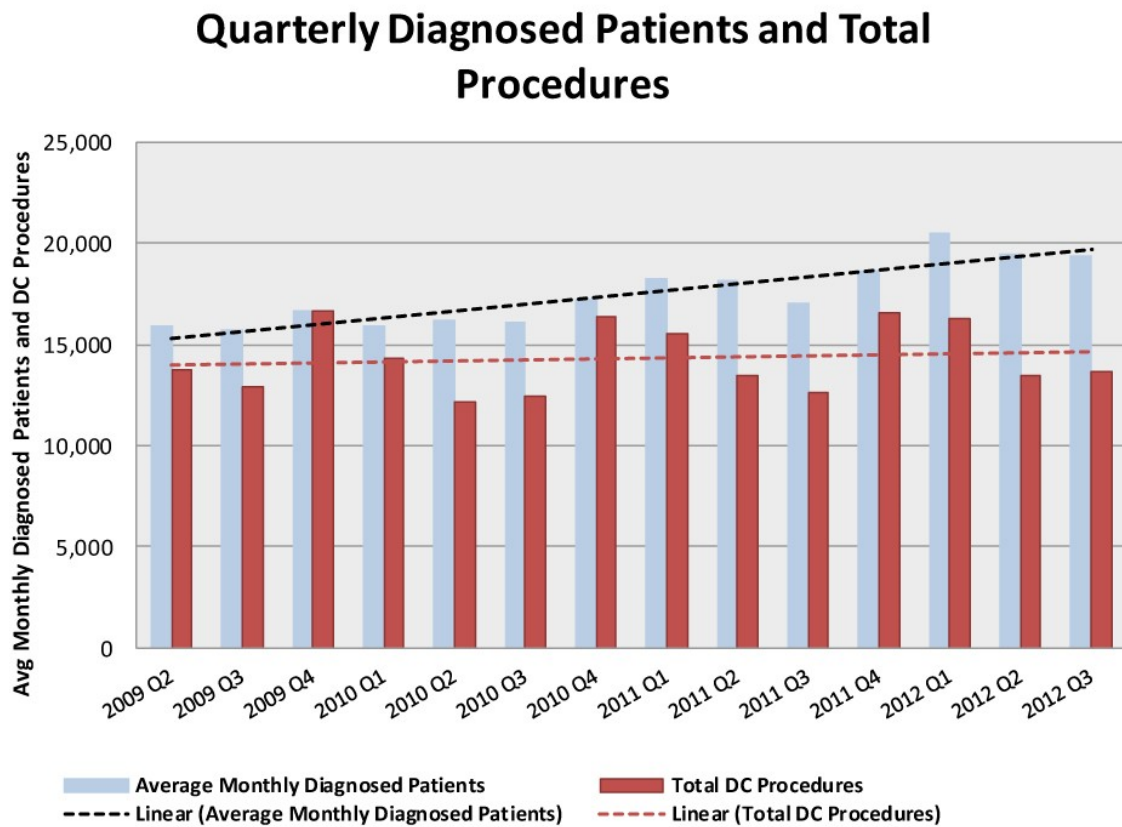
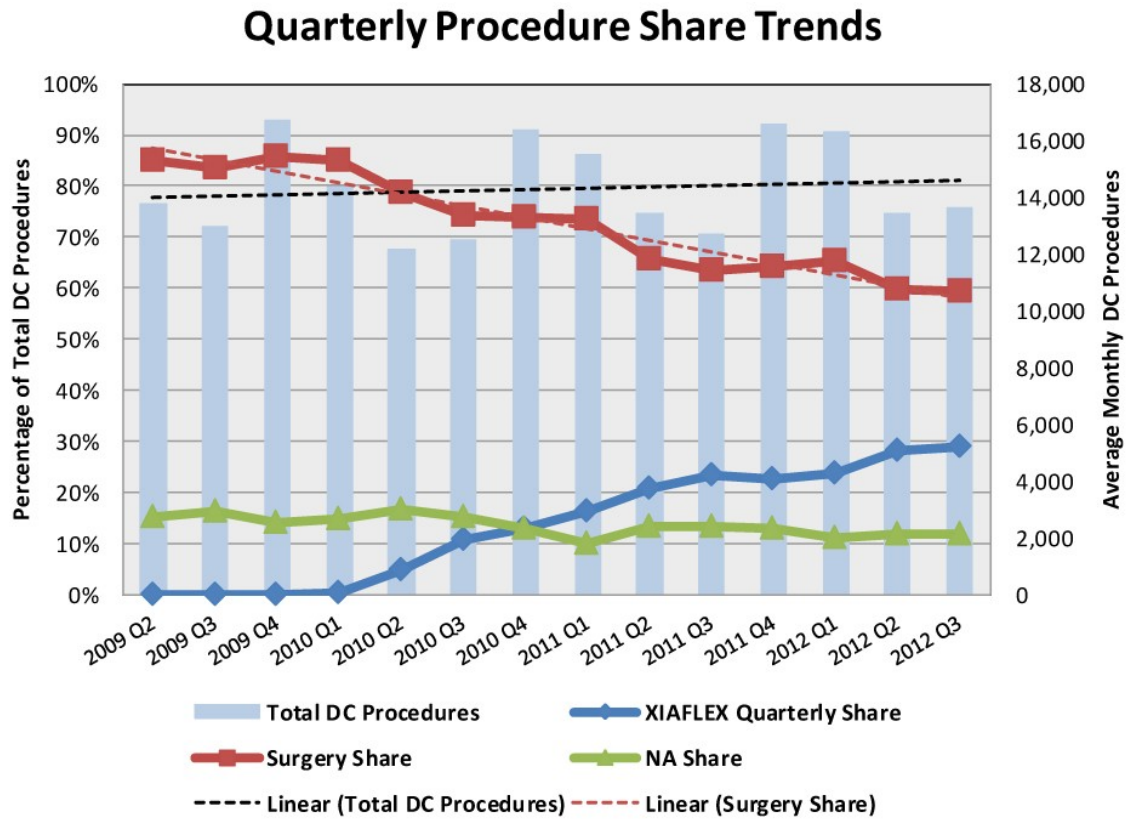


Figure 2. Procedure Share Trends by Quarter



- Contracted Research with: Auxilium Pharmaceuticals, Inc. (Tursi)
- Consulting Fees (e.g. advisory boards) received from: Auxilium Pharmaceuticals, Inc. (Verheyden)
- Other Financial Relationship: Auxilium Pharmaceuticals, Inc. (Verheyden, Tursi, Dickinson)

