RF Paper 01: Biomechanical Comparison of Screw Trajectory to Fracture Pattern for Unstable Scaphoid Fractures

Session I - 8:00 - 8:05 AM

Category: Fractures and Dislocations
Keyword: Hand
Not a clinical study

♦ Gregory K. Faucher, MD
♦ M. Leslie Golden, MS
♦ Kyle Robert Sweeney, MD
♦ William Hutton, DSc
♦ Claudius D. Jarrett, MD

Hypothesis: Current recommendation for stabilizing all scaphoid fractures is to place a long screw inserted along the central axis of the bone irrespective of fracture pattern. This has been shown to be a sound construct in transverse waist fracture patterns. Controversy remains, however, as to whether this concept can be applied to oblique fracture patterns as well. We hypothesize that a screw placed perpendicular to the fracture line in an oblique fracture will provide fracture fixation strength that is comparable to that provided by a centrally placed screw.

Methods: Oblique iatrogenic fractures were made in 8 matched pairs of cadaveric scaphoids. One scaphoid from each pair was randomized to receive a screw placed centrally along the long axis of the scaphoid. In the other matched scaphoid, a screw was placed perpendicular to the osteotomy line. An MTS testing machine was used to apply cyclic loading to each scaphoid at a force of 120N and a rate of 1Hz until the fracture underwent 2mm of displacement, catastrophic failure, or 4000 cycles was reached. The scaphoids that survived 4000 cycles were then progressively loaded to failure. Screw size, fatigue strength, load to failure and mechanism of failure were compared between the groups.

Results: We found no difference in number of cycles or load to failure between the two groups. The number of cycles was 3510.3 ± 1199.4 for a perpendicular screw and 3470.0 ± 1298.2 for a central screw (P=1.00). Load at failure was 258.4 ± 84.6N for a perpendicular screw and 294.3 ± 115.2N for a central screw (P=0.92). Screws placed perpendicular to the fracture line (18.5 mm) were significantly shorter in length than central screws (22.8 mm) (p = 0.0089). No difference was found when load to failure was normalized for screw size, with average 13.9 N/mm for the perpendicular group and 12.9 N/mm for the longitudinal group (p=0.53). The most common mode of failure of both groups was fracture of the distal pole of the scaphoid. This occurred in 71.4% (5 scaphoids) in the central axis screw group and 85.7% (6 scaphoids) in the perpendicular-screw group.

Summary: These results support a fracture specific approach to scaphoid fixation. We believe that a perpendicularly placed screw provides equivalent strength to one placed along the central axis. This promising alternative employs a technically easier approach with a short screw that preserves more bone stock in both acute fractures and nonunions.

References:

1. McCallister WV, Knight J, Kaliappan R, Trumble T. Central placement of the screw in simulated fractures of the scaphoid waist. J Bone and Joint Surg. 2003;85A:72-78.
2. Luria S, Lenart L, Lenart B, Peleg E, Kastelec M. Optimal fixation of oblique scaphoid fractures: a cadaver model. J Hand Surg. 2012;37A:1400-04.
3. Ezquerro F, Jiménez S, Perez A, Prado M, de Diego G, Simon A. The influence of wire positioning upon the initial stability of scaphoid fractures fixed using kirschner wires: a Finite Element Study. Med Eng Phys. 2007;29:652-660.
4. Gokce V, Oflaz H, Dulgeroglu A, Bora A, Gunal I. Kirschner wire fixation for scaphoid fractures: an experimental study in synthetic bones. J Hand Surg [Eu]. 2011;36(4):325-8.
5. Newport ML. Williams CD, Bradley WD. Mechanical strength of scaphoid fixation. J Hand Surg Br. 1996;21:99-102.
6. Compson JP. The anatomy of acute scaphoid fractures: a three-dimensional analysis of patterns. J Bone and Joint Surg [Br]. 1998;80B:218-24.
7. Smith DK, Cooney III WP, An KN, Linscheid RL, Chao EY. The effects of simulated unstable scaphoid fractures on carpal motion. J Hand Surg [Am]. 1989;14:283-91.
8. Russe O. Fracture of the carpal navicular. Diagnosis, non-operative treatment, and operative treatment. J Bone and Joint Surg. 1960;42A: 759-768.
9. Hart A, Mansuri A, Harvey E, Martineau P. Central versus eccentric internal fixation of acute scaphoid fractures. J Hand Surg. 2013;38A:66–71.
10. Levitz S, Ring D. Retrograde (volar) scaphoid insertion – a quantitative computed tomographic analysis. J Hand Surg. 2005;30(3):543-8.

TABLE 1

Strength of Fixation and Screw Size

Fixation	Variable	N	Mean	Std Dev	Median	Minimum	Maximum
Longitudinal	**Screw size (mm)**	8	22.8	2.1	23.0	20.0	26.0
	Load at Failure (N)	8	294.3	115.2	269.5	150.0	540.0

Fixation	Variable	N	Mean	Std Dev	Median	Minimum	Maximum
	Cycles	6	3470.0	1298.2	4000.0	820.0	4000.0
	Load/Screw Size(N/mm)	8	12.9	4.7	11.5	7.5	22.5
Perpendicular	**Screw size (mm)**	8	18.5	2.6	18.0	16.0	22.0
	Load at Failure (N)	7	278.1	68.6	306.0	150.0	350.0
	Cycles	6	3510.3	1199.4	4000.0	1062.0	4000.0
	Load/Screw Size(N/mm)	7	14.81	3.7	15.0	9.4	19.4

Table 1: Table comparing screw size, load at failure, cycles, and normalized force for screw size.

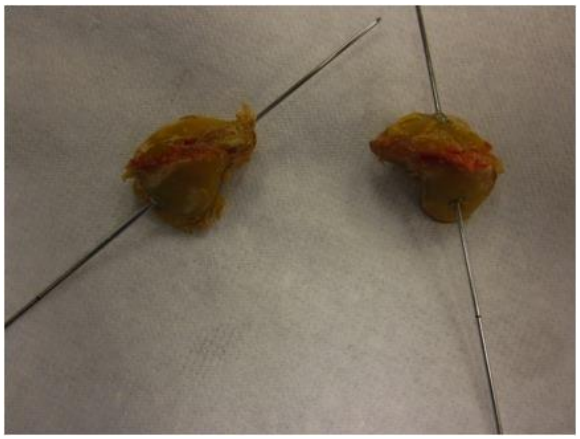


Figure 1: Scaphoid specimens illustrating longitudinal and central screw trajectories across oblique scaphoid fracture patterns.

♦ Nothing of financial value to disclose

RF Paper 02: Internal Fixation of Acute Scaphoid Fractures via an Open Dorsal Approach: A Radiographic and Clinical Outcome Evaluation

Session I - 8:05 - 8:10 AM

Category: Fractures and Dislocations
Keyword: Wrist
Level 3 Evidence

♦ David Saper, MD

♦ Andrew B. Stein, MD

♦ Akash Shaw, BS

Hypothesis: Reports of radiographic and patient outcomes using an open dorsal approach are limited in the literature. We sought to evaluate a consecutive series of acute scaphoid fractures treated by internal fixation via a dorsal open approach.

Methods: 53 consecutive acute scaphoid fractures that underwent open reduction and internal fixation with an open dorsal approach were identified. Patients included in the study had an acute scaphoid fracture diagnosed and treated operatively within six months of the time of injury. Radiographs were used to assess fracture healing and position. Outcome measures included the rate of fracture union, central versus eccentric screw placement, grip strength, and complications including revision surgery.

Results: The average age for all patients was 30 years (standard deviation of 9 years) with 45 male and 8 female patients. The average time from the date of injury to surgery was fifty-two days. Patients were followed for an average of 263 days after surgery. 51 patients were available for follow-up. The rate of fracture union, determined by clinical and radiographic criteria, was 80% and 76% of compression screws were placed centrally within the scaphoid. Out of the 10 patients with non-unions only two required repeat surgery with bone graft. Grip strength was within 5 kg of the uninjured side in all 51 patients post operatively.

Summary:

- Patient outcomes after internal fixation with an open dorsal approach to the scapoid are limited in the literature.
- A large consecutive series of internal fixation with an open dorsal approach for scaphoid fracture demonstrated an acceptable radiographic and clinical outcome rate.
- This approach afforded a high rate of central screw placement (76%).
- The dorsal open approach demonstrated consistent rates of scaphoid union, safe and reliable central screw placement, and a low complication rate.

References:

1. ADOLFSSON, L., LINDAU, T. and ARNER, M., 2001. Acutrak screw fixation versus cast immobilisation for undisplaced scaphoid waist fractures. J Hand Surg Br, 26(3), pp. 192-195.
2. BEDI, A., JEBSON, P.J., HAYDEN, R.J., JACOBSON, J.A. and MARTUS, J.E., 2007. Internal fixation of acute, nondisplaced scaphoid waist fractures via a limited dorsal approach: an assessment of radiographic and functional outcomes. J Hand Surg Am, 32(3), pp. 326-333.
3. BUSHNELL, B.D., MCWILLIAMS, A.D. and MESSER, T.M., 2007. Complications in dorsal percutaneous cannulated screw fixation of nondisplaced scaphoid waist fractures. J Hand Surg Am, 32(6), pp. 827-833.
4. CHAN, K.W. and MCADAMS, T.R., 2004. Central screw placement in percutaneous screw scaphoid fixation: a cadaveric comparison of proximal and distal techniques. The Journal of hand surgery, 29(1), pp. 74-79.
5. DIAS, J.J., WILDIN, C.J., BHOWAL, B. and THOMPSON, J.R., 2005. Should acute scaphoid fractures be fixed? A randomized controlled trial. J Bone Joint Surg Am, 87(10), pp. 2160-2168.
6. DODDS, S.D., PANJABI, M.M. and SLADE, J.F., 2006. Screw fixation of scaphoid fractures: a biomechanical assessment of screw length and screw augmentation. J Hand Surg Am, 31(3), pp. 405-413.
7. TRUMBLE, T.E., CLARKE, T. and KREDER, H.J., 1996. Non-union of the scaphoid. Treatment with cannulated screws compared with treatment with Herbert screws. J Bone Joint Surg Am, 78(12), pp. 1829-1837.
8. MCCALLISTER, W.V., KNIGHT, J., KALIAPPAN, R. and TRUMBLE, T.E., 2003. Central placement of the screw in simulated fractures of the scaphoid waist: a biomechanical study. The Journal of bone and joint surgery.American volume, 85-A(1), pp. 72-77.
9. IBRAHIM, T., QURESHI, A., SUTTON, A.J. and DIAS, J.J., 2011. Surgical Versus Nonsurgical Treatment of Acute Minimally Displaced and Undisplaced Scaphoid Waist Fractures: Pairwise and Network Meta-Analyses of Randomized Controlled Trials. J Hand Surg Am, 36(11), pp. 0-0.

♦ Nothing of financial value to disclose

RF Paper 03: Trapezial Fractures and Associated Injuries of the Ulnar Carpus.

Session I - 8:10 - 8:15 AM

Category: Fractures and Dislocations
Keyword: Wrist
Level 4 Evidence

♦Amber R. Leis, MD
♦Frances E. Sharpe, MD

Hypothesis: Fractures of the trapezium occur commonly with ulnar sided carpal fractures.

Methods: Over a 5-year period (2004-2009) the Kaiser Fontana Medical Center electronic records were queried to identify any surgical procedure or hospital encounter with diagnosis codes for wrist fracture, hand fracture, or carpal fracture. Records were reviewed and data were collected regarding which carpal bones were fractured. All cases of trapezium fracture were evaluated further and their cases are presented.

Results: Seven trapezial fractures were identified, representing 7% of all carpal fractures, and 29% of all non-scaphoid carpal fractures. Of the 7 trapezium fractures identified, 4 (57%) were associated with Bennett's fracture and 4 (57%) were associated with ulnar sided carpal fractures. Three of these associated ulnar carpal injuries were triquetral fractures, ranging from dorsal chip to comminuted, and one was a hamate fracture. All patients were male, age range 17-33, and involved in motorcycle or bicycle accidents. Three of the four cases involved the dominant hand. All patients underwent operative reduction and fixation.

Summary: Trapezial fractures are considered rare among carpal injuries. They are reported to occur most often in association with Bennett's fracture. At our institution, however, we observed a higher than expected number of trapezial fractures, and a significant portion of them were associated with ulnar sided carpal injury. It is possible that the increasing popularity of high speed recreational activities are making the incidence of trapezial fracture more common than previously reported. When the mechanism of injury occurs axially along the thumb, the pattern of injury may include a Bennett type fracture. However, the anatomy of the carpal bones and their strong ligamentous connection may cause them to behave more like the pelvis or mandible, where break at one location in the carpal ring results in a second area of disruption. The anatomy of the transverse carpal ligament may be responsible for the transmission of forces between the trapezium and ulnar carpus, resulting in frequent concomitant injuries of the hamate. Although the identification of these additional ulnar sided carpal fractures may not ultimately affect patient management, we feel that recognition of this injury pattern enhances our

understanding of the force transmission relations in the carpus, and should prompt surgeons to look for the contre coup injury in cases of trapezium fracture.

♦ Nothing of financial value to disclose

RF Paper 04: Non-Operative Treatment of Closed Extra-Articular Distal-Third Diaphyseal Fractures of the Humerus: A Comparison of Functional Bracing and Long Arm Casting

Session I - 8:15 - 8:20 AM

Category: Fractures and Dislocations
Keyword: Other
Level 3 Evidence

♦ David Saper, MD

♦ Andrew Jawa, MD

♦ Christiaan Swellengrebel, BS

♦ Paul H. Yi, BA

● ♦ David C. Ring, MD, PhD

Hypothesis: The optimal nonoperative treatment of closed extra-articular distal third diaphyseal humerus fractures is equivocal, with advocates of functional bracing raising concerns of elbow stiffness associated with long arm casting while proponents of long arm casting claim superior alignment. We hypothesized that functional bracing and long arm casting for the treatment of closed extra-articular distal third diaphyseal humerus fractures would have no significant difference in union rate, functional outcome, or radiographic alignment.

Methods: We identified 105 consecutive patients who were treated with a functional brace or a long arm cast for a closed extra-articular fracture of the distal third of humeral diaphysis at two level-1 trauma centers between 2003 and 2011. At a minimum follow-up of six months or earlier with clinical and radiographic evidence of healing, 51 patients treated with functional bracing were compared to 24 treated with long arm casting for rate of union, functional outcome (range of motion), and radiographic alignment. Elbow range of motion and radiographic alignment of the humerus at the latest follow-up were compared using Student's t-test with the level of significance set at p 20º of elbow motion. The average varus-valgus angulation in the functional bracing group was 17 ± 7.8 degrees and 13 ± 8.4 degrees in the long arm casting group (p = 0.11) and the average anterior-posterior angulation was 9 ± 6.2 degrees versus 7 ± 7.5 degrees (p = 0.54).

Summary:

- In the nonoperative treatment of closed extra-articular distal-third diaphyseal fractures of the humerus, both functional bracing and long arm casting have a 100% union rate.
- No significant differences were observed in average elbow motion or radiographic alignment at latest follow-up between the two treatment modalities.