AM E-POSTER 140: A Novel Technique for Flexor Tendon Pulley Reconstruction Using Acellular Dermal Matrix

Category: Tendon

Keyword: Hand

Level 4 Evidence

- ◆ ▲ Kelly B. Currie, MD
- ◆ ▲ Jennifer Victory, BSN, RN
- ◆ ▲ Julie Tirrell, RN
- ◆ ▲ Melissa Scribani, MPH
- ◆ ▲ W. Thomas Huntsman, MD
- ◆ ▲ Sumeet Makhijani, MD

Hypothesis: After traumatic injury, reconstruction of the flexor tendon pulley system to prevent bowstringing has historically been challenging. In some instances opening an uninjured pulley is necessary to repair an underlying flexor tendon laceration. Primary repair of the pulley has been the gold standard, but numerous reliable yet imperfect techniques have been described in the literature^{1,2}. Acellular dermal matrix (ADM) is a biologic material used commonly in breast reconstruction; however, there have been no published accounts of its use for pulley repair in the human hand^{3,4}. Repair of flexor tendon pulleys using acellular dermal matrix is a simple reconstruction option with reliable outcomes.

Methods: This was a retrospective review of a single surgeon's (WTH) experience utilizing ADM as a conduit for flexor tendon pulley reconstruction between 2001 and 2012. Chart review was performed by searching CPT codes for hand surgeries indicating ADM was utilized. Patients were excluded if they had injuries to more than one finger or planned staged surgeries. Hand therapy notes were reviewed and were from a single therapist over the entire study period. Measurements of MCP, PIP, and DIP active and passive range of motion were analyzed at end of therapy.

Results: Thirty-one patients were identified as having ADM used for reconstructive hand surgery after trauma. Of the 32, eight patients were identified as having single digit injuries in which ADM was used to repair a pulley. Of the 8 patients, injuries were to 1 thumb, 3 index, 1 long, 1 ring, and 2 small digits. 75% were male, average age 40.7 years, mean follow up 10.4 weeks. One patient required reoperation for tenolysis. Seven patients (87.5%) had normal active MCP flexion at the end of therapy (normal being =55 degrees for thumb, =90 degrees for other digits[3] or =100% flexion compared to the uninjured hand). The remaining one patient who had less than normal active MCP flexion was at 84% flexion compared to the same digit in the uninjured hand. At the PIP joints, average active flexion was 82 degrees, or 82% of normal³.

The thumb IP joint had 52% active flexion compared to the uninjured hand. At the DIP joints, 1 of 7 had normal active DIP flexion at the end of their therapy, with an average active flexion of 30 degrees. There were no bowstringing or triggering of tendons.

Summary: Acellular dermal matrix is a simple, reliable conduit in the reconstruction armamentarium for flexor tendon pulley repair.

References:

1. Mehta V, Phillips C, Flexor Tendon Pulley Resonstruction. *Hand Clin* (2005) 21:245-251.
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3. Oruc M, et al, Pulley Reconstruction with Different Materials: Experimental Study. *Ann Plast Surg* (2008) 61:215-220.
4. Hanff G, et al, Reconstruction of Flexor Tendon Pulley with Expanded Polytetrafluoroethylene (E-PTFE): An experimental study in rabbits. *Scand J Plast Reconstr Hand Surg* (1991) 25:25-30.
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FLEXOR TENDON PULLEY REPAIR WITH ACELLULAR DERMAL MATRIX: DATA AND RESULTS

Digit Involved	Gender (M/F)	Age	Nerve or Vessel Involved (Y/N)	Weeks of Therapy	MCP Flexion Active	MCP Flexion Passive	MCP Flexion Uninjured Hand	PIP Flexion Active	PIP Flexion Passive	PIP Flexion Uninjured hand	DIP Flexion Active
Small	F	27	N	8.6	90	NML		72	NML		25
Small	M	29	Y	9.9	95			82			45
Ring	M	32	N	15.8	92	103	90	96	108	108	10
Long	M	48	N	13.1	92	NML	87	97	NML	96	23
Index	M	28	Y	7.3	103	NML	103	90	105	115	28
Index	M	19	Y	11.6	95	NML	90	62	NML	90	65
Index	M	67	N	7	67	80	80	75	96	107	13
Thumb	F	62	Y	9.9	54	62	51	32	62	62	

NML: Recorded as normal

Blank: Not recorded

- ▲ This presentation will discuss AlloDerm/AlloMax by Lifecell/Bard-Davol
- ◆ Nothing of financial value to disclose

AM E-POSTER 141: Flexor Tendon Transfer With Bridge Tendon Graft for the Treatment of Zone 3 and 4 Flexor Tendon Rupture

Category: Tendon

Keyword: Hand

Level 4 Evidence

◆ Hisao Kohda, MD

◆ Hironori Matsuzaki, MD

◆ Keiichi Maniwa, MD

Hypothesis: Repairing a ruptured flexor tendon in the palm is often difficult because of the damage to the tendon or its myostatic contracture, or both. We aggressively use a tendon transfer to the adjacent flexor with a bridge tendon graft. We evaluated the clinical results of this procedure for zone 3 and 4 flexor tendon ruptures.

Methods: We reviewed the records of patients who had undergone flexor tendon reconstruction for zone 3 and 4 injury between January 1993 and December 2010, and evaluated the range of motion and postoperative complications.

Results: Ruptured tendons in the 8 patients (mean age, 61 years; range 39 to 76 years; 6 men) were the flexor Digitorum Profundus (FDP) of little finger in 6, FDP and Flexor Digitorum Sublimis (FDS) of little finger in 1, and FDP of the long finger with FDS of the long and index fingers in 1. Causes of tendon rupture were chronic synovitis in 2, forced extension while gripping in 2, non-union of hook of hamate in 1, piso-triquetral osteoarthritis in 1, Kienböck disease in 1, and steroid injection in 1. All patients were treated with tendon transfer of the distal stump to the adjacent FDP accompanied by a bridge tendon graft using the palmaris longus tendon; injured FDS were not repaired. Active motion exercise was begun soon after surgery. Mean follow-up time was 11 months (range, 5 to 24 months). One patient had postoperative flexion contracture of the metacarpo-phalangeal joint and was successfully treated with flexor tenolysis. Mean total active motion of the fingers was 87% (range, 76% to 94%). The functional results evaluated by Strickland's criteria were excellent in 4, and good in 4.

Summary: The advantages of tendon transfer to the adjacent FDP are its availability to the ruptured tendon, where the proximal tendon does not have sufficient excursion, and its ease of tension adjustment when compared to FDS transfer. However, as the tenorrhaphy point moves distally, flexion force tends to weaken. Concomitant use of a bridge tendon graft with tendon transfer can better align the transferred tendon and avoids opening the flexor retinaculum, although this procedure is technically complicated and has a risk of adhesion. We believe that tendon transfer with a bridge tendon graft can provide promising results if it is combined with early postoperative motion exercise.

◆ Nothing of financial value to disclose

AM E-POSTER 142: Osteoid Osteomas of the Wrist. Report of 19 Cases.

Category: Tumor

Keyword: Wrist

Level 4 Evidence

◆ Alberto L. Lluch, MD, PhD

◆ Angel Ferreres-Claramunt, MD, PhD

◆ Marc Garcia-Elias, MD, PhD

Hypothesis: Diagnosis of osteoid osteomas of the wrist should be based on its clinical manifestation: constant pain and point tenderness. Surrounding bone sclerosis is not observed, and the tumor can be easily removed by simple curettage.

Methods: Nineteen patients were treated for severe and constant wrist pain secondary to an osteoid osteoma. Twelve were men and 7 were women, from 14 to 56 years of age, with an average age of 34.

One osteoid osteoma was excised from the trapezium, the trapezoid and capitate; three from the scaphoid, the hamate, the distal radius and the distal ulna; four from the triquetrum; and none from the lunate. In only 13 cases, radiographic examination demonstrated a lytic lesion. This accounts for the delay between the onset of symptoms and the final diagnosis, made on an average of 2 years and 1 month (minimum of 2 months and maximum of 5 years). MRI and bone scan examinations were negative in 3 cases.

When the osteoid osteoma is found near a joint or a tendon which has a synovial lining, it causes a reactive articular or tendon synovitis. This reactive synovitis was so severe that 4 patients had been previously treated for tendon sinovitis: 1 around the FCR (trapezium and scaphoid), 1 around the ABPL (scaphoid and distal radius) and 3 around the ECU (triquetrum and distal ulna). Midcarpal joint synovitis was very severe in three cases.

All osteoid osteomas are identifiable as localized round and reddish masses found near the cortex of the bone, with most of them protruding from it, facilitating its excision, without the need to remove the surrounding bone.

Results: Although the pathology report was not definite in three cases, all of the patients experienced complete relief of the pain. After a follow up from 2 months to 29 years (mean 11 years), only one patient showed a recurrence 7 years later. This was one of the three in which histological diagnosis was not definite.

Summary: The diagnosis of an osteoid osteoma in the wrist should mainly be based on a clinical suspicion of the lesion in patients complaining of constant pain and localized point tenderness. Radiographic examination may show a lytic lesion without a reactive bone sclerosis. A bone

scan or MRI will confirm the diagnosis in most cases. The tumor can be easily excised without the need of removing the neighboring bone tissue.

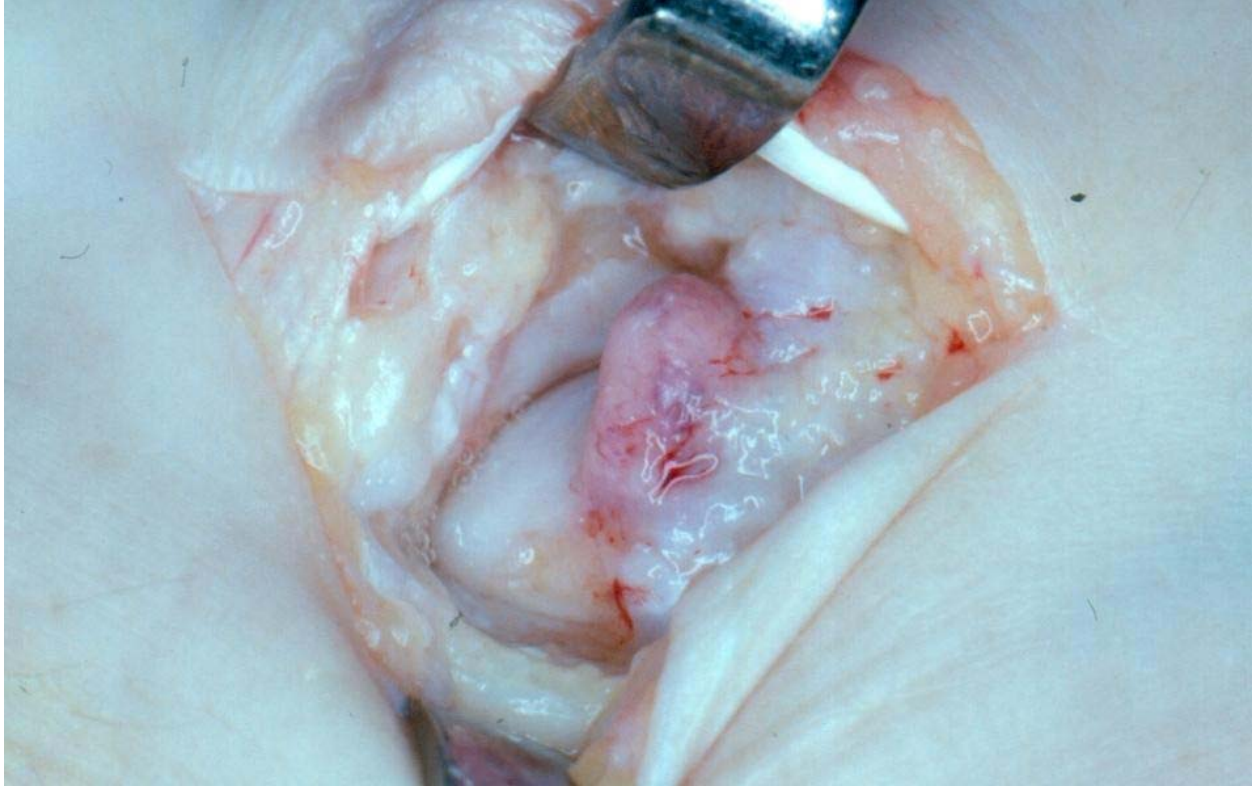
Figure 1. Osteolytic lesion at the triquetrum

Figure 2. Osteoid osteoma protruding through the dorsal cortex of the triquetrum

References:

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2. Osteoid osteoma of the hand and wrist. Ambrosia JM, Wold LE, Amadio PC. *J Hand Surg* 1987;12A:794-800.
3. Bone and Soft Tissue Tumors. Athanasian EA. In: *Green's Operative Hand Surgery*. 6th ed. Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH. (eds). Philadelphia: Elsevier;2011: 2141-2195.