- Most patients in either group regained full elbow range of motion.
- Both functional bracing and long arm casting are viable options to consider for the nonoperative treatment of a closed, extra-articular distal-third diaphyseal fracture of the humerus.

References:

1. Sarmiento A, Horowitch A, Aboulafia A, Vangsness CT, Jr. Functional bracing for comminuted extra-articular fractures of the distal third of the humerus. J Bone Joint Surg Br. 1990 Mar;72(2):283-7. PubMed PMID: 2312570. Epub 1990/03/01. eng.
2. Jawa A, McCarty P, Doornberg J, Harris M, Ring D. Extra-articular distal-third diaphyseal fractures of the humerus. A comparison of functional bracing and plate fixation. J Bone Joint Surg Am. 2006 Nov;88(11):2343-7. PubMed PMID: 17079389. Epub 2006/11/03. eng.
3. Ring D, Chin K, Taghinia AH, Jupiter JB. Nonunion after functional brace treatment of diaphyseal humerus fractures. J Trauma. 2007 May;62(5):1157-8. PubMed PMID: 17495717. Epub 2007/05/15. eng.
4. Wallny T, Westermann K, Sagebiel C, Reimer M, Wagner UA. Functional treatment of humeral shaft fractures: indications and results. J Orthop Trauma. 1997 May;11(4):283-7. PubMed PMID: 9258827. Epub 1997/05/01. eng.
5. Camden P, Nade S. Fracture bracing the humerus. Injury. 1992;23(4):245-8. PubMed PMID: 1618565. Epub 1992/01/01. eng.
6. Sarmiento A, Zagorski JB, Zych GA, Latta LL, Capps CA. Functional bracing for the treatment of fractures of the humeral diaphysis. J Bone Joint Surg Am. 2000 Apr;82(4):478-86. PubMed PMID: 10761938. Epub 2000/04/13. eng.
7. Levy JC, Kalandiak SP, Hutson JJ, Zych G. An alternative method of osteosynthesis for distal humeral shaft fractures. J Orthop Trauma. 2005 Jan;19(1):43-7. PubMed PMID: 15668583. Epub 2005/01/26. eng.
8. Rutgers M, Ring D. Treatment of diaphyseal fractures of the humerus using a functional brace. J Orthop Trauma. 2006 Oct;20(9):597-601. PubMed PMID: 17088660. Epub 2006/11/08. eng.

Table 1. Demographics of long arm casting and functional bracing group

	Functional Bracing n=51	Long arm casting n=24
Sex		
Male	27 (54 %)	14 (58 %)
Female	24 (46 %)	10 (42 %)
Average age (in years)	34 (range, 18 - 90)	32 (range, 18 - 82)
Mechanism of Injury		
Standing height	16 (31.3 %)	5 (20,8 %)
Greater height	2 (4 %)	1 (4.2 %)
Motor vehicle collision	16 (31.3 %)	7 (29,2%)

Sports activity	15 (29,4 %)	5 (20,8%)
Other	2 (4 %)	6 (25 %)
Follow-up (in months)	7 (range, 2 – 25)	4 (range, 2 - 15)

● Contracted Research: Skeletal Dynamics
● Royalties/Honoraria: Wright Medical; Skeletal Dynamics; Medartis
● Consulting Fees: Wright Medical: Biomet; Skeletal Dynamics; Acumed
● Other Financial Relationships: Stock Options: Illuminos
♦ Nothing of financial value to disclose

RF Paper 05: Bio-Absorbable Pin Fixation In Pediatric Radial Neck Fractures And Malunions

Session I - 8:20 - 8:25 AM

Category: Fractures and Dislocations
Keyword: Elbow
Level 4 Evidence

♦ Corey B. Fuller, MD
♦ Phillip T. Guillen, MD
♦ Montri Wongworawat, MD
♦ Barth B. Riedel, MD

Hypothesis: Current treatment algorithms for pediatric radial neck fractures reserve open treatment with fixation for severe residual angulation. There is a paucity of literature guiding treatment for delayed presentation resulting in malunion. In addition, bioabsorbable pins have been used successfully for many other fractures in the upper extremity, eliminating issues surrounding subsequent hardware removal and pin site infections. We hypothesized open reduction with bio-absorbable fixation for pediatric radial neck fractures, with an osteotomy when necessary, is a reasonable alternative to traditional metal fixation, eliminating issues surrounding subsequent hardware removal and pin site infections.

Methods: This study retrospectively evaluated outcomes of radial neck fractures in three children, 4-8 years old, with delayed initial presentation to clinic averaging 21 days. Initial presentation demonstrated average angular deformity of 63° and translational deformity of 44% in the AP plane with painful and reduced range of motion in all patients. Patients underwent open reduction and fixation with Self-Reinforced Poly-LLactic Acid pins after attempted closed reduction failed to improve the deformity. Two patients required formal osteotomies for healed fractures. Postoperative follow-up average was 7.1 months (range 4.8-11.3) and consisted of radiographic and clinical evaluation with Wong-Baker FACES™ Visual Analog scale and the Mayo Elbow Performance (MEP) Score.

Results: Final radiographs demonstrated an improvement in angular deformity by 54° (from 63° to 9°) and translational deformity by 30% (from 44% to 14%). There was no evidence of physeal closure, avascular necrosis or proximal radioulnar synostosis. Finalclinical outcomes demonstrated significantly improved pain free range of motion with excellent MEP scores, averaging 95/100. There were no cases requiring hardware removal or complicated by local inflammatory reactions.

Summary:

- This small series shows encouraging results with bio-absorbable fixation and use of an osteotomy when necessary in pediatric radial neck fractures and malunions.
- Bio-absorbable fixation may eliminate issues surrounding subsequent hardware removal and pin site infections in surgical treatment of radial neck fractures.
- This study is first known published account using bio-absorbable pins in pediatric radial neck fractures and malunions.

References:

1. Steinberg, E.L., et al., Radial head and neck fractures in children. Journal of pediatric orthopedics, 1988. 8(1): p. 35-40.
2. Waris, E., et al., Use of bioabsorbable osteofixation devices in the hand. Journal of hand surgery, 2004. 29(6): p. 590-8.
3. Tan, B.H. and A. Mahadev, Radial neck fractures in children. Journal of orthopaedic surgery, 2011. 19(2): p. 209-12.
4. Evans, M.C. and H.K. Graham, Radial neck fractures in children: a management algorithm. Journal of pediatric orthopaedics. Part B, 1999. 8(2): p. 93-9.
5. Majed, A. and Baco A.M., Late diagnosis and treatment of paediatric radial neck fracture. Injury Extra, 2006. 37(9): p. 322-4.
6. Papageorgious, T.G., et al., Treatment of A Late Presenting Displaced Radial Neck Fracture in A 10 Years-old Girl. Journal of Medical Cases, 2011. 2(6): p252-4.
7. Ceroni, D., et al., Neck osteotomy for malunion of neglected radial neck fractures in children: a report of 2 cases. Journal of Pediatric Orthopedics, 2010. 30(7): p649-54.

♦ Nothing of financial value to disclose

RF Paper 06: Evaluation of Current Treatment Techniques for Distal Radius Fractures Amongst Belgian Orthopaedic Surgeons

Session II - 8:30 - 8:35 AM

Category: Fractures and Dislocations
Keyword: Wrist
Level 4 Evidence

♦ David van Schaik, MD

Hypothesis: In the treatment of distal radius fracture several different surgical options are in use. Consensus exists among orthopaedic surgeons in Belgium on treatment of distal radius fractures, Frykman type I and VII.

Methods: Members of the Belgium Orthopaedic Association were invited to fill out an online questionnaire. We presented two cases: an extra-articular fracture, with dorsal displacement (Frykman type I) and an intra-articular fracture, with dorsal displacement (Frykman type VII). Treatment of choice and follow up protocols were questioned, as well as justification of treatment of choice. We used IDM SPSS statistics 20 for our data analysis, crosstabs and chi-squared tests to compare different kind of orthopaedic surgeons and their treatment options.

Results: We received 158 responses. In case of a Frykman type I fracture, the majority of surgeons would have performed a MUA and K-wiring (37.3%) or a volar plating (34.8%). MUA and casting (19.6%), casting alone (5.1%) and external fixation (6%) were less favorable treatment options.

Especially upper limb specialists (64.1 %) preferred volar plating compared to other (subspecialized) surgeons. In case of a Frykman type VII fracture, less diversity was measured. Volar plating was the treatment of choice (66.5%). MUA and K-wiring came in second (24.7%) and external fixation was very rare (4.4%). Volar plating seemed common sense for both the upper limb specialists (92.3%) and residents (92.3 %).

Surgeons indicated as primary justification for their treatment of choice that it provides the best functional outcome, respectively 45.5% and 64.6% in case one and two.

The postoperative protocols varied distinctly in the number of follow-up consultations and follow-up radiographs. Paracetamol was preferably prescribed as an analgesic over other drugs (NSAID, tramadol) in both cases (97.4/ 97.5 %). Only 7% of the surgeons prescribed vitamin C as a standard treatment in both cases.

Summary: There is no clear consensus among orthopaedic surgeons on the surgical treatment of distal radius fractures. Although it seems volar plating is more frequently used in the intra-articular types, especially by upper limb specialist and residents.

♦ Nothing of financial value to disclose

RF Paper 07: Systematic Differences in the Treatment of Complex Distal Radius Fractures by Subspecialty Trained Surgeons.

Session II - 8:35 - 8:40 AM

Category: Fractures and Dislocations
Keyword: Wrist
Level 4 Evidence

♦ Tobias Mann, MD, MSc
♦ Jason Dahl, MD
♦ Peter M. Murray, MD
♦ John C. Elfar, MD
♦ Warren C. Hammert, MD

Hypothesis: The management of distal radius fractures (DRF) differs based on the personality of the fracture and the experience of the surgeon. We hypothesized that newly practicing orthopaedists with subspecialty training in hand surgery would differ in the management of DRFs and associated conditions at the time of surgery when compared to non-hand fellowship trained surgeons.

Methods: We queried the American Board of Orthopaedic Surgery (ABOS) database for 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 management of carpal tunnel syndrome and ulnar shaft and styloid fractures. Hand subspecialty trained surgeons were compared to those completing other fellowships and non-fellowship trained orthopaedists during their board collection period. Using Fisher's exact two-tailed test and the Chi-square two-tailed test, these groups were examined to determine if a statistical significant difference existed between them. 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, 2536 were treated non-operatively and 1922 with percutaneous fixation. Open treatment was balanced with: 3617 extra-articular, 2881 simple-intra-articular and 4477 multifragmented intra-articular fractures.

Hand subspecialists were more likely to treat multifragmented intra-articular DRFs (47.1% vs. 36.3%, p=0.0001) than non-hand fellowship trained surgeons. Hand surgeons were more likely to perform a carpal tunnel release (7.3% vs. 1.8%, p=-0.0001) or ulnar styloid (4.5% vs. 2.0%, p=0.0001) or ulnar shaft (2.0% vs. 1.2%, p=0.0009) repair at the same time as DRF fixation.

Summary:

- DRF management differs depending on subspecialty training in orthopaedic surgeons taking part II of the ABOS examination.
- Procedures associated with the management of DRF are also dependent on subspecialty training of the treating surgeon.
- Hand subspecialists are more likely to treat multifragmented intra-articular fractures early in practice than are non-hand fellowship trained surgeons.

References:

1. Wolfe, S.W., Green's operative hand surgery. 6th ed. Green's operative hand surgery, ed. S.W. Wolfe2011, Philadelphia, Pa.: Elsevier/Churchill Livingstone.
2. Jupiter, J.B., Fractures of the distal end of the radius. The Journal of bone and joint surgery. American volume, 1991. 73(3): p. 461-9.
3. Graff, S. and J. Jupiter, Fracture of the distal radius: classification of treatment and indications for external fixation. Injury, 1994. 25 Suppl 4: p. S-D14-25.
4. Grewal, R., et al., A randomized prospective study on the treatment of intra-articular distal radius fractures: open reduction and internal fixation with dorsal plating versus mini open reduction, percutaneous fixation, and external fixation. J Hand Surg Am, 2005. 30(4): p. 764-72.
5. Hammond, J.W., et al., Surgeon experience and clinical and economic outcomes for shoulder arthroplasty. The Journal of bone and joint surgery. American volume, 2003. 85-A(12): p. 2318-24.

♦ Nothing of financial value to disclose

RF Paper 08: Complications of Volar Locked Plating for Distal Radius Fractures

Session II - 8:40 - 8:45 AM

Category: Fractures and Dislocations
Keyword: Forearm
Level 4 Evidence

♦David M. Brogan, MD
♦Hillary A. Becker, MD
♦Ashley C. Walker, NP
♦David G. Dennison, MD
●Alexander Y. Shin, MD

Hypothesis: The purpose of this study was to evaluate the incidence and characterize the complications of locked volar plating of distal radius fractures

Methods: A retrospective review of all adult patients with distal radius fractures treated with volar locked plating at a single institution between 2001-2009 was undertaken. Patients treated with additional plating or external fixation of the distal radius were excluded. 596 wrists in 585 patients were included in the analysis. Major complications included: hardware-related problems; tendon rupture or irritation; carpal tunnel syndrome requiring release or compartment syndrome requiring reoperation; DRUJ instability requiring reoperation; major medical complications; post-traumatic arthritis requiring wrist fusion; arterial injuries and mal-union. We identified all other complications as minor complications.

Results: The average age was 56.5 years, with a F:M ratio of 3.1:1 . Average follow-up was just over 8 months. We identified a total of 85 major and 100 minor complications for a total of 185 complications sustained by 155 patients (26%). The types of complications observed are listed in Figure 1. Of the 155 patients with complications, 29 had symptomatic hardware removed, 3 had EPL ruptures and 1 an FPL rupture. Carpal tunnel syndrome requiring surgical intervention was diagnosed in the immediate post-operative period (within the first 3 months of surgery) in 11 patients. One of these required a return to the operating room within 5 days of the index surgery, the rest were observed for a period of weeks or months and eventually returned to the OR on an elective basis.

Summary:

- We found 185 complications in a review of 596 wrists treated with volar locked plating for distal radius fractures at one institution.

- At least one major or minor complication occurred in 26% of patients undergoing volar locked plating.
- The most common of these were sensory disturbances (9.7%) followed by hardware-related problems (6.3%). After hardware removal, carpal tunnel release was the second most common reason for return to the operating room, with all but one of these performed as an elective procedure.
- The overall rate of tendon related problems was also very low (2.0%) with EPL rupture noted in 3 patients, along with a single FPL rupture.

Major Complications (85)		
Hardware-related		
	Intra-articular	**4**
	Loosening	**4**
	Painful hardware requiring removal	**29**
	Painful hardware without removal	**1**
Tendon-related		
	EPL rupture	**3**
	FPL Rupture	**1**
	EPL tethering / irritation	**2**
	FCR tendon scarring	**2**
	ECU tendonitis	**2**
	FPL irritation	**2**
Carpal tunnel syndrome requiring release		**11**
Post-op compartment syndrome requiring fasciotomy		**1**
Malunion / Loss of Fixation		**7**
DRUJ Instability or Foveal pain requiring surgery		**7**
Post-traumatic arthritis requiring wrist fusion		**2**
Arterial Injuries		
	Radial artery entrapment in fx	**1**
	Intra-op radial artery laceration	**1**
Major medical		
	Death from P.E.A. on POD 5	**1**
	Narcotics overdose	**1**
	Post-op aspiration	**1**
	Massive Post-Op PE	**1**
	Post-Op DVT	**1**
Minor Complications (100)		
CRPS		**12**
Ulnar Impaction / Ulnar Pain		**9**
Delayed union		**5**
Sensory disturbances		
	Median nerve (not requiring CTR)	**43**
	Superficial branch radial nerve	**9**
	AIN palsy	**1**
	Ulnar nerve	**5**
Superficial wound infection treated with antibiotics		**7**
Crepitation of flexor tendons with finger extension		**1**
DeQuervain's Tenosynovitis		**6**
Pin migration requiring reoperation		**2**

● Contracted Research: Integra Orthopedics
● Royalties/Honoraria: Trimed Orthopedics
● Consulting Fees: Acumed Orthopedics, LMT Surgical, Biotech Orthopedics
♦ Nothing of financial value to disclose

RF Paper 09: Complications Following Zone II Flexor Tenolysis in Isolated Digits

Session II - 8:45 - 8:50 AM

Category: Tendon
Keyword: Hand
Level 4 Evidence

♦David Myer, MD
●Peter J. Stern, MD
♦Shannon Hiratzka, MPH
♦Stephen Brandstetter, MD

Hypothesis: Zone II flexor tenolysis is regarded as a safe procedure with a low complication rate. Furthermore, variables including demographic factors, digit involved, mechanism of injury, and number and type of concomitant surgical procedures do not affect rates of complication or outcomes.

Methods/Results: A retrospective review identified patients who underwent single digit flexor tenolysis after flexor tendon injury in zone II from 2000-2010. Patient demographics, mechanism of injury, total active range of motion (TAM), concomitant procedures performed at time of index tenolysis, and complications (including tendon rupture, infection, wound dehiscence, and need for later surgery) were also recorded. We then examined differences with respect to patient demographics and surgical characteristics for complications and outcomes as represented by TAM gained (0 to 10% improvement, and >10% improvement). Statistical analysis was performed using Chi square tests, Fisher's exact tests, or Wilcoxon Rank Sum. Multivariate modeling techniques were employed to adjust for potential confounding of patient and surgical variables on outcomes. Continuous non-normal data were categorized for modeling. Two tailed p values of 10% improvement over preoperative TAM. Those that underwent tenolysis with dorsal PIPJ capsulotomy or extensor tenolysis were significantly (p=.02) less likely to experience complications than those undergoing tenolysis alone or tenolysis with other additional procedures. Significantly worse ROM was observed in small fingers (p=.01). Patients less than 40 years old had significantly (p=.03) improved outcomes (70% achieving >10% improvement) and fewer failures (13% had no improvement) in comparison to age groups 40-55 and >55 (34% and 35% had no improvement, respectively).

Summary:

- Serious complications following zone II flexor tenolysis are common (26%).
- Postoperatively, there was a 10% flexor tendon rupture rate.
- 13% required at least 1 additional procedure.
- Small fingers had significantly worse ROM compared to all other digits.

- Outcomes were also significantly different between age groups; patients 40.
- Thirty patients (25%) achieved no improvement in ROM.

References:

1. Whitaker et al. The role of flexor tenolysis in the palm and digits. J Hand Surg. 1977: 2 (6): 462-470.
2. Fetrow, KO. Tenolysis in the Hand and Wrist. J Bone Joint Surg Am. 1967; 49: 667-685.
3. Yamazaki, H. et al. Results of Tenolysis for flexor tendon adhesion after phalangeal fracture. The Journal of Hand Surgery (European Volume). 2008; 33E; 5: 557-560.
4. Foucher, G et al. A Post-Operative Regime after digital flexor tenolysis. J of Hand Surg (British and European Volume). 1993; 18B: 35-40.

●Consulting Fees: Board of Trustee for Journal of Bone and Joint Surgery

♦ Nothing of financial value to disclose

RF Paper 10: The Epidemiology of Flexor Pulley Reconstruction

Session II - 8:50 - 8:55 AM

Category: Tendon
Keyword: Hand
Level 2 Evidence

●Christopher J. Dy, MD, MSPH
♦Stephen Lyman, PhD
♦Joseph J. Schreiber, MD
♦Huong Do, MS
♦Aaron Daluiski, MD

Hypothesis: There are no population-based studies describing the frequency and complication profile of flexor pulley reconstructions. We used a statewide discharge database to determine the incidence of pulley reconstruction and to evaluate the influence of demographics on frequency of re-operation. We hypothesized that age, insurance type, and concomitant nerve procedure would influence the likelihood of re-operation.

Methods: We used the Statewide Planning and Research Cooperative System (SPARCS) ambulatory surgery database from New York State, representing all out-patient surgery in the state. Patients who underwent flexor pulley reconstruction from 1998 to 2009 were identified using CPT4 codes and subsequent surgery records for these patients were identified through 2010, allowing at least 1 year follow-up. Concomitant nerve procedure and flexor tendon repair/reconstruction were identified. The type and timing of subsequent procedures, including tenolysis and repeat pulley reconstruction were recorded.

Univariate statistics were calculated to compare age, sex, and payer type between patients with and without re-operation. A multivariable logistic regression model was used to evaluate the association of the demographics with the chances of undergoing re-operation.

Results: There were 623 patients who had flexor pulley reconstruction from 1998 to 2009. The incidence of pulley reconstruction was 0.27 per 100,000 persons with an annual frequency of 52 procedures (Figure 1). Index procedures were performed by 271 different surgeons, with 25% of surgeons performing only one pulley reconstruction over 12 years.

There were 39 (6.3%) re-operations (64% tenolysis, 23% repeat reconstruction, 13% tenolysis and repeat reconstruction; mean time to re-operation: 232 days). There was no difference in age, concomitant nerve or tendon repair, or workers' compensation between patients with and without re-operation (Table 1). Regression modeling showed a higher likelihood among men (OR: 2.8; 95% CI: 1.2, 6.7) of undergoing re-operation, after adjusting for age, workers' compensation

status, and concomitant nerve repair. No other variables were associated with increased likelihood of re-operation.

Summary:

- Flexor pulley reconstructions are rare, with an annual average of 52 procedures in New York State. 25% of surgeons performed only one flexor pulley reconstruction over a 12- year period.
- The re-operation rate is 6.3%, which is similar to the re-operation rate for flexor tendon repair (6.1%) using the same database (Dy 2012).
- The existing literature contains few reports of whether adverse events occur after pulley reconstruction. Our report is the largest series of pulley reconstructions (623 patients) and provides information that can be used to counsel patients about their likelihood of re-operation.

References:

1. Dy CJ, Daluiski A, Do HT, Hernandez-Soria A, Lyman S. The Epidemiology of Re-operation after Flexor Tendon Repair. J Hand Surg Am. 2012 Mar;37(3):543-551.e1. Epub 2012 Feb 6. PMID: 22459656.

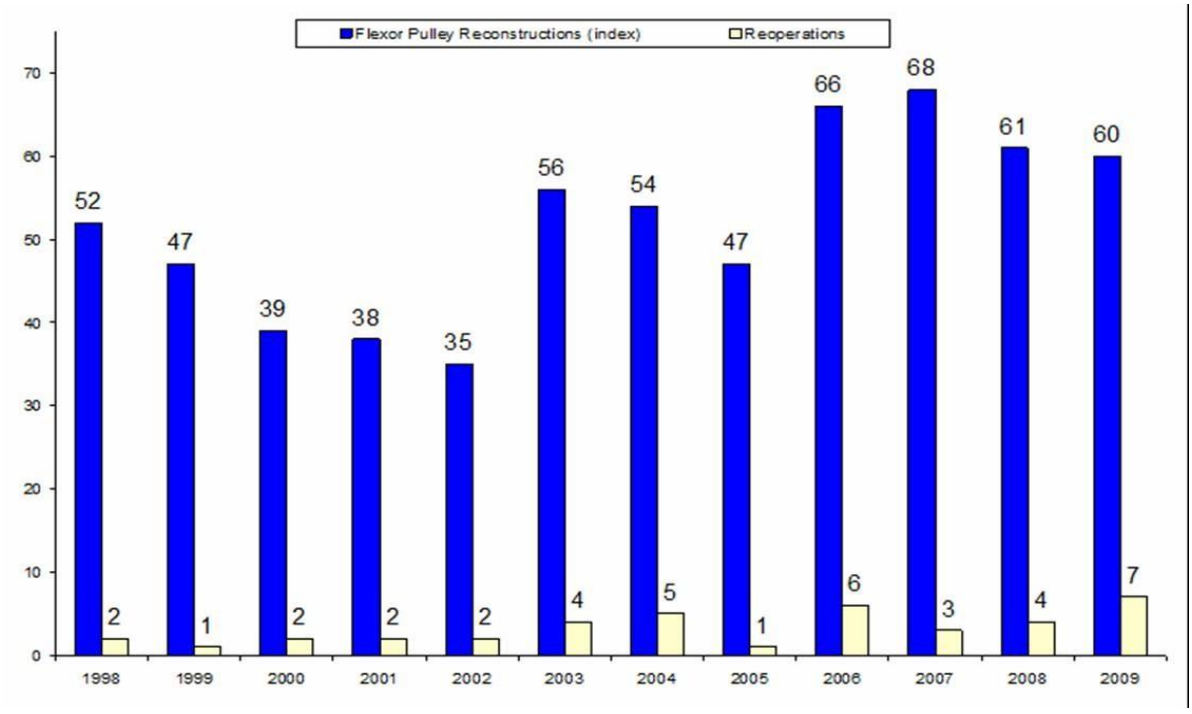


Table 1

	No re-operation *n=584*	Re-operation *n=39*	p-value
Age	41	38	p=0.39
Male Sex	60%	82%	p=0.01
Concomitant nerve repair	8%	15%	p=0.14

Concomitant flexor tendon repair	15%	21%	p=0.36
Primary Payer			
Workers' Compensation	17%	26%	
Government (Medicare/Medicaid)	20%	13%	
Private insurance	50%	56%	
Self-pay	5%	0%	

● Contracted Research: NIH/NIAMS T32 Research Fellowship (AR07281); ASSH Resident/Fellow Fast Track Grant
♦ Nothing of financial value to disclose

RF Paper 11: Biomechanical Assessment of Suture Pullout Strength: A Comparison of the Anchor Suture and the Modified Kessler

Session III - 10:15 - 10:20 AM

Category: Basic Science - Lab Research
Keyword: Forearm
Not a clinical study

♦Terrill P. Julien, MD

Hypothesis: The anchor suture technique is a viable alternative for repairing midsubstance muscle lacerations.

Methods: Fifteen adolescent porcine hindlegs were used. The muscle was isolated and proximal and distal attachments were secured in a cylindrical polymethyl methacrylate fixation device then subjected to tensioning.

Three groups of five legs were used. Each was measured prior to testing. The control group (group 1) was the intact set of five muscles. Groups two and three underwent the same laceration protocol as described in detail later. Group two, the modified kessler (MK) group, was comprised of six kessler constructs, yielding twelve strands crossing the repair site. Group three was repaired with the anchor suture (AS) technique as previously described by the authors. 6 anchor sutures were placed in the repaired muscles, leading to a total of twelve strands crossing the repair site.

A standard preload of 5-8N was used to pre-tension the muscles. Following this, the specimens underwent a constant linear elongation at a rate of 25mm/min. The load-displacement curve was generated with termination being a 50% drop in tension. The primary endpoint was the ultimate failure or pullout in the construct. The secondary endpoint was the mode of failure of each construct.

Results: The average length of the control group, MK and AS groups were 125mm, 110mm and 102mm. The corresponding widths were 38.6mm, 40.8mm and 45.0mm. There were no statistical differences among the groups. Load-displacement curves were generated for all 15 specimens. A one-way ANOVA and Fisher post-hoc analysis were run between the groups. The ultimate strength of the intact muscle group of was found to be 608.1 N. This was significantly ($p<0.05$) higher than the pullout strength of the MK and AS groups. The pullout strength of the AS group was 143.1N, nearly twice that of the MK group 69.8N ($p=0.11$).

Suture pullout was the most common mode of failure. In the MK group, 73% (22/30) sutures pulled though, leading to failure. 27% (8/30) remained intact. In the AS group, similar results

were found with 27% (8/30) of the sutures remaining intact during the testing while 73% (22/30) anchors and sutures pulled through.

Summary: The ultimate strength of an intact porcine lower limb muscle was approximately 608.1. Following a mid-substance laceration repair, the pullout strength of muscles repaired with the AS technique was 143.1N. The authors suggest this as a viable alternative to repair muscle lacerations.

References:

2. Garrett WE, Seaer AV, Boswick J, Urbaniak JR, et al. Recovery of skeletal muscle after laceration and repair. J Hand Surg Am. 1984; 9(5): 683-92.
3. Orava S, et al. Total rupture of pectoralis major muscle in athletes. Int J Sports Med. 1984; 5(5):272-4.
4. Chekofsky KM, Spero CR, Scott WN. A method of repair of late quadriceps rupture. Clin OrthopRelat Res. 1980;(147):190-1.
5. Heckman JD, Levine MI. Traumatic closed transection of the biceps brachii in the military parachutist. J Bone Joint Surg Am. 1978; 60(3):369-72.
6. Kawashima M, Sato M, Torisu T, Himeno R, et al. Rupture of the pectoralis major. Report of 2 cases. Clin OrthopRelat Res. 1975;(109):115-9.
7. Berson BL. Surgical repair of pectoralis major rupture in an athlete. Case report of an unusual injury in a wrestler. Am J Sports Med. 1979;7(6):348-51.
8. Urs ND, Jani DM. Surgical repair of rupture of the pectoralis major muscle: a case report. J Trauma. 1976;16(9):749-50.
9. Kragh JF, Svoboda SJ, Wenke JC, et al. Suturing of lacerations of skeletal muscle. J Bone Joint Surg Br. 2005; 87(9):1303-5.
10. Kragh JF, Basamania CJ. Surgical repair of acute traumatic closed transection of the biceps brachii. J Bone Joint Surg Am, 2002; 84-A(6):992-8.
11. Huard J, Li Y, Fu FH. Muscle injuries and repair: current trends in research. J Bone Joint Surg Am. 2002; 84-A(5): 822-32.

♦ Nothing of financial value to disclose

RF Paper 12: Distal Interphalangeal Joint Bony Dimensions and Headless Compression Screw Sizes: A Mismatch

Session III - 10:20 - 10:25 AM

Category: Basic Science - Anatomy
Keyword: Hand
Not a clinical study

♦Dominic J. Mintalucci, MD
♦Jonas L. Matzon, MD
●Kevin F. Lutsky, MD
♦Genghis Niver, MD
♦Michael Rivlin, MD
●Pedro K. Beredjiklian, MD

Hypothesis: Currently available headless compression screws are oversized for use in distal interphalangeal joint (DIPJ) arthrodesis.