◆ Nothing of financial value to disclose

AM E-POSTER 143: Extensive Curettage Using a High-Speed Burr versus Dehydrated Alcohol Instillation in Treatment of Enchondroma of the Hand

Category: Tumor

Keyword: Hand

Level 3 Evidence

◆ Hyun Dae Shin, MD, PhD

◆ Soo Min Cha, MD

Hypothesis: The purpose of this retrospective comparative study was to compare the clinical and radiological outcomes of patients treated with extensive curettage using a high-speed burr and dehydrated alcohol instillation after simple curettage for enchondromas of the hand.

Methods: Sixty-two patients with enchondroma were treated by either high-speed burring with simple curettage (n = 29, Group 1) or alcohol instillation after curettage (n = 33, Group 2), without augmentation of the lesion, between March 2004 and February 2010. The mean final follow-up period was 32.5 months. Clinical outcomes were compared between the two groups using a visual analogue scale (VAS) for postoperative pain; Disabilities of the Arm, Shoulder, and Hand (DASH) scores; total range of active motion; grip strength; and the Wilhelm and Feldmaier formula. Radiological outcomes of bony formation were evaluated.

Results: No significant differences in the VAS scores, DASH scores, total range of active motion, or grip strength were observed between the two groups. The complete healing time was 11.6 ± 2.7 and 12.1 ± 2.6 weeks in Groups 1 and 2, respectively, with no significant difference. The distribution of the results of the formula by Wilhelm and Feldmaier were not significantly different between the two groups. No surgery-related complications, postoperative pathologic fractures, or recurrence was found in either group.

Summary: For the treatment of enchondroma in the metacarpal bone and proximal phalanx, alcohol instillation immediately after manual curettage was as effective as extensive curettage by a high-speed burr. The clinical and radiologic outcomes were satisfactory in both groups.

References:

1. Goto T, Kawano H, Yamamoto A, et al. Simple curettage without bone grafting for enchondromas of the foot. *Arch Orthop Trauma Surg.* 2004;124:301-305.
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Table I. Preoperative and postoperative clinical outcomes[Ⓢ]

[Ⓢ]	Preoperative [Ⓢ]	Final follow-up [Ⓢ]	p-value [Ⓢ]	[Ⓢ]
VAS Score [Ⓢ]	[Ⓢ]	[Ⓢ]	[Ⓢ]	[Ⓢ]
Group 1 [Ⓢ]	4.8 ± 0.6 [Ⓢ]	1.1 ± 0.8 [Ⓢ]	< 0.01 [Ⓢ]	[Ⓢ]
Group 2 [Ⓢ]	4.9 ± 0.8 [Ⓢ]	1.4 ± 0.8 [Ⓢ]	< 0.01 [Ⓢ]	[Ⓢ]
DASH Score [Ⓢ]	[Ⓢ]	[Ⓢ]	[Ⓢ]	[Ⓢ]
Group 1 [Ⓢ]	41.7 ± 4.6 [Ⓢ]	11.6 ± 2.5 [Ⓢ]	< 0.01 [Ⓢ]	[Ⓢ]
Group 2 [Ⓢ]	43.6 ± 5.0 [Ⓢ]	12.7 ± 2.4 [Ⓢ]	< 0.01 [Ⓢ]	[Ⓢ]
Total range of active motion (Affected ray) [Ⓢ]	[Ⓢ]	[Ⓢ]	[Ⓢ]	[Ⓢ]
Group 1 [Ⓢ]	185.2 ± 15.3 [Ⓢ]	242.1 ± 16.6 [Ⓢ]	0.03 [Ⓢ]	[Ⓢ]
Group 2 [Ⓢ]	179.4 ± 21.8 [Ⓢ]	239.4 ± 18.9 [Ⓢ]	< 0.01 [Ⓢ]	[Ⓢ]
Grip Strength [Ⓢ] (%, ratio to uninjured side) [Ⓢ]	[Ⓢ]	[Ⓢ]	[Ⓢ]	[Ⓢ]
Group 1 [Ⓢ]	74.1 ± 8.4 [Ⓢ]	90.3 ± 5.7 [Ⓢ]	0.03 [Ⓢ]	[Ⓢ]
Group 2 [Ⓢ]	72.6 ± 8.2 [Ⓢ]	92.6 ± 4.4 [Ⓢ]	< 0.01 [Ⓢ]	[Ⓢ]

Table II. Comparison of the postoperative clinical and radiologic outcomes

	Group 1	Group 2	p-value
VAS Score	1.1 ± 0.8	1.4 ± 0.8	0.15
DASH Score	11.6 ± 2.5	12.7 ± 2.4	0.08
Total range of active motion (°, Affected ray)	242.1 ± 16.6	239.4 ± 18.9	0.55
Grip Strength (% , ratio to uninjured side)	90.3 ± 5.7	92.6 ± 4.4	0.09
The resolution time of bony tenderness after surgery (weeks)	7.2 ± 1	7.4 ± 1.1	0.48
The time of complete healing after surgery (weeks)	11.6 ± 2.7	12.1 ± 2.6	0.49
Radiologic evaluation by Tordai	Grade I : 20 Grade II : 9 Grade III : 0	Grade I : 22 Grade II : 11 Grade III : 0	0.64
Formula by Wilhelm and Feldmaier	Excellent : 20 Good : 8 Satisfactory : 1	Excellent : 22 Good : 8 Satisfactory : 3	0.66

◆ Nothing of financial value to disclose

AM E-POSTER 144: The Radial Artery Superficial Palmar Branch Free Flap for Finger Soft Tissue Reconstruction

Category: Vascular/Microvascular

Keyword: Hand

Level 4 Evidence

◆ Yong Jin Kim, MD

Hypothesis: To report the usefulness and clinical results of the radial artery superficial palmar branch free flap for finger soft tissue reconstruction.

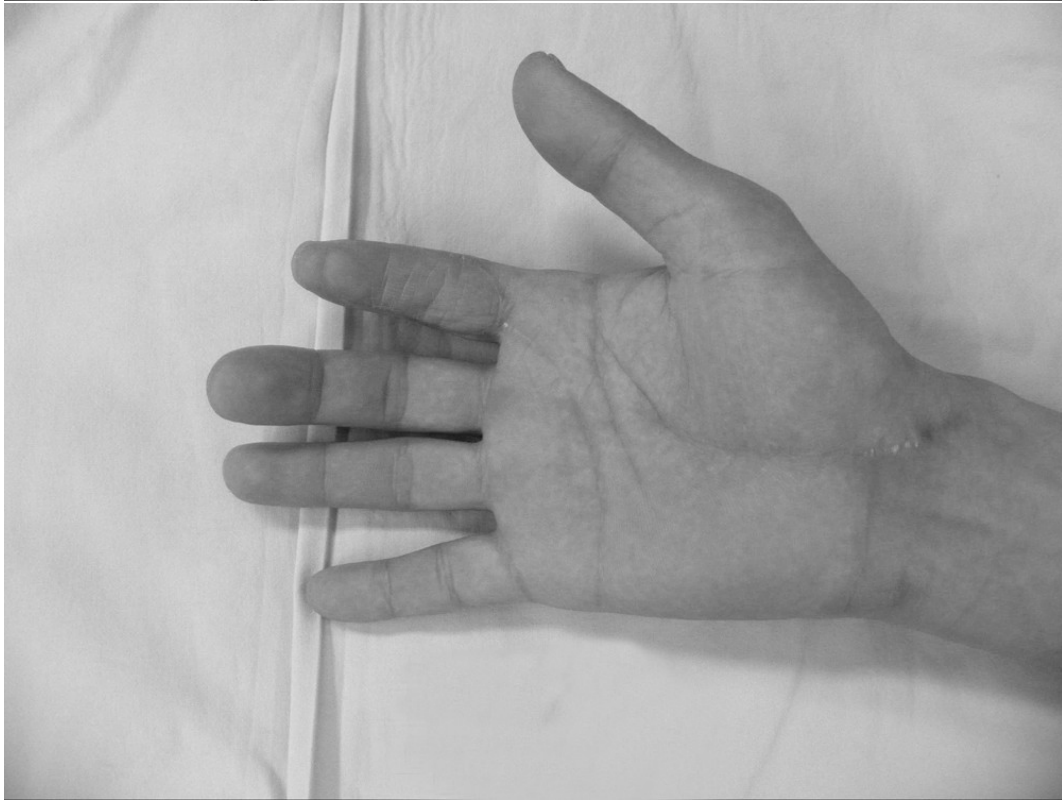
Methods: The radial artery superficial palmar branch flap is based on the perforators of the superficial palmar branch of the radial artery and its venae comitantes. This flap can be used as a sensible flap including palmar cutaneous branch of the median nerve. Fifty radial artery superficial palmar branch free flaps which were performed at Centum Institute during last October 2010 to December 2012 were evaluated. The mean size of the flap was 2.5 x 4.5cm (range 2 x 2.5 to 3x8 cm). The donor site was always closed primarily.

Results: The overall survive rate was 92 percent. The flaps showed well-padded tissue with grabrous skin. All patients have touch sensation and showed 12mm two point discrimination in an average (8 to 20mm). Donor site morbidity was conspicuous.

Summary: The radial artery superficial palmar branch free flap can be used as an option for soft tissue reconstruction of finger defects where local or island flaps are unsuitable.

References:

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2. Omogawa S, Mizumoto S, Iwai M, Fukui A. Innervated radial thenar flap for sensory reconstruction of fingers. *J Hand Surg Am* 1996;21, 373-380.
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◆ Nothing of financial value to disclose

AM E-POSTER 145: Radial Artery Perforator Adiposal Flap for the Treatment of Recurrent Adhesion Neuropathy of the Median Nerve

Category: Vascular/Microvascular

Keyword: Wrist

Level 4 Evidence

- ◆ Takuya Uemura, MD, PhD
- ◆ Kiyohito Takamatsu, MD, PhD
- ◆ Mikinori Ikeda, MD
- ◆ Mitsuhiro Okada, MD, PhD
- ◆ Kenichi Kazuki, MD, PhD
- ◆ Hiroaki Nakamura, MD, PhD

Hypothesis: Recurrent adhesion neuropathy of the median nerve with persistent wrist pain can be a challenging problem. Current opinion dictates that coverage of the median nerve with well-vascularized soft tissue is important after secondary neurolysis. In the present study, we introduced a novel method using a radial artery perforator adiposal flap for coverage of the neurolysed median nerve to minimize reformation of scar adhesion.

Methods: Three patients, who had previously undergone nerve surgeries, repair of a median nerve laceration in two men and primary neurolysis of the median nerve in one woman were included. Because all had substantial median nerve hypersensitivity at the wrist, the secondary neurolysis was performed. The average age was 61 years (range 42 - 89 years). The average interval between the prior nerve surgery and re-exploration was eight months (range 5 - 11 months). The visual analogue pain scale score, presence of a positive tinel sign at the wrist, wrist range of motion, scores of the quick Disabilities of the Arm, Shoulder and Hand (DASH) were examined both preoperatively and at the final follow-up. The average follow-up was 21 months (range 15 - 28 months).

Results: As the median nerve was left unduly exposed after neurolysis, the radial artery perforator adiposal flap was used to envelop the nerve protectively. The adiposal flap size ranged from 800 to 1200 mm² (average 966 mm²) and was enough to cover the exposed median nerve. After surgery, the positive tinel sign on the wrist disappeared in all patients and the mean visual analog pain scale score decreased from 9.5 to 2.0. The fat pads remained beneath the skin and were detected in magnetic resonance imaging at the final follow up exam. Average arc of wrist motion improved from 130° preoperatively to 158° postoperatively. The average score of the quick DASH improved from 58 preoperatively to 28 postoperatively. There was a slight pigmentation of the skin but no major complications and there was no recurrence of median nerve adhesion neuropathy.

Summary: This is the first report of the application of the radial artery perforator adiposal flap for the coverage of the neurolysed median nerve, modified to be thinner and softer than the radial artery perforator adipofascial flap. The results of interposing the radial artery perforator adiposal flap between dysaesthetic volar wrist skin and the neurolysed median nerve have been successful in terms of both pain relief and restoration of hand function.