Methods: Standard PA and lateral radiographs of the hand were obtained in 102 patients, corrected for magnification, and analyzed using Phillips iSite digital imaging software. After the exclusion of poor quality radiographs, measurements of the anatomic dimensions of the distal and middle phalanges were performed in 60 small, ring, long, and index fingers. These dimensions were then compared to the diameters and lengths of several commercially available headless compression screws commonly used to perform DIPJ arthrodesis. Descriptive statistics were performed.

Results: Interobserver reliability analysis revealed excellent bony measurement correlation between observers. Overall, commercially available screw diameters overestimated the bony dimensions of the DIPJ. When all fixation devices were combined, screws were oversized relative to the bony anatomy in 72% of small fingers, 49% of ring fingers, 53% of long fingers, and 66% of index fingers. This mismatch was worse in women compared to men. For the small finger, only one of sixteen compression screw types demonstrated a compatability rate greater than 90%.

Summary:

- A significant size mismatch exists between the anatomic dimensions of the middle and distal phalanges and commercially available headless compression screws.
- This mismatch was greater in the small and index finger, and in women.

- Caution must be used when considering these screws for DIPJ arthrodesis to avoid problems related to screw prominence in the narrow aspects of the distal and middle phalanges.

● Consulting Fees: Synthes (Lutsky)
● Ownership Interests: Shares of Stock, Tornier Inc. (Beredjiklian)
♦ Nothing of financial value to disclose

RF Paper 13: Anatomic Course of the Medial Antebrachial Cutaneous Nerve – A Cadaveric Study with Proposed Clinical Application in Failed Cubital Tunnel Release

Session III - 10:25 - 10:30 AM

Category: Basic Science - Anatomy
Keyword: Elbow
Not a clinical study

♦Scott K. Tanaka, MD
♦Gary M. Lourie, MD

Hypothesis: Understanding the proximal course of the medial antebrachial cutaneous nerve (MACN) in the arm will assist in its diagnosis and treatment when involved in failed cubital tunnel release.

Methods: Dissections of thirteen fresh frozen cadaver limbs were performed. The following measurements were taken: medial epicondyle to coracoid, medial epicondyle to piercing of the deep fascia, medial epicondyle to the division into anterior and posterior branches, and the number and position of the posterior crossing branches.

Results: The MACN was found to pierce the deep fascia of the arm anterior to the medial intermuscular septum to become subcutaneous on average 9.28 cm proximal to the medial epicondyle (range: 6.5-11.6 cm). This was 23-37% of the distance from the medial epicondyle to the coracoid. The MACN coursed along with the basilic vein distally until the anterior and posterior branches began to diverge from the vein in their respective directions. The average distance from the medial epicondyle to the division into anterior and posterior branches was 6.39 cm. In four specimens even after division into distinct anterior and posterior branches, both nerves continued to course distally together with the basilic vein before diverging. The anterior division consistently remained either deep or anterior to the basilic vein in all specimens. The posterior branches numbered from 1 to 4 branches as they crossed posterior to the medial epicondyle. These branches ranged from 3.2 cm proximal to the medial epicondyle to 5.8 cm distal to the medial epicondyle.

Summary:

- We more clearly defined the location where the MACN becomes subcutaneous which is necessary to consistently perform an anesthetic blockade for diagnostic purposes where the anatomy is more predictable.
- Key anatomic landmarks to assist in revision surgery include the basilic vein consistently coursing with the MACN anterior to intermuscular septum and only the posterior division of the MACN was found posterior to the basilic vein. This will allow for identification

outside the zone of previous surgery and resection of the posterior branch prior to arborization, sparing the anterior division and increased morbidity.

References:

1. Dellon AL, MacKinnon SE. Injury to the medial antebrachial cutaneous nerve during cubital tunnel surgery. J Hand Surg Br. 1985 Feb;10(1):33-6.
2. Lowe JB 3rd, Maggi SP, Mackinnon SE. The position of crossing branches of the medial antebrachial cutaneous nerve during cubital tunnel surgery in humans. Plast Reconstr Surg. 2004 Sep 1;114(3):692-6.
3. Race CM, Saldana MJ. Anatomic course of the medial cutaneous nerves of the arm. J Hand Surg Am. 1991 Jan;16(1):48-52.
4. Masear VR, Meyer RD, Pichora DR. Surgical anatomy of the medial antebrachial cutaneous nerve. J Hand Surg Am. 1989 Mar;14(2 Pt 1):267-71.
5. Stahl S, Rosenberg N. Surgical treatment of painful neuroma in medial antebrachial cutaneous nerve. Ann Plast Surg. 2002 Feb;48(2):154-8; discussion 158-60.
6. Sarris I, Göbel F, Gainer M, Vardakas DG, Vogt MT, Sotereanos DG. Medial brachial and antebrachial cutaneous nerve injuries: effect on outcome in revision cubital tunnel surgery. J Reconstr Microsurg. 2002 Nov;18(8):665-70.
7. Weiss W, Silver JK, Lennard TA. Easy Injections. Pg 113-114.
8. Viscomi CM, Reese J, Rathmell JP. Medial and lateral antebrachial cutaneous nerve blocks: An easily learned regional anesthetic for forearm arteriovenous fistula surgery. Regional Anesthesia. 1996 Jan-Feb;21(1):2-5.
9. DiGiovanni AJ. A technique for selective blockade of the medial antebrachial cutaneous nerve. Anesthesiology 1969 Feb;30(1):242-243.

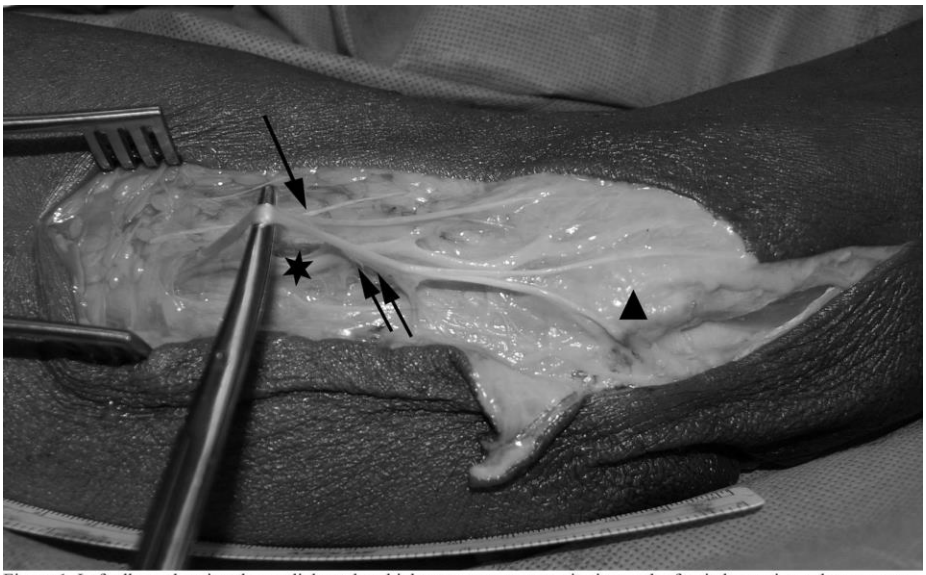


Figure 1. Left elbow showing the medial antebrachial cutaneous nerve as it pierces the fascia becoming subcutaneous and branching of into two anterior and three posterior branches. The basilic vein is shown deep to the nerve. (Single arrow- Anterior division of the medial antebrachial cutaneous nerve; Double arrow – Posterior division of the medial antebrachial cutaneous nerve; Star – Basilic vein; Triangle – Medial epicondyle)

♦ Nothing of financial value to disclose

RF Paper 14: Decreasing Cast pressures and Preventing Complex Regional Pain Syndrome by Using a Simple Novel Method of Casting for Distal Radius Fractures

Session III - 10:30 - 10:35 AM

Category: Basic Science - Clinical Research
Keyword: Wrist
Not a clinical study

♦Melissa Arief, MD
♦Mukund R. Patel, MD

Hypothesis: A novel method of casting where the cast is placed and set with the fingers in flexion will have decreased cast pressures compared to the standard cast placed with fingers in extension. This may decrease the risk of developing edema, finger stiffness, and complex regional pain syndrome.

Methods: This study observed that the circumference of the hand at the metacarpalphalangeal joints is increased with fingers in flexion than in extension. When a cast is applied with the fingers in extension, the metacarpals are cramped together and finger motion is limited. When a cast is applied with fingers flexed, the metacarpals are at maximum abduction and full motion is achieved. This allows for edema control, prevents stiffness, and reduces pain. This study recruited 25 healthy volunteers to compare the two cast techniques using pressure measurements taken using an Ad Instruments Pressure Transducer by incorporating a 50cc empty normal saline bag into the cast at the level of the metacarpals with the hand positioned in a neutral and full flexion position with increasing amounts of air inserted into the bag to mimic swelling. A retrospective review of 300 patients with distal radius fractures treated with this novel method of casting was performed to determine a rate of CRPS.

Results: Measurements of hand circumference with the hand in flexion is on average 1.06 cm greater than in extension. Pressure results comparing the two cast methods indicated that pressures were significantly decreased in the novel "flexion cast" in both mid-flexion and full flexion with the difference becoming more accentuated as "saline swelling" is increased. Results also found that there is a statistically significant difference in cast pressure between genders. Clinical retrospective data collected over 3 years following one surgeon's practice of this method demonstrated a 0% rate of CRPS.

Summary:

- The results of this study demonstrated that this easy to perform method of casting in "flexion" has innately lower cast pressures as "swelling" is increased. In addition it prevents swelling early on by allowing full range of motion of the fingers.

- Results of this study found that females in both methods of casting have statistically significant higher cast pressures than males. This could be an important contributing factor to the higher incidence of CRPS in females.
- This study demonstrated the usefulness and efficacy of a simple novel cast technique that may improve outcomes for distal radius fractures and decrease the risk of CRPS.

References:

1. P.E. Zollinger, W.E. Tuinebreijer, R.S. Breederveld, R.W. Kreis Can vitamin C prevent complex regional pain syndrome in patients with wrist fractures?A randomized, controlled, multicenter dose-response study J Bone Joint Surg, 89A (2007), pp. 1424–1431.
2. Field J, Protheroe DL, Atkins RM. Algodystrophy after Colles fractures is associated with secondary tightness of casts. J Bone Joint Surg Br.1994;76: 901-5.76901 1994.
3. Thomson McBride A, Barnett A, Livingstone J, et al. Complex regional pain syndrome (type 1): a comparison of 2 diagnostic criteria methods. Clin J Pain. 2008;24:637–640.
4. Schürmann M, Zaspel J, Löhr P, et al. Imaging in early posttraumatic complex regional pain syndrome: a comparison of diagnostic methods. Clin J Pain. 2007;5:449–457.
5. Veldmann PH, Reynen HM, Arntz IE, et al. Signs and symptoms of reflex sympathetic dystrophy: prospective study of 829 patients. Lancet. 1993;342:1012–1016.
6. Atkins RM, Duckworth T, Kanis JA. Features of algodystrophy after Colles' fracture. J Bone Joint Surg Br.1990;72: 105-10.72105 1990.
7. Atkins RM, Duckworth T, Kanis JA. Algodystrophy following Colles' fracture. J Hand Surg [Br].1989;14: 161-4.14161 1989.
8. Zollinger PE, Tuinebreijer WE, Kreis RW, Breederveld RS. Effect of vitamin C on frequency of reflex sympathetic dystrophy in wrist fractures: a randomised trial. Lancet.1999;354: 2025-8.3542025 1999.
9. Oyen WJ, Arntz IE, Claessens RM, et al. Reflex sympathetic dystrophy of the hand: an excessive inflammatory response? Pain. 1993;55:151–157.
10. Drummond PD. Involvement of the sympathetic nervous system in complex regional pain syndrome. Int J Low Extrem Wounds. 2004;3:35–42.

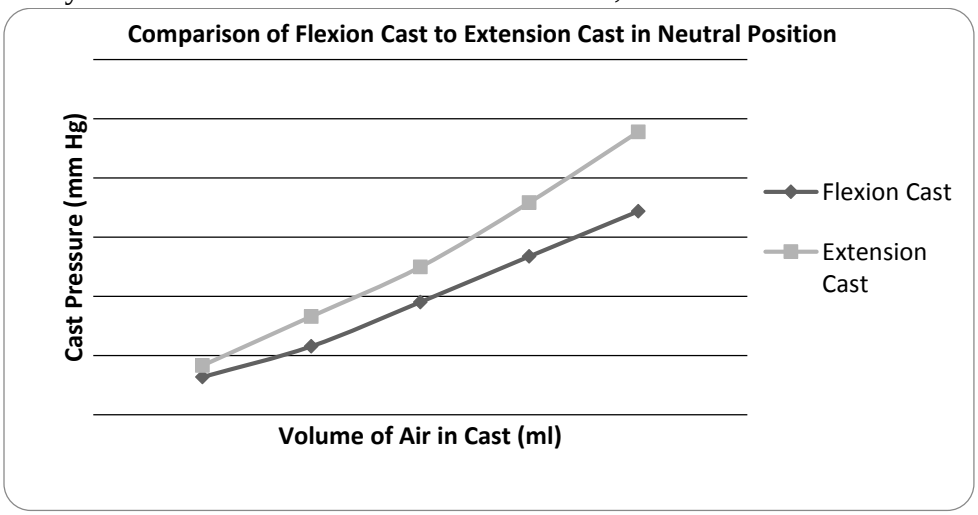


Figure 1: This chart demonstrates the difference in cast pressure between the flexion cast and extension cast with the hand in neutral position as the amount of air in the normal saline bag is increased by 10 ml per measurement simulating increased swelling.

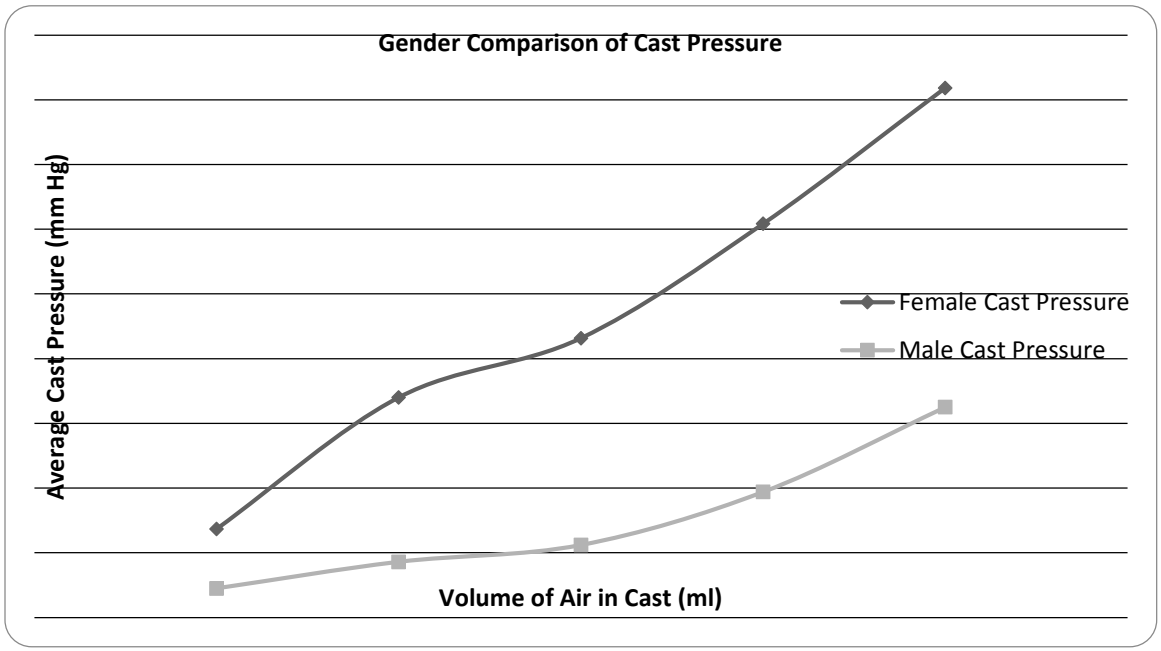


Figure 2: This chart demonstrates the difference in average cast pressure with both types of casts between males and females with the fingers in neutral position as the amount of air in the normal saline bag is increased by 10 ml per measurement simulating increased swelling.