Figure

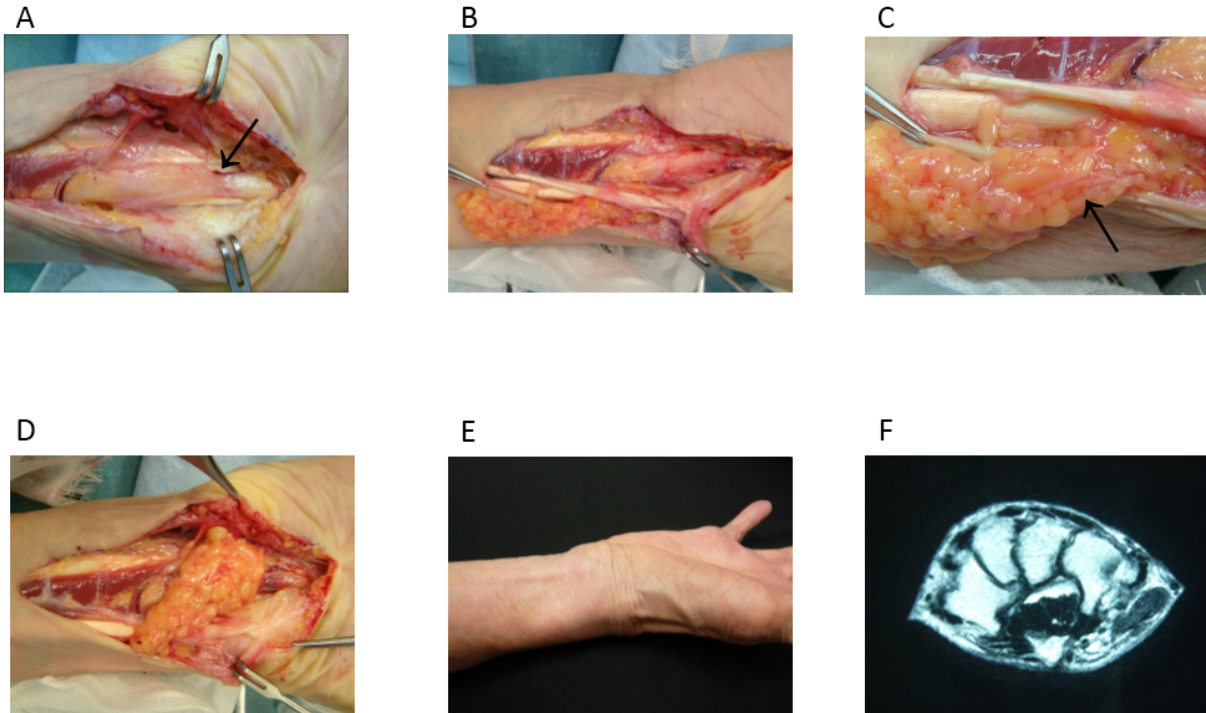


Table. 1. Summary of cases.

Age	Sex	Hand	The prior operation	Intervals between the prior operation and reoperation (months)	Follow up periods (months)	Flap size (mm ²)	Visual analogue pain scale		Hyper Tinel sign		Range of wrist motion				Quick DASH scores		Hand 20 scores		CMAP of the APB		
							Pre-op	Post-op	Pre-op	Post-op	Pre-op		Post-op		Pre-op	Post-op	Pre-op	Post-op	Pre-op	Post-op	
											Extension	Flexion	Extension	Flexion							
Patient 1	42	Male	Right	Nerve repair	11	28	30mm×40mm (1200)	9.5	1.5	Presence	Absence	60	80	90	90	48	34	91	75	Absence	Presence (3.62)
Patient 2	89	Female	Right	Neurolysis	5	15	20mm×40mm (800)	9.5	1	Presence	Absence	60	60	75	70	85	25	59	39	Absence	Presence (4.6)
Patient 3	52	Male	Left	Nerve repair	8	21	30mm×30mm (900)	9.5	3.5	Presence	Absence	60	70	70	80	40	25	48	38	Absence	Presence (4.26)
Average	61	-	-	-	8.0	21	966	9.5	2.0	-	-	60	70	78	80	58	28	66	51	-	4.2

DASH; Disabilities of the Arm, Shoulder and Hand. CMAP; compound muscle action potential. APB; abductor pollicis brevis. DML; distal motor latency.

◆ Nothing of financial value to disclose

AM E-POSTER 146: Extended Twisted Wrap-Around Flap for Degloving Injury of Finger

Category: Vascular/Microvascular

Keyword: Hand

Level 4 Evidence

◆ Yuichi Hirase, MD

Hypothesis: Degloving injury of the finger is very difficult to reconstruct. Function as a digit must be reconstructed, and the aesthetic aspect must also be considered because it is used naked. Sensation of the finger tip is necessary, and range of motion must be retained. In order to gain satisfaction with the result of reconstruction, knowledge and skill of the orthopedic surgery, plastic surgery and microsurgery are needed.

We have used the extended twisted wrap-around flap (E-TWA flap), which combines a TWA flap with a dorsal pedis flap, for degloving injury and gained more satisfactory results than previously obtained.

Methods: The TWA flap is made of two wrap-around flaps harvested from the great toe and second toe. This flap is extended as an E-TWA flap by combining the TWA flap with a dorsal pedis flap. The vascular pedicle is the 1st. metatarsal artery or dorsal pedis artery, and a few subcutaneous veins are attached. In each flap, the digital nerve is included and sutured to digital nerves in the recipient site. In most cases, the donor defect is covered by artificial dermis and skin grafted a few weeks later.

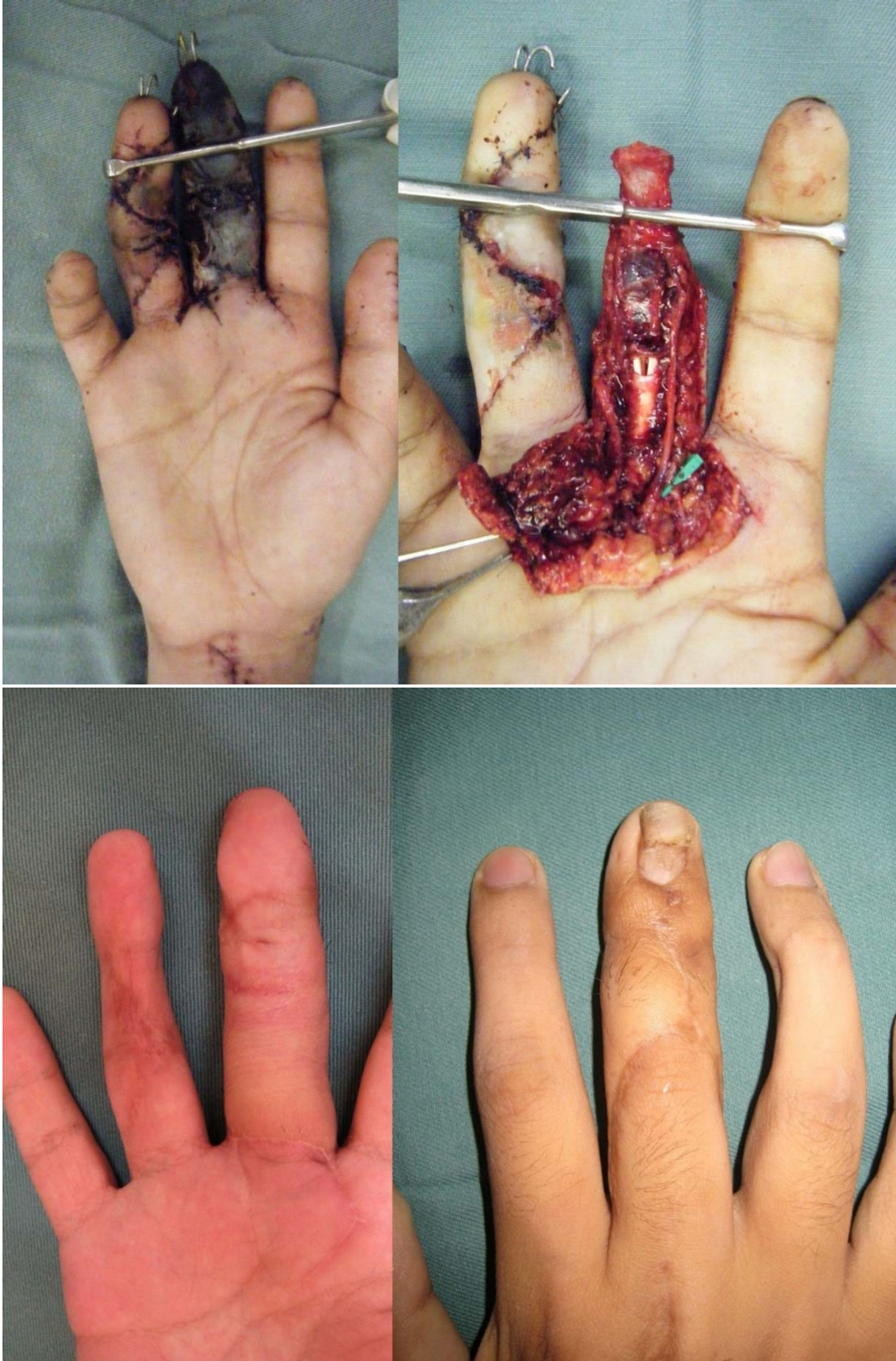
Results: Over the past ten years we have experienced 26 cases of TWA flap and E-TWA flap. In 14 cases, E-TWA flap was used for a degloving injury of the finger. All flaps survived except one case of partial necrosis.

Summary: This method has some advantages. A large skin flap with nail can be harvested. Damage of the foot is very small because the sole of the great toe and second toe are left intact in spite of harvesting flaps. Reconstruction of the fingertip with an excellent aesthetic result can be achieved.

Although the DIP joint of the finger is fused in most cases, the function of the PIP joint remains. As neurography can be performed on both sides of the finger, recovery of sensation is very good.

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◆ Nothing of financial value to disclose

AM E-POSTER 147: The Free Distal Volar Forearm Perforator Flap: Clinical Application in Digital Reconstruction

Category: Vascular/Microvascular

Keyword: Hand

Level 4 Evidence

- ◆ Vachara Niumsawatt, MBBS
- ◆ Dr. Chasari Tancharoen MBBS
- ◆ Mr. Edmund W. Ek MBBS, FRACS
- ◆ Mr. Damon J. Thomas MBChB, FRACS

Hypothesis: Soft tissue defects of the digits can be a challenging problem for the hand surgeon. For non-graftable defects numerous local, regional and free flaps have been described for resurfacing, each with their own limitations – bulk, colour, texture mismatch, donor morbidity. Perforator flaps increasingly provide the optimal option for reconstruction of digital defects as they are thin, pliable and with low donor-site morbidity.

Methods: A thin, pliable fasciocutaneous flap can be raised from the distal volar forearm based on a perforator of the radial artery. The pedicle is up to 2-3 cm in length with a diameter of at least 0.5mm in diameter, suitable for anastomosis to the digital artery. Venous drainage is via the venae comitante of the radial artery and superficial volar veins.

Results: Two patients presented to our emergency department following circular saw injuries. Both patients suffered multi-digit trauma with subsequent soft tissue defects over the dorsum of the digit. Reconstructive requirements were met utilizing a free fasciocutaneous flap raised on a distal volar forearm perforator from the radial artery. Both patients had uneventful recovery with no donor site morbidity.

Summary: Dorsal digital soft tissue reconstruction requires thin, pliable, ideally hairless and sensate skin. Most loco-regional options are limited by the need for multi-stage surgery, bulk, limited reach or donor site morbidity. In our two cases the reconstructive requirements were met with preservation of the radial artery. While it requires microsurgical skill and instruments, this flap provides another option for the reconstructive hand surgeon.

- ◆ Nothing of financial value to disclose

AM E-POSTER 148: Disability and Health After Replantation or Revascularisation in the Upper Extremity in a Population in Southern Sweden – A Retrospective Long Time Follow Up

Category: Vascular/Microvascular

Keyword: Hand

Level 4 Evidence

◆ Hans-Eric Rosberg, MD, PhD

Hypothesis: To investigate long time consequences, as activity limitations in hand/arm, the general health and cold sensitivity, after replantation or revascularization in the upper extremity and to examine if sense of coherence (SOC) can be an indicator for rehabilitation focus.

Methods: During 15 years (1994-2008), 326 patients needed replantation/revascularization in the upper extremity. 297 patients were available for follow up. Information was collected from the medical notes and by questionnaires [Quick-DASH (disability hand/arm), EuroQ-5D VAS (general health), CISS (cold sensitivity) and SOC (sense of coherence)]. Severity of injury was classified with the modified Hand Injury Severity Score (MHISS). Functional parameters (grip and pinch strength, ROM) were collected from certificate for insurance company.

Results: There was a seasonal, but not a weekly, fluctuation in number of injuries among the patients [272 (84%) men and 54 (16%) women; median age 39 years (1-81 years)], where most injuries affected fingers (63%) and thumb (25%), commonly affecting the proximal phalanx (43%). The injuries were commonly related to saws (22%), machines (20%) and wood cutters (20%). A direct anastomosis (30%) or vein grafts (70%) were used. The overall survival rate was 90%. Fifty nine per cent were classified as Major (MHISS) injuries and they were older, had a worse disability, quality of life, functional outcome and had a lower SOC. Equal parts of the injuries took part during work (50%) and leisure (50%), but the DASH scores at follow up were worse ($p=0.005$) in the former. Twenty percent changed work and 10% retired early due to the injury. Patients with early retirement were significantly older, had a more severe injury, worse disability, quality of life and functional outcome. The median DASH score was low [11.4 (0-88.6)] and correlated with MHISS. Abnormal cold sensitivity (CISS>50) was seen in 51/209 (24%) and they had a worse disability, quality of life, functional outcome and lower SOC. The patients with a low SOC had on the whole a worse outcome compared to patients with a high SOC and with significant difference in age, EQ-5D, Quick-DASH and CISS.