♦ Nothing of financial value to disclose

RF Paper 15: Osseous Anatomy of the Distal Radioulnar Joint: An Assessment Using Three Dimensional Modeling

Session III - 10:35 - 10:40 AM

Category: Basic Science - Anatomy
Keyword: Wrist
Not a clinical study

♦ Parham Daneshvar, MD
♦ Ruby Grewal, MD, MSc, FRCS(C)
♦ Ryan Willing, PhD
● Graham J. King, MD, FRCSC

Hypothesis: We hypothesize that the three dimensional anatomy of the distal radioulnar joint is quite variable, and mid-coronal reverse obliquity alignment is associated with ulnar positive variance.

Methods: Computed tomography images of one hundred cadaveric forearms were obtained. These included 54 right arms and 56 left. Using MIMICS (Materialise), three dimensional models of the entire radius and ulna were obtained. Paraview (Kitware) was used to obtain the appropriate sections for evaluation and quantification. Measurements of the radius of curvature of the sigmoid notch and ulnar seat, as well as the length of the sigmoid notch, volar and dorsal lips were performed in the axial plane at the level the wrist joint (0), as well as 2, 4, 6 and 8mm proximal to the joint. Similar measurements were taken in the mid coronal and at one-third and two-thirds in the volar and dorsal coronal sequences. In addition, mid coronal plane angular measurements were made of the sigmoid notch and ulnar seat.

Results: The average ulnar variance was -0.64 mm (SD 1.80). At the level of the wrist joint, the radius of curvature of the sigmoid notch, and ulnar head were 18.6 mm (SD 8.3), and 8.1mm (SD 1.3) respectively. The volar and dorsal lip lengths measured at 1.91mm (SD 1.15) and 1.33mm (SD 0.87). The mean mid-coronal length of the sigmoid notch was 8.4mm (SD 1.7). The coronal length of the sigmoid notch measured 7.3mm (SD 1.7) at one-third volar compared to 9.2mm (SD 2.1) at one-third dorsal coronal planes with statistical significance of $p<0.001$, and 6.0mm (SD 1.6) at two-third volar compared to 9.8mm (SD 2.2) at two-third dorsal coronal planes with statistical significance of $p<0.001$. The mid coronal angle of the sigmoid notch and ulnar seat was 5.3° (range -26.4 to 23.8, SD 9.3), and 19.2° (range -10.4 to 33.0, SD 8.3). Larger positive ulnar variance is directly correlated with more reverse oblique mid coronal angle of the sigmoid notch and decreased ulnar head obliquity.

Summary: This study confirms the diversity in sigmoid notch and ulnar head anatomy which is relevant in the designs of both partial and complete DRUJ replacements. The significantly

smaller radius of curvature of the ulnar head compared to the sigmoid notch demonstrates the relative incongruity of this articulation. The sigmoid notch is significantly larger dorsally compared to its volar length, which may explain the tendency of ulnar head to be unstable dorsally.

References:

1. Deshmukh SC, Shanahan D, Coulthard D. Distal radioulnar joint incongruity after shortening of the ulna. Journal of hand surgery (Edinburgh, Scotland). Oct 2000;25(5):434-438.
2. Garcia-Elias M, Pitagoras T, Gilabert-Senar A. Relationship between joint laxity and radio-ulno-carpal joint morphology. Journal of hand surgery (Edinburgh, Scotland). Apr 2003;28(2):158-162.
3. Huang JI, Hanel DP. Anatomy and biomechanics of the distal radioulnar joint. Hand clinics. May 2012;28(2):157-163.
4. May MM, Lawton JN, Blazar PE. Ulnar styloid fractures associated with distal radius fractures: incidence and implications for distal radioulnar joint instability. The Journal of hand surgery. Nov 2002;27(6):965-971.
5. Nishiwaki M, Nakamura T, Nakao Y, Nagura T, Toyama Y. Ulnar shortening effect on distal radioulnar joint stability: a biomechanical study. The Journal of hand surgery. Jul 2005;30(4):719-726.
6. Sagerman SD, Zogby RG, Palmer AK, Werner FW, Fortino MD. Relative articular inclination of the distal radioulnar joint: a radiographic study. The Journal of hand surgery. Jul 1995;20(4):597-601.
7. Stuart PR, Berger RA, Linscheid RL, An KN. The dorsopalmar stability of the distal radioulnar joint. The Journal of hand surgery. Jul 2000;25(4):689-699.
8. Tolat AR, Stanley JK, Trail IA. A cadaveric study of the anatomy and stability of the distal radioulnar joint in the coronal and transverse planes. Journal of hand surgery (Edinburgh, Scotland). Oct 1996;21(5):587-594.
9. af Ekenstam, F., Anatomy of the distal radioulnar joint. Clin Orthop Relat Res, 1992(275): p. 14-8.

● Royalties/Honoraria: Wright Medical Technology; Tornier Inc; Tenent Medical
● Consulting Fees: Wright Medical Technology, Tornier Inc.
● Intellectual Properties: Wright Medical Technology; Tornier Inc.
♦ Nothing of financial value to disclose

RF Paper 16: Distal Radioulnar Interposition Arthroplasty: Soft Tissue Stabilization for Distal Radioulnar Instability

Session IV - 10:45 - 10:50 AM

Category: Instability
Keyword: Forearm
Level 2 Evidence

♦Eric R. Wagner, MD
♦Shumaila Sarfani, BS
●Sanjeev Kakar, MD

Hypothesis: Although soft tissue interposition arthroplasty has recently emerged as a viable salvage option for advanced distal radioulnar instability, there is little information assessing the outcomes. In this investigation, we compare the outcomes of 22 patients who underwent distal radioulnar interposition arthroplasty (DRIA) with either pronator quadratus or allograft.

Methods: A review of the medical records with prospective questionnaires was performed of all patients who underwent soft tissue interposition procedures for distal radioulnar joint instability from 1998-2011 within a single institution. Outcome measures included pain levels, Disability of the Arm Shoulder and Hand (DASH), Patient Rated Wrist Evaluations (PRWE), satisfaction scores, complications and revision surgeries were recorded.

Results: Twenty-two patients underwent DRIA with an average follow-up of 58.2 months. Eleven (50%) patients underwent interposition with pronator quadratus (PQ) and 11 (50%) underwent allograft tendon interposition.. The average number of prior procedures the patients underwent prior to soft tissue interposition. There was no significant increase in the postoperative range of motion (p0.20). Postoperative pain levels significantly decreased after interposition ($p<0.001$), with no difference between the postoperative pain levels of the two groups ($p=0.3$). The average postoperative DASH and PRWE scores were 34.8 (+/-17) and 45.4 (+/- 18), respectively. There was no difference in DASH ($p<0.80$) or PRWE ($p<0.75$) between the two interposition groups. Four (36%) patients in the PQ group reported moderate or severe limitations, including 3 reporting weakness and 1 instability. Two (18%) patients in the allograft group reported limitations, both reporting weakness. Two (9%) patients failed their interposition with 1 patient within the PQ group revised to an ulnar head replacement at 15 months and 1 patient within the Achilles group revised to a ulnar head and custom sigmoid notch arthroplasty after 19 months. In terms of secondary procedures, there was 1 tenolysis for extensor tendon irritation in the PQ group, while 2 patients in the allograft group underwent additional procedures, including 1 extensor tenolysis and 1 revision DRIA with allograft achilles tendon. No variables had a significant impact on the risk for revision or postoperative procedure.

Summary: Distal radius interposition arthroplasty with soft tissue is a reasonable option for patients with significant distal radioulnar instability. Patients experience good pain relief and functional outcomes in an intermediate to long-term follow-up period.

● Consulting Fees: Arthrex Inc
● Other financial relationships: Arthrex, Inc.
♦ Nothing of financial value to disclose

RF Paper 17: Tendon Grafts for Distal Radioulnar Ligament Reconstruction: How Much Is Needed? How Much Is Available?

Session IV - 10:50 - 10:55 AM

Category: Instability
Keyword: Wrist
Not a clinical study

●Christopher J. Dy, MD, MSPH
♦Eugene Jang, MS
●Scott W. Wolfe, MD

Hypothesis: In the original description of the 'anatomic' distal radioulnar ligament (DRUL) reconstruction (Adams 2002), a tendon graft is looped around the ulna and its ends woven into a half-hitch. In performing this procedure, we have encountered occasions in which the tendon graft length is insufficient to loop around the ulna, requiring us to use a suture anchor to secure the graft. We investigated the length of tendon graft needed to complete the reconstruction as originally described and when modified with a suture anchor. We also harvested a variety of tendon grafts from each specimen to determine the length of graft available. We hypothesized that the majority of graft sources would not have sufficient length of tendon graft available to perform the DRUL reconstruction as originally described.

Methods: The DRUL reconstruction was performed in 7 fresh-frozen cadaver specimens. We measured the length of tendon graft needed to complete the originally described technique and a modification that eliminates the loop and uses a suture anchor. We then harvested the following tendons from each specimen: palmaris longus (when present), extensor indicis pollicis, abductor pollicis longus, one slip of the extensor digiti minimi, and portions of flexor carpi ulnaris, flexor carpi radialis, and extensor carpi ulnaris. We measured the length of tendon from musculotendinous junction to distal insertion.

Results: The mean lengths of tendon graft needed to complete the original and modified DRUL reconstructions are 138mm and 88.6mm, respectively (Table 1). The palmaris tendon was insufficient in three of seven specimens to complete the original technique (and absent in an additional specimen), but was sufficient to complete the modified technique. The average length of the tendon grafts were: palmaris longus (131.4mm), APL (71.7mm), EIP (110.3mm), EDM (109.8mm), partial FCU (66.4mm), partial FCR (86.6mm), partial ECU (64.3mm) (Table 1). While three specimens did not have sufficient donor tendon of any type to complete the original Adams technique, the modified technique could be performed in all specimens from one of the donor tendons available.

Summary:

- The anatomic DRUL reconstruction, as originally described, requires an average of 138mm of graft to complete. Three of the seven specimens tested did not have sufficient donor tendon to employ the original technique.
- A modification of the technique with a suture anchor requires 88.6mm of graft and could be completed in all specimens tested. This modification may be useful in settings where there is insufficient tendon graft to complete the loop around the ulna.

References:

1. Adams BD, Berger RA. An anatomic reconstruction of the distal radioulnar ligaments for posttraumatic distal radioulnar joint instability. J Hand Surg [Am] 2002 Mar;27(2):243-51.

Table 1

Adams DRUJ Reconstruction (original)	138.0±36.4 mm
Adams DRUJ Reconstruction (modified)	88.6±19.5 mm
Palmaris longus	131.4±20.9 mm
Extensor digiti minimus	109.8±22.4 mm
Extensor indicis pollicis	110.3±26.4 mm
Abductor pollicis longus	71.7±17.0 mm
Flexor carpi ulnaris (portion)	66.4±16.1 mm
Flexor carpi radialis (portion)	86.6±18.3 mm
Extensor carpi ulnaris (portion)	64.3±18.1 mm

● Contracted Research: NIH/NIAMS T32 Research Fellowship (AR07281); ASSH Resident/Fellow Fast Track Grant (Dy)
● Royalties/Honoraria: TriMed, Inc, Elsevier, Inc., Extremity Medical (Wolfe)
● Consulting Fees: Extremity Medical, TriMed, Inc (Wolfe)
● Intellectual Properties: KinematX Total Wrist Arthroplasty, Extremity Medical, NJ (Wolfe)
♦ Nothing of financial value to disclose

RF Paper 18: Minimally Invasive Scapholunate Tenodesis Comparable to Triligament Tenodesis in Restoring Scapholunate Gap and Scapholunate Angle: A Biomechanical, Cadaveric Study

Session IV - 10:55 - 11:00 AM

Category: Instability
Keyword: Wrist
Not a clinical study

♦Matthew Stillwagon, MS3
♦Chris Papangelou, PhD
♦Xin Yan, PhD
♦Richard J. Harrison, Jr., MD

Background: The purpose of this study was to compare the triligament tenodesis (3LT) to a new technique, the minimally invasive scapholunate tenodesis (MIST), in the treatment of stage 3 scapholunate instability. MIST utilizes Bio-tenodesis screws and palmaris longus tendon graft to reconstruct the dorsal scapholunate ligament and correct scaphoid subluxation.

Hypothesis: MIST is comparable to 3LT in restoration of scapholunate (SL) gap and SL angle following a complete SL ligament rupture while being less invasive and sparing the flexor carpi radialis tendon.

Methods: Metal beads were embedded into the scaphoid and lunate of six matched pairs of human cadaver wrists. Changes in bead distance were tracked using anteroposterior fluoroscopy of wrists in 5 different positions: 1) horizontal and neutral, perpendicular to floor; 2) horizontal and perpendicular to floor in passive ulnar deviation; 3) horizontal and perpendicular to floor in weighted (5 lbs) ulnar deviation; 4) vertical and neutral; 5) vertical and neutral with weights (4 lbs). Changes in bead distance were used as a correlate to SL gap. SL angle was evaluated using lateral digital fluoroscopy of unweighted (position 6) and weighted (position 7) wrists in vertical, neutral position. Fluoroscopic images were taken in the native (n=12), SL ligament resected (n=12) and SL ligament reconstructed wrist states (n=12) in all 7 positions. The SL ligament reconstructions alternated between 3LT (n=6) and MIST (n=6). Non-parametric Wilcoxon signed rank test with continuity correction was used to determine statistical significance of median differences ($P<0.05$).

Results: A significant increase in median SL gap was seen in positions 1-5 following SL ligament resection. The greatest increase of median SL gap was seen in position 5 (1.350 mm). The median SL angle was significantly increased in weighted wrist ($P=0.005$) following resection but not in the unweighted wrist ($P=0.456$). There was no significant difference between

the two repairs in restoring median SL gap or median SL angle immediately following the reconstructions in all positions tested.