Summary:

- 10% had retired and 20% changed work due to the injury.
- 24% had an abnormal cold intolerance.
- Quick-DASH scores were low at follow up but correlated with severity of injury.

- A more severe injury had a worse quality of life and functional outcome.
- Low SOC influences the patients' outcome and is relevant in rehabilitation.

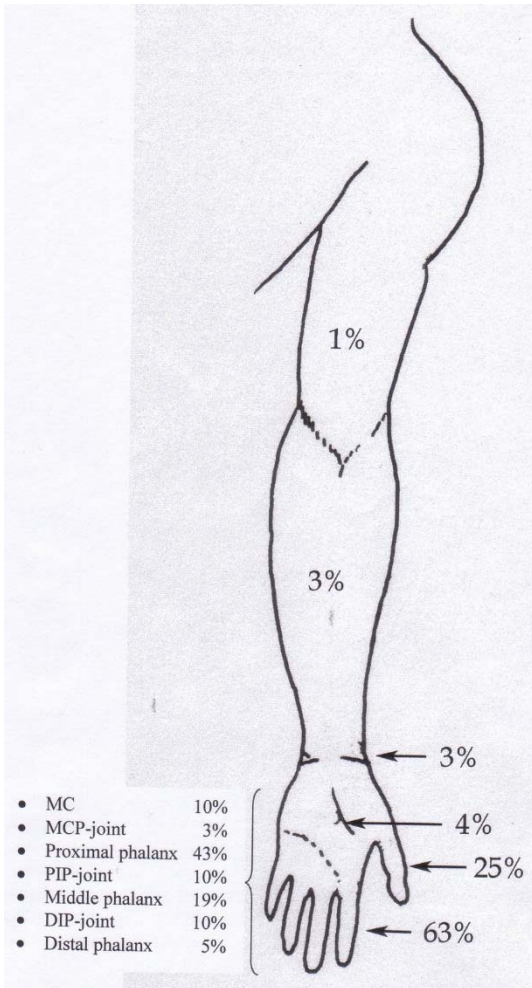
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Table I

Median and min-max values for some variables for the total number of patients and divided into groups with different replantation/revascularization level.

	Total n=326	Thumb n=83	Finger n=205	Middle hand n=14	Wrist n=9	Proximal to wrist n=13
Age (Years)	39 (1-81)	46 (8-81)	34 (1-76)	30,5 (9-63)	30 (18-66)	49 (8-68)
Sex F/M	17%/83%	16%/84%	17%/83%	14%/86%	22%/78%	15%/85%
Cause of injury (%)	Saw 22% Wood cutting 20% Machine 20%	Saw 29% Machine 23% Woodcutter 18%	Saw 22% Woodcutter 21% Machine 18%	Saw 21% Woodcutter 21% Machine 21%	Farmer 33% Machine 22% Woodcutter 11%	Woodcutter 31% Crush 23% Farmer 15%
HISS	120 (24-409)	144 (78-406)	84 (24-409)	174 (56-337)	200 (107-323)	190 (100-250)
EQ-5D VAS	80 (5-100)	80 (30-100)	80 (12-100)	80 (15-90)	70 (5-78)	80 (10-100)
EQ-5D Index	0.824 (-0.624 -1.0)	0.824 (-0.324 -1.0)	0.824 (-0.624 -1.0)	0.824 (0.075 - 1.0)	0.708 (0.034-0.713)	0.824 (0.374 - 1.0)
QuickDASH	11.4 (0-88.6)	9.1 (0-72.7)	9.1 (0-88.6)	13.6 (2.3-47.7)	43.2 (27.3-88.6)	29.5 (0-59.1)
CISS	36 (10-89)	35 (4-75)	35 (0-89)	37 (14-82)	44 (18-52)	41 (4-56)
SOC	75 (27-93)	76 (50-90)	73 (27-93)	79 (40-91)	72 (68-84)	80 (28-91)
ADL	13 (10-25)	13 (10-21)	13 (10-24)	14 (10-22)	21 (14-25)	18 (14-21)
JAMAR % of contralat.	66 (0-100)	84 (24-100)	64 (2-100)	56 (7-100)	28 (0-51)	25,5 (0-75)
PINCH % of contralat.	75 (0-100)	56 (12-100)	80 (6-100)	62 (9-100)	31 (12-62)	40,5 (0-80)



◆ Nothing of financial value to disclose

AM E-POSTER 150: Primatrix: A New Method to Time Long Problem

Category: Wound Healing/Burns

Keyword: Hand

Level 4 Evidence

◆ Som Kohanzadeh, MD

◆ Liana M. Lugo, MD

◆ Morgan Martin Sparks, MD

◆ Leo Chris Derosier, MD

◆ Jorge de la Torre, MD

Hypothesis: Soft tissue coverage in hand injuries is a problem because of underlying exposed bone, tendon, nerve or vessels and often requires loco-regional or free flap reconstruction which is costly with long operative times and postoperative care, as well as significant donor morbidity. Primatrix (TEI Biosciences) allows us to provide coverage of these vital structures without the need for flap reconstruction.

Methods: We performed a retrospective review of all patients undergoing the usage of primatrix for soft tissue coverage over the past 18 months with our group of plastic surgeons; in particular, focusing on cases with hand injury. We additionally, identified any other comorbidities, i.e. diabetes, tobacco use, history of previous hand or upper extremity injury, and any additional traumatic injuries.

Results: Primatrix use in hand reconstruction was identified for 5 patients undergoing 5 procedures on 6 hands (bilateral in one patient). These patients varied in age from a newborn (4 months) to 71 years of age. All suffered significant hand injuries resulting in soft tissue defects. After the use of primatrix in these patients, none went on to require flaps or local tissue rearrangement, most went on to completion of treatment with split thickness skin grafts over the primatrix. Follow up period ranged from 2 - 18 months. Complications included incomplete take of primatrix in 1 patient, which was then treated with local wound care and skin grafting. There was no incidence of hematoma, seroma or infection. There was one case of keloid formation. All patients went on to physical therapy. All regained use of their hands upon final visit.

Summary:

- Primatrix can serve as an alternative either as a bridging method but sometimes even as an alternative to more complex reconstructive cases in the hand
- It saves patients from long anesthetic times, extensive postoperative wound care (as in the case of abdominal or groin flaps), and saves precious soft tissue for alternative use in poly-trauma patients

- Further study will be required to delineate the ideal use for the product, at this point we present its use as an option for soft tissue reconstruction in the hand.

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◆ Nothing of financial value to disclose