Summary:

- Following complete SL ligament rupture, the bead displacement model successfully detected the expected increase in SL gap in positions 1-5.
- In a cadaveric model, MIST appears to be comparable to 3LT in correcting SL gap and SL alignment when bead distances and angle measurements are recorded immediately following the reconstructions.
- Potential advantages of MIST compared to 3LT is that it: (1) is less invasive, requiring small 1-2 cm incisions; (2) utilizes the palmaris longus as opposed to the flexor carpi radialis and; (3) technically simpler.

References:

1. Brunelli GA, Brunelli GR. A new technique to correct carpal instability with scaphoid rotary subluxation: a preliminary report. Journal of Hand Surgery. 1995;20A:S82-S85.
2. Kuo CE, Wolfe SW. Scapholunate instability: current concepts in diagnosis and management. Journal of Hand Surgery. 2008;37A:998-1013.
3. Dohi Y, Omokawa S, Ono H. et al. Arthroscopic gap distance can predict the degree of scapholunate ligament tears: a cadaver study. Journal of orthopaedic science: official journal of the Japanese Orthopaedic Association. Nov 5 2011.
4. Salva-Coll G, Garcia-Elias M, Llusa-Perez M, Rodriguez-Baeza A. The role of the flexor carpi radialis muscle in scapholunate instability. Journal of Hand Surgery. 2011;36A:31-36.
5. Garcia-Elias M, Lluch AL, Stanley JK. Three-ligament tenodesis for the treatment of scapholunate dissociation: indications and surgical technique. The Journal of hand surgery. Jan 2006;31(1):125-134.
6. Talwalkar SC, Edwards AT, Hayton MJ, Stilwell JH, Trail IA, Stanley JK. Results of tri-ligament tenodesis: a modified Brunelli procedure in the management of scapholunate instability. J Hand Surg Br. Feb 2006;31(1):110-117.
7. Larson CF Stigsby B, Lindequist S, Bellstrom T, Mathiesen FK, Ipsen T. Observer variability in measurements of carpal bone angles on lateral wrist radiographs. Journal of Hand Surgery. 1991;16A:893-898.

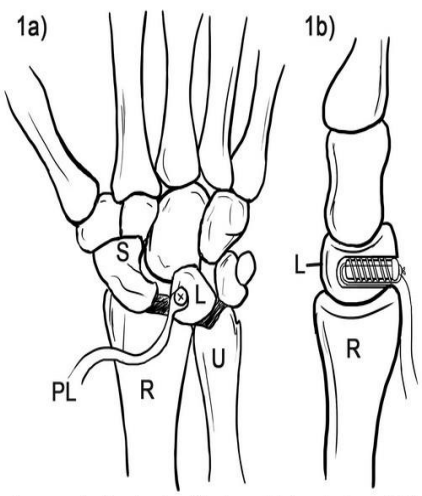


Image 1. Posterior (**1a**) and lateral view (**1b**) showing palmaris longus secured with Bio-tenodesis screw in lunate tunnel. L, lunate; PL, palmaris longus; R, radius; S, scaphoid; U, ulna

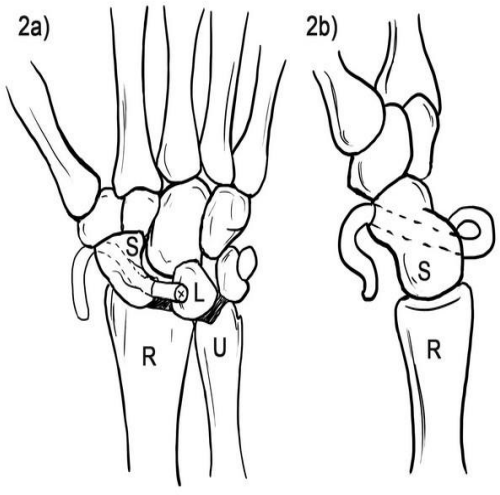


Image 2. Posterior (**2a**) and lateral view (**2b**) showing palmaris longus passed through scaphoid from dorsal to palmar. L, lunate; R, radius; S, scaphoid; U, ulna

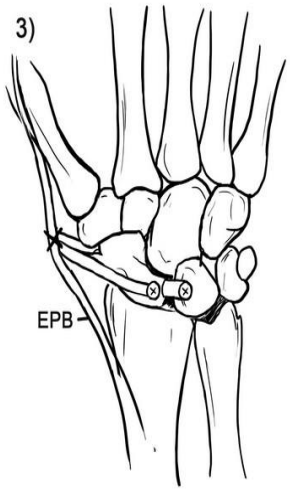


Image 3. Posterior view showing palmaris longus secured to scaphoid with Bio-tenodesis screw and sutured to EPB. EPB, extensor pollicis brevis

♦ Nothing of financial value to disclose

RF Paper 19: Pathoanatomy of the Osteoarthritic Trapeziometacarpal Joint

Session IV - 11:00 - 11:05 AM

Category: Arthritis
Keyword: Hand
Not a clinical study

♦Carissa L. Meyer, MD
♦Vincent D. Pellegrini, Jr., MD

Hypothesis: Anatomical studies provide conflicting evidence regarding the role of the palmar and dorsal ligaments of the thumb trapeziometacarpal joint as primary stabilizers and contributors to the development of osteoarthritis. We postulate that the degree and pattern of cartilage wear corresponds primarily to degeneration of the palmar beak ligament rather than the dorsoradial ligament, suggesting a principal role of the beak ligament in the pathogenesis of osteoarthritis.

Methods: Twenty-two thumb specimens, nineteen embalmed and three fresh-frozen, were harvested to include the thumb ray and trapezium. Thirteen male and nine female specimens had an average age of 77 years.

Sequential dissection was performed to assess integrity of the capsule and ligamentous structures. The status of the articular cartilage (normal, chondromalacia, or eburnation), distribution of wear (palmar, dorsal, radial or ulnar) and the status of the palmar and dorsal ligaments was recorded.

Results: Sixteen (73%) specimens demonstrated advanced arthritis with at least one quadrant containing eburnation. All had substantially more eburnation in the palmar compared to dorsal compartments, and 12 had palmar eburnation exclusively with dorsal chondromalacia. No specimen exhibited eburnation isolated to the dorsal compartment. Five specimens demonstrated dorsal chondromalacia with normal palmar cartilage, and one was entirely normal.

All 16 specimens exhibiting eburnation demonstrated degeneration of the palmar beak ligament from the metacarpal lip with 1-4mm of retraction. Ten specimens with eburnation demonstrated an intact dorsoradial ligament, and six had 1mm of retraction of the dorsoradial ligament. In all specimens, the dorsal ligaments remained stout and firmly attached.

Chondromalacia was present in the dorsal compartments of twenty specimens and involved an average of 3 quadrants irrespective of the status of the dorsoradial ligament.

Summary:

- Palmar eburnation in joints with attrition of the adjacent palmar beak ligament, in the absence of corresponding articular disease on the dorsal surfaces, implies a causal association between beak ligament degeneration and osteoarthritis of the trapeziometacarpal joint.
- The dorsoradial ligament remained stout and in continuity in all specimens with little sign of degeneration, even in joints with advanced arthritis.
- Notwithstanding the importance of the dorsal ligaments in joint stability, the close association between palmar beak ligament degeneration and articular surface eburnation supports a causative role for beak ligament degeneration in trapeziometacarpal osteoarthritis.

References:

1. Bettinger PC, Linschield RL, Berger RA, Cooney WP III, An KN. An anatomic study of the stabilizing ligaments of the trapezium and trapeziometacarpal joint. J Hand Surg Am. 1999;24(4):786-98.
2. Colman M, Mass DP, Draganich LF. Effects of the deep anterior oblique and dorsoradial ligaments on trapeziometacarpal joint stability. J Hand Surg Am. 2007;32(3):310-17.
3. Edmunds JO. Current concepts of the anatomy of the thumb trapeziometacarpal joint. J Hand Surg Am. 2011;36(1):170-82.
4. Hagert E, Lee J, Ladd AL. Innervation patterns of thumb trapeziometacarpal joint ligaments. J Hand Surg Am. 2012;37(4):706-14.
5. Ladd AL, Weiss AP, Crisco JJ, Hagert E, Wolf JM, Glickel SZ, Yao J. The thumb carpometacarpal join: anatomy, hormones, and biomechanics. Instr Course Lect. 2013;62:165-79.
6. Pellegrini Jr, VD. Osteoarthritis of the trapeziometacarpal joint: The pathophysiology of articular cartilage degeneration. I. Anatomy and pathology of the aging joint. J Hand Surg Am. 1991;16(6):967-74.
7. Pellegrini, Jr VD. Osteoarthritis of the trapeziometacarpal joint: The pathophysiology of articular cartilage degeneration. II. Articular wear patterns in the osteoarthritic joint. J Hand Surg Am. 1991;16(6):975-82.
8. Pellegrini, Jr VD. Contact patterns in the trapeziometacarpal joint: The role of the palmar beak ligament. J Hand Surg Am. 1993;18(2):238-44.

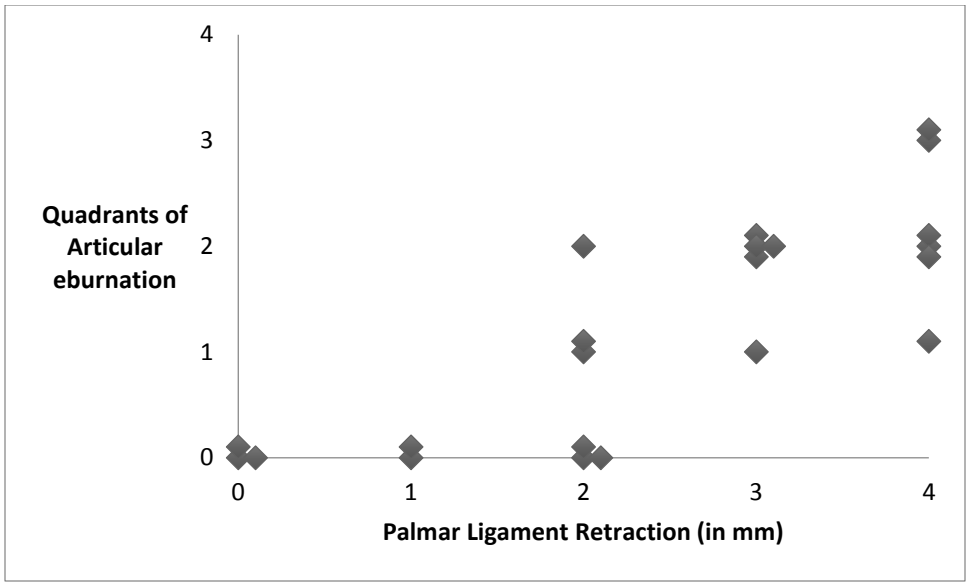


Fig. 1 Relationship of palmar ligament integrity and severity of articular disease. Increased ligament retraction corresponds to more extensive articular eburnation.

♦ Nothing of financial value to disclose

RF Paper 20: Mid-term Follow-up of Proximal Row Carpectomy with Capitate Osteochondral Autograft

Session IV - 11:05 - 11:10 AM

Category: Arthritis
Keyword: Wrist
Level 4 Evidence

♦Jimmy Mihn B. Dang, DO
♦Jason A. Nydick, DO
♦Jeffrey D. Stone, MD

Hypothesis: Proximal row carpectomy with osteochondral autograft transplantation can be a viable option for wrist arthritis in the presence of capitate arthrosis, and the outcomes comparable to traditional PRC studies.

Methods: From 2005-2011 6 patients underwent a proximal row carpectomy with osteochondral autograft transplantation. The decision to proceed with an osteochondral autograft transplantation was done intra-operatively after evaluation of the capitate for any focal areas of arthrosis as an alternative to four corner arthrodesis. An osteochondral plug was harvested from the available carpal bones from the proximal row and then transplanted into the prepared capitate defect. Postoperative wrist range of motion, grip strength, pain score, DASH score, return to activity and complications were recorded. Radiographs were evaluated for incorporation of the autograft and for progression of arthritis.

Results: Four patients were available for follow up. The majority of the patients underwent the procedure for osteoarthritis of the wrist secondary to scapholunate advanced collapse. Average duration of follow-up was 3.59 years [1.5-8.05 years]. Range of motion compared to contralateral side averaged 81% [68-91], dorsiflexion/palmar flexion arc, 87.7% [80-100%] radial/ulnar deviation arc, and 100% pronation/supination arc. Grip strength averaged 76.5% of contralateral side [48-100%]. All but one patient returned to previous work and extra-curricular activities. Pain scores on a scale from 1-10 averaged 2.25 [0-8]. Postoperative DASH scores averaged 23.94 [2.5-48.3] with patients demonstrating improved DASH scores over time. The two patients with 3+ years of follow-up, DASH scores averaged 4.59 whereas the two patients with 3 years.

Summary:

- Proximal row carpectomy supplemented with an osteochondral autograft can be an effective treatment option for early stages of wrist osteoarthritis despite focal capitate arthritis as an alternative to four corner arthrodesis.
- Results are comparable to published reports on traditional proximal row carpectomy.

- Improvement in pain and function continues to improve over time.
- Radiographic progression of radiocapitate arthrosis occur in the mid-long term follow-up but does not correlate with patients symptoms or function.

References:

1. Imbriglia JE, Broudy AS, Hagberg WC, et al. Proximal row carpectomy: clinical evaluation. J Hand Surg. 1990; 15A:426-430.
2. Culp RW, McGuigan FX, Turner MA, et al. Proximal row carpectomy: a multicenter study. J Hand Surg. 1993; 18A:19-25.
3. Jebson PJ, Hayes EP, Engber WD. Proximal row carpectomy: a minimum 10-year follow-up study. J Hand Surg. 2003; 28A:561-569.
4. DiDonna ML, Kiefhaber TR, Stern PJ. Proximal row carpectomy. Study with a minimum of ten years of follow-up. J Bone Joint Surg Am. 2004; 86:2359-2365.
5. Tomaino MM, Miller RJ, Cole I, et al. Scapholunate advanced collapse wrist: proximal row carpectomy or limited wrist arthrodesis with scaphoid excision? J Hand Surg. 1994; 19A: 134-142.
6. Wyrick JD, Stern PJ, Kiefhaber TR. Motion-preserving procedures in the treatment of scapholunate advanced collapse wrist: proximal row carpectomy versus four-corner arthrodesis. J Hand Surg. 1995; 20A:965-970.
7. Cohen MS, Kozin SH. Degenerative arthritis of the wrist: proximal row carpectomy versus scaphoid excision and four-corner arthrodesis. J Hand Surg. 2001; 26A:94-104.
8. Tang P, Imbriglia JE. Osteochondral resurfacing (OCRPRC) for capitate chondrosis in proximal row carpectomy. J Hand Surg. 2007; 32A:1334-1342.
9. Ferlic DC, Clayton ML, Mills MF. Proximal row carpectomy: review of rheumatoid and nonrheumatoid wrists. J Hand Surg. 1991; 16A:420-424.
10. Tang P, Gauvin J, Muriuki M. Comparison of the "contact biomechanics" of the intact and proximal row carpectomy wrist. J Hand Surg. 2009; 34A:660-670.

♦ Nothing of financial value to disclose

RF Paper 21: Nerve Injuries Secondary to Surgical Procedures

Session V - 1:00 - 1:05 PM

Category: Nerve/Neuromuscular
Keyword: Other
Level 3 Evidence

♦Gilberto Agustin Gonzalez, MD

Hypothesis: Nerve injuries produce pain and can be case traumatic, iatrogenic, compression neuropathies and radiation-induced plexopathy.

Methods: 59 non-consecutive adult patients were referred to and evaluated for residual nerve symptomatology. All of the patients had new nerve symptoms following a surgical procedure. The symptoms were related to position of the patient during the operation or the operation itself. Patient demographics, extremity involved, nerve or territories involved, and surgeries that lead to residual symptomatology were recorded and analyzed.

Results: There were a total of 59 patients, 28 men (47%) and 31 women (53%), the mean age was 50 years old, range (18 to 81). Forty cases involved the upper extremity (68%) and the remaining 19 cases (32%) involved the lower extremity. Thirty-six cases (61%) corresponded to the right side of the body and 23 cases (39%) corresponded to the left side of the body.
The nerves and territories reported to be involved in our study were: Spinal Accessory Nerve, Auriculotemporal Nerve, Axillary Nerve, Cluneal Nerve, Femoral Nerve, Infrapatelar Branch Nerve, Lateral Antebrachial Cutaneous Nerve (LABC), Lower Plexus, Medial Plantar Nerve, Median Nerve, Musculocutaneous Nerve, Common Peroneal Nerve, Radial Nerve, Superficial Radial Nerve, Suprascapular Nerve, Tibial Nerve, and the Ulnar Nerve. The surgeries identified as most frequently resulting in nerve injuries were Joint Replacements and Arthroscopies. The most common injured nerve in our study was found to be the Ulnar Nerve.

Summary: Nerve injuries secondary to surgical procedures are common, particularly after trauma related surgeries. When treating trauma patients, it is very important to establish if the nerve injury was present prior to the trauma; however, no matter the cause of injury, is important to establish a prompt diagnosis and treatment plan, and especially with respect to those injuries that are time sensitive.

References:

1. Tanriverdi TN, Savrun FK, Kiziltan ME. Traumatic peripheral nerve injuries: demographic and electrophysiological findings of 802 patients from a developing country. Clin Neuromuscul Dis. 2006 Mar; 7(3): 97-103.
2. Zhang J, Moore AE, Stringer MD. Iatrogenic upper limb nerve injuries: a systematic review. ANZ J Surg. 2011, Apr; 81(4): 227-36.

3. Wilbourn AJ. Iatrogenic peripheral Nerve lesions. Ann Plast Surg. 2005 Jul; 55(1): 112.
4. Kretschmer T, Antoniadis G, Braun V. Evaluation of iatrogenic lesions in 722 surgically treated cases of peripheral nerve trauma. Neurosurg. 2001 Jun; 94 (6): 905-12.
5. Huang Y, Chu x, Zhu Q. Peripheral nerve injury as a complication from orthopedic operation. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 1997 Nov; 11(6): 343-6.
6. Kretschmer T, Antoniadis G. Iatrogenic nerve injuries. Part 1: Frequency distribution, new aspects, and timing of microsurgical treatment. Chirurg. 2004 Nov; 75(11): 1104-12.
7. Paprocka J, Kajor M, Jamroz E. Hereditary neuropathy with liability to pressure palsy. Folia Neuropathol. 2006; 44(4): 290-4.

Table 3. Type of Surgery that lead nerve injury

SURGERY	NUMBER
ACL RECON	1
ANKLE LIGAMENT RECON	1
BICEPS TENDON REP	1
CHOLESTEATOMA RESEC	1
CTR	5
ELBOW LIG SURG	1
ELBOW OSTEOSYNT	1
ENDOSCOPY	1
GUYON'S DECOMP	1
HUMERUS OSTEOSYNT	2
KNEE ARTHROSCOPY	3
LAPAROSCOPY	1
LOBECTOMY	1
LRTI	2
MORTON	2
LYMPH NODE BIOPSY	1
PILONIDAL CYST	1
DISTAL RADIUS FRACT	1
PLANTAR FASCIOTOMY	3
QUERVAIN	1
RADIATION AFTER BREAST CANCER	1
ROTATOR CUFF	1
SHOULDER SCOPE	3
TARSAL TUNNEL RELEASE	1
TSR	1
THR	5
TOTAL	59

Table 4. Correlation of Damage Nerve with Type of Surgery Prior to Nerve Injury

NERVE	TYPE OF SURGERY PRIOR TO NERVE INJURY		
ACCESSORY	NODE BIOPSY		
AURICULOTEMPORAL	CHOLESTEATOMA SURGERY		
AXILLAR	ROTATOR CUFF		
AXILLAR	SHOULDER ARTHROSCOPY		
CLUNEAL	PILONIDAL CYST		
FEMORAL	LAPAROSCOPY		
INFRAPATERAL BRANCH	KNEE ARTHROSCOPY		
INFRAPATERAL BRANCH	KNEE ARTHROSCOPY		
INFRAPATERAL BRANCH	KNEE ARTHROSCOPY		
LABC	QUERVAIN		
LABC	BICEPS TENDON REPAIR		
LOWER PLEXUS	TSR		
MEDIAL PLANTAR	PLANTAR FASCIOTOMY		
MEDIAL PLANTAR	PLANTAR FASCIOTOMY		
MEDIAL PLANTAR	PLANTAR FASCIOTOMY		
MEDIAN	SHOULDER ARTHROSCOPY		
MEDIAN	CTR		
MEDIAN	CTR		
MEDIAN	CTR		
MEDIAN	CTR		
MEDIAN	CTR		
MUSCULUCUTANEOUS	SHOULDER RELOCATION		
PERONEAL	MORTON		
PERONEAL	ACL RECON		
PERONEAL	MORTON		
PERONEAL	THR		
PERONEAL	THR		
PERONEAL	THR		
PERONEAL	VEIN STRIPPING		
PERONEAL	THR		
PERONEAL	THR		
PERONEAL	THR		
RADIAL	HUMERUS OSTEOSYNTHESIS		
RADIAL	TSR		
RADIAL	HUMERUS OSTEOSYNTHESIS		
RS	PINNING WRIST FRACURE		
RS	LRTI		
RS	LRTI		
RS	WRIST ARTHROSCOPY		
SUPRASCAPULAR	ENDOSCOPY		
SUPRASCAPULAR	TOS		
SUPRASCAPULAR	TOS		
TIBIAL	TARSAL TUNNEL RELEASE		
TIBIAL	ANKLE SURGERY		
ULNAR	ELBOW OSTEOSYNTHESIS		
ULNAR	ULNAR DECOMPRESSION		

♦ Nothing of financial value to disclose

RF Paper 22: The Efficacy of ECRB and Supinator Releases and Arm Position in Reducing Radial Tunnel Pressures

Session V - 1:05 - 1:10 PM

Category: Nerve/Neuromuscular
Keyword: Forearm
Not a clinical study

♦Brooke L. Ballard, MD
♦Brian P. Wills, MD
♦Robert C. Matthias, Jr., MD
♦Paul C. Dell, MD

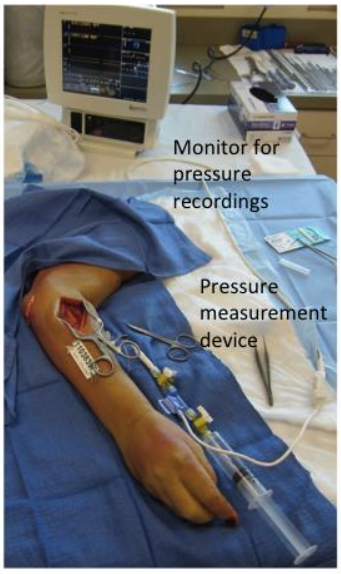
Hypothesis: 1) The forearm position that best reduces radial tunnel pressures includes elbow flexion, wrist extension, and supination. 2) Release of the supinator and extensor carpi radialis brevis (ECRB) muscles significantly reduces compression in the radial tunnel.

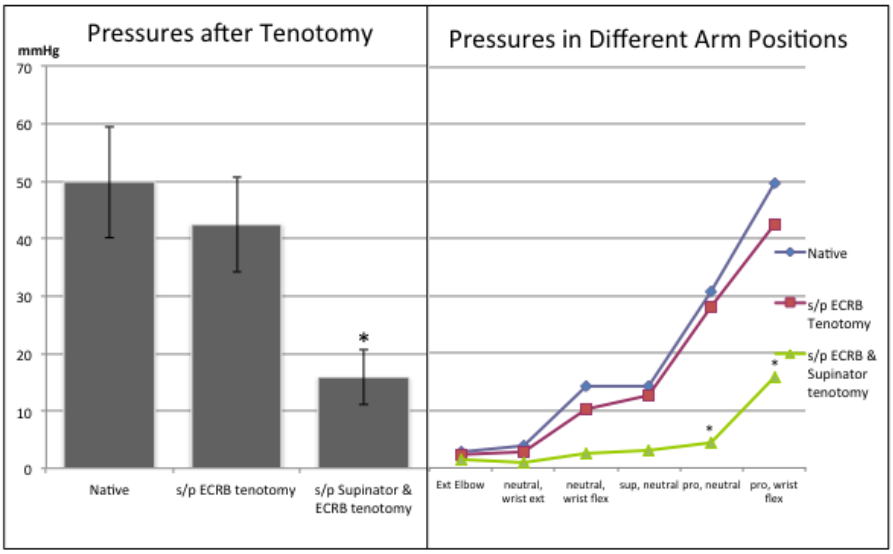
Methods: Radial tunnel pressures were measured in several elbow and wrist positions in upper extremity fresh frozen cadaver specimens (n=6). The ECRB and supinator were sequentially released, and with each step pressures were recorded. Statistical analysis included a 3-way ANOVA with post-hoc Tukey testing.

Results: Radial tunnel pressures were measured in several elbow and wrist positions in upper extremity fresh frozen cadaver specimens (n=6). The ECRB and supinator were sequentially released, and with each step pressures were recorded. Statistical analysis included a 3-way ANOVA with post-hoc Tukey testing.

Summary:

- Conservative treatment of radial tunnel syndrome may include splinting in a combination of elbow flexion, wrist extension and supination.
- ECRB and supinator sequential tenotomies successfully release pressure in the radial tunnel.
- Consideration may be given to releasing the supinator in addition to the ECRB for significant reduction in pressure in the radial tunnel.





♦ Nothing of financial value to disclose

RF Paper 23: A Novel Hand-Held Thumb Dynamometer for Measuring Thumb Abduction Strength in Patients with Carpal Tunnel Syndrome

Session V - 1:10 - 1:15 PM

Category: Nerve/Neuromuscular
Keyword: Hand
Level 3 Evidence

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Hypothesis: A novel hand-held thumb dynamometer (HHTD) can easily and reliably measure thumb abduction strength of the abductor pollicis brevis (APB) and objectively assess median nerve function. This was tested in patients with carpal tunnel syndrome (CTS) by measuring thumb abduction strength before and after carpal tunnel release (CTR).

Methods: Thirty-four hands in 25 patients (5 men and 20 women; mean age, 52 years; range, 31-68 years) with clinical and electrodiagnostic diagnosis of CTS were evaluated. Thumb abduction strength was measured by our novel HHTD (N-2000 Spring Tension Gauge. Neuses Tools, Rolling Meadows, IL.) (Figure 1). The HHTD was tested weekly with calibration weights, and its accuracy was maintained. Patients underwent open CTR with local anesthesia and were not splinted postoperatively. Throughout the postoperative period, thumb abduction strength was tested weekly until the sixth postoperative week and then again at the twelfth postoperative week. Thumb abduction strength was also measured in a control group of 56 hands in 28 volunteers (8 men and 20 women; mean age, 44 years; range, 29-66 years) with normal hands.

Results: Thumb abduction strength improved in patients with CTR (Figure 2). Patients regained preoperative strength at about the fourth postoperative week. By the twelfth postoperative week, APB strength approached that of hands without CTS.

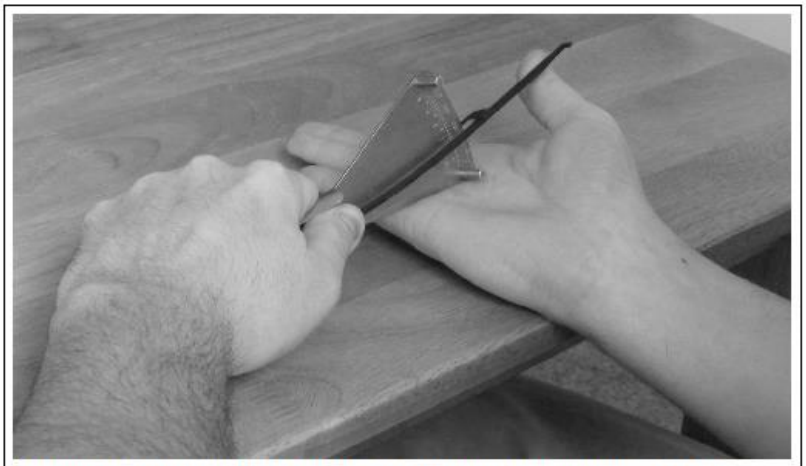
Summary:

- By isolating the APB, this novel HHTD objectively assesses motor function of the median nerve in the hand. It also accurately measures the APB's strength as it returns to preoperative values and eventually to those of a hand without CTS. Thus, the hand surgeon can quantify median nerve function by measuring weakness of APB in CTS and gauge response to CTR with our novel HHTD.

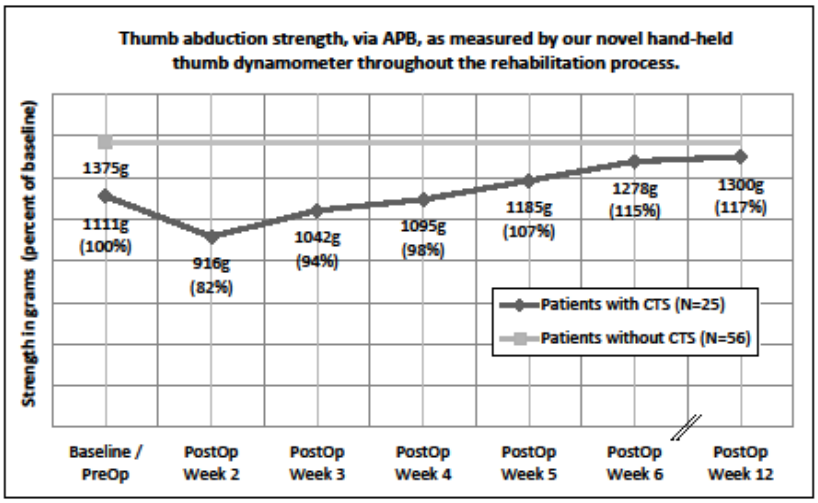
- This HHTD lacks the disadvantages of other devices which are: beyond the scope of clinical practice [1], cumbersome to use [2], not portable [3], prohibitively expensive [4-6] (costing from $975.00 [7] to $2,800 [8]), subject to inaccurate readings (as the examiner cannot stabilize the device) [4-6, 9] and yet to be proven effective clinically [9].
- Due to its reliability, small size, portability, simple design, ease of use, and low cost (approximately $47.15 [10]), the HHTD can be easily incorporated into the physical exam for the hand surgeon more so than other previously reported devices.

References:

1. Bourbonnais D, Duval P. Static dynamometer for the measurement of multidirectional forces exerted by the thumb. Med Biol Eng Comput. 1991;29:413-8.
2. Trumble TE, Kahn U, Vanderhooft E, Bach AW. A technique to quantitate motor recovery following nerve grafting. J Hand Surg Am. 1995;20:367-72.
3. Boatright JR, Kiebzak GM, O'Neil DM, Peindl RD. Measurement of thumb abduction strength: normative data and a comparison with grip and pinch strength. J Hand Surg Am. 1997;22:843-8.
4. Liu F, Carlson L, Watson HK. Quantitative abductor pollicis brevis strength testing: reliability and normative values. J Hand Surg Am. 2000;25:752-9.
5. Liu F, Watson HK, Carlson L, Lown I, Wollstein R. Use of quantitative abductor pollicis brevis strength testing in patients with carpal tunnel syndrome. Plast Reconstr Surg. 2007;119:1277-83.
6. Schreuders TA, Roebroeck ME, Jaquet JB, Hovius SE, Stam HJ. Measuring the strength of the intrinsic muscles of the hand in patients with ulnar and median nerve injuries: reliability of the Rotterdam Intrinsic Hand Myometer (RIHM). J Hand Surg Am. 2004;29:318-24.
7. JTech Commander PowerTrack II Muscle Dynamometer. 2010. (Accessed 02/10/2013, 2013, at http://prohealthcareproducts.com/hand-dynamometers-c-2/jtech-commander-powertrack-ii-muscle-dynamometer-p-495.).
8. Personal Communication with med-engineers.com Sales Representivite. Rotterdam, The Netherlands. 2013.
9. Bell MS. A handy measuring device. Can J Plast Surg. 2006;14:53.
10. Personal Communication with Neuses Tool Sales Representivite. Rolling Meadows, IL. 2013.



Our novel hand-held thumb dynamometer measures thumb abduction strength of the abductor pollicis brevis muscle, between 0 and 2200 grams. The patient's hand is placed on the examination table with the wrist in extension and forearm in supination, minimizing the action of the extrinsic abductor pollicis longus muscle [6]. The deflecting bar of the HHTD is placed on the radial aspect of the interphalangeal joint of the involved thumb. The base of the HHTD is held by the examiner and firmly placed over the distal palmar crease to stabilize the device. This prevents erroneous readings from examiner-induced forces. The patient abducts the thumb against the deflecting bar of the HHTD.



♦ Nothing of financial value to disclose

RF Paper 24: Timing of Forearm Arterial Repair in the Well-Perfused Limb

Session V - 1:15 - 1:20 PM

Category: Vascular/Microvascular
Keyword: Forearm
Level 4 Evidence

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♦Ines C. Lin, MD
●L. Scott Levin, MD, FACS
●David J. Bozentka, MD
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Hypothesis: The purpose of this study is to evaluate for a difference in the outcomes of patients with a well-perfused hand who were taken to the OR within 6 hours of forearm arterial injury and patients who were treated in a semi-urgent fashion. We hypothesize that patients who were taken to the OR emergently do not have better clinical results.

Methods: A review of 201 consecutive patients who were taken to the OR with forearm-level radial or ulnar arterial injury identified 26 patients who had a well-perfused hand at presentation, in whom hemostasis was achieved within 15 minutes with manual pressure and no signs of hemodynamic instability. Outcomes of interest included quickDASH scores and patient-reported cold intolerance.

Results: Of the 26 patients, group 1 included 17 patients who were taken to the OR within 6 hours (average 2 hours), and group 2 included 9 patients who were taken to the OR in a delayed fashion (range 6 - 128 hours, average 38 hours). Minimum follow-up in both groups was 13 months. Average quickDASH score was 24.5 and 14.1 for group 1 and group 2 respectively ($p = 0.2$). Four out of 17 patients in group 1 reported cold intolerance compared to no patients in group 2. The ratio of radial and ulnar artery injuries were 8:9 in group 1 and 5:4 in group 2. All patients in both groups had at least one other associated injury (flexor tendon, median nerve, and/or ulnar nerve injury), and there was no difference between group 1 and group 2 in terms of the number of tendon and/or nerve injuries. All patients spent 3 days in the hospital, except for the two patients in the group 2. Average time spent in the OR was significantly less in the group 2 compared to the group 1 (1.7 vs 2.8 hours, $p < 0.01$).

Summary: In the setting of forearm arterial injury with a well-perfused distal limb we report no difference in quickDASH scores and cold intolerance in patients taken to the OR emergently

compared to those who underwent surgery in a delayed manner. With careful evaluation and monitoring, semi-urgent operative repair is feasible and may improve certain aspects of patient care and hospital resource utilization.

References:

1. Gelberman RH, Nunley JA, Koman LA, Gould JS, Hergenroeder PT, MacClean CR, et al. The results of radial and ulnar arterial repair in the forearm. Experience in three medical centers. J Bone Joint Surg Am. 1982 Mar;64(3):383-7.
2. Daoutis N, Gerostathopoulos N, Bouchlis G, Efstathopoulos D, Misitzis D, Anagnostou S, et al. Results after repair of traumatic arterial damage in the forearm. Microsurgery. 1992;13(4):175-7.
3. Lee RE, Obeid FN, Horst HM, Bivins BA. Acute penetrating arterial injuries of the forearm. Ligation or repair? Am Surg. 1985 Jun;51(6):318-24.
4. de Witte PB, Lozano-Calderon S, Harness N, Watchmaker G, Green MS, Ring D. Acute vascular injury associated with fracture of the distal radius: a report of 6 cases. J Orthop Trauma. 2008 Oct;22(9):611-4.
5. Joshi V, Harding GE, Bottoni DA, Lovell MB, Forbes TL. Determination of functional outcome following upper extremity arterial trauma. Vasc Endovascular Surg. 2007 Apr-May;41(2):111-4.
6. Fitridge RA, Raptis S, Miller JH, Faris I. Upper extremity arterial injuries: experience at the Royal Adelaide Hospital, 1969 to 1991. J Vasc Surg. 1994 Dec;20(6):941-6.
7. Stricker SJ, Burkhalter WE, Ouellette AE. Single-vessel forearm arterial repairs. Patency rates using nuclear angiography. Orthopedics. 1989 Jul;12(7):963-5.
8. Borman KR, Snyder WH, 3rd, Weigelt JA. Civilian arterial trauma of the upper extremity. An 11 year experience in 267 patients. Am J Surg. 1984 Dec;148(6):796-9.
9. MacKenzie EJ, Hoyt DB, Sacra JC, Jurkovich GJ, Carlini AR, Teitelbaum SD, et al. National inventory of hospital trauma centers. JAMA. 2003 Mar 26;289(12):1515-22.

● Royalties/Honoraria: Mavrek Medical (Levin)
● Intellectual Properties: Sternal Talon (Levin)
Consulting Fees: Synthes (Bozentka)
♦ Nothing of financial value to disclose

RF Paper 25: Enhanced Bone to Bone Healing via Pectoralis Major Transfer with Its Bony Insertion to Stabilize Symptomatic Scapular Winging

Session V - 1:20 - 1:25 PM

Category: Tendon
Keyword: Shoulder
Level 4 Evidence

♦Eric R. Wagner, MD
♦Bassem T. Elhassan, MD

Hypothesis: The purpose of this study the outcome of transfer of the sternal head of the pectoralis major with its bony insertion to the inferior pole of the scapula for symptomatic winging secondary to serratus anterior paralysis.

Methods: Twenty patients had serratus anterior paralysis secondary to trauma or prior surgery with documented long thoracic nerve injury by EMG. Indications included pain, scapular winging, and limited active range of motion. All patients underwent transfer of the sternal head of the pectoralis major with its bony insertion to the inferior pole of the scapula. At 3 months post operatively all patients underwent a dynamic ultrasound of the pectoralis and CT scan of the scapula. If bone healing was confirmed then patient is allowed to progress quickly to strengthening and unrestricted activities.

Results: At an average follow-up of 17 months, 17 patients had complete and 3 patients had partial resolution of the scapula winging. Shoulder range of motion improved significantly with improvement of active shoulder forward flexion from 98˚ to 135˚ ($p < 0.01$), and abduction from average 82˚ preoperatively to 118o post-operatively ($p < 0.01$). All patients reported pain levels as moderate or severe preoperatively, while only 2 out of 20 reported moderate or severe pain after surgery ($p < 0.01$). The mean shoulder Constant Score improved from 45, with a relative score of 51% preoperatively to 76, with a relative score of 81% postoperatively ($p < 0.01$). The shoulder subjective value was 48% preoperatively to 77% postoperatively ($p < 0.03$). Finally, the preoperative and postoperative DASH score improved from 53 to 14, respectively ($p < 0.01$). CT scans at an average 3 months post-operatively demonstrated full healing in 18 patients and partial healing in two. Dynamic ultrasound of the pectoralis major muscle demonstrated normal muscle contraction during active shoulder flexion in 16 patients and weak contraction in 4 patients. Nineteen of 20 report their shoulder as significantly better than preoperatively.

Summary: Transfer of the sternal head of the pectoralis major with its bony insertion to the inferior pole of the scapula does stabilize and restore the function to the scapula in patients with symptomatic winging. The main advantages of this technique are the ability to directly transfer

the tendon to the scapula with bone to bone healing potential which allows faster healing of the repair that in turns leads to quicker return to full unrestricted activities.

♦ Nothing of financial value to disclose

RF Paper 26: Scoping Review of DASH Score Reporting for Hand and Wrist Conditions

Session VI - 2:15 - 2:20 PM

Category: Pain & Disability (chronic)
Keyword: Hand
Not a clinical study

♦Heather Baltzer, MSc, MD
♦Christine B. Novak, PT, PhD
●Steven J. McCabe, MD

Hypothesis: We hypothesized that a review the literature on the application of Disability of the Arm, Shoulder and Hand (DASH) score for evaluating of hand and wrist pathology would provide a map of scores that had an increasing trend corresponding with more severe pathology and would demonstrate variation in DASH score measurement methodology.

Methods: We searched MEDLINE, EMBASE, and Cochrane Central Register of Controlled Trials from the earliest available date through January 1, 2013. Combinations of the following search terms were used: DASH AND Hand. Further refinements to the search were imposed post hoc and included combinations of the following search terms: DASH and each of the conditions that had been identified on the initial search. All articles reporting a DASH score for hand and wrist pathology reviewed. Minimum inclusion criteria were that the reported score was for a patient population with a single pathology. Studies that did not report baseline DASH scores for each condition were not included. The patterns of DASH score reporting (pre- and post-operative timing, repeated measures, other reported outcomes and study design) were recorded in order to identify themes.

Results: The literature search identified 791 citations. Review of abstracts led to the retrieval of 118 full text articles, of which 98 were selected for review: 61 (62.2%) and 29 (29.6%) articles prospective and retrospective cohort studies, respectively, 7 (7.1%) randomized trials, and one (1.0%) systematic review. DASH scores were mapped for 23 conditions. 42 (60%) articles reported repeated DASH measurements with great variation in time points, ranging from two weeks to two years. The trend in increasing DASH scores did not necessarily follow an expected course; digital and upper limb replant had much lower scores than DeQuervain's tenosynovitis and 1st CMC osteoarthritis (Figure 1).

Summary:

- Two main themes emerged from this scoping review: (1) varied methodology of applying the DASH questionnaire and (2) trends in increasing DASH scores that do not correspond to the severity of the condition.

- These themes are likely closely linked and emphasize the need for further study into for contextualizing DASH score according to other factors, such as pain, depression and patient factors.
- Variation in DASH measurement methodology may be addressed through development of standardized guidelines for applying the DASH questionnaire, which currently do not exist.

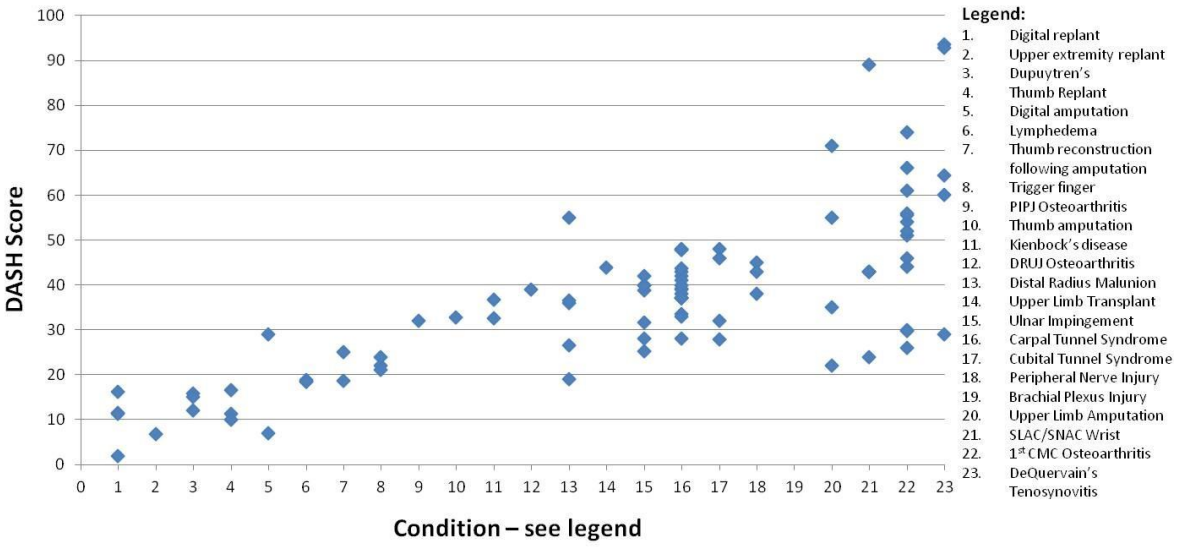

Figure 1: Map of reported DASH scores for 23 hand and wrist conditions. Each point on the graph represents an individual DASH score represented from an independent study.

● Consulting Fees: Actelion

♦ Nothing of financial value to disclose

RF Paper 27: Accuracy of Patient Recall of Hand and Elbow Disability on the QuickDASH Questionnaire Over a Two-Year Period

Session VI - 2:20 - 2:25 PM

Category: Other
Keyword: Hand
Level 3 Evidence

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♦Daniel London, BA
●Martin I. Boyer, MD, FRCS(C)
♦Ryan P. Calfee, MD, MSc

Hypothesis: The purpose of this study was to quantify recall accuracy on the QuickDASH questionnaire as a function of the duration of the recall interval. We hypothesized that patient recall accuracy would decrease with increasing time since the initial office visit (IOV).

Methods: This cross-sectional study enrolled 140 patients. Patients were stratified into groups of 35 based on the time since their IOV (3 months, 6 months, 12 months, and 24 months). All patients completed the QuickDASH as part of a standard intake form at the time of their IOV (actual baseline score). Patients were contacted by phone and recalled their upper extremity disability from the time of their initial office visit using the QuickDASH. Patients also completed the QuickDASH to rate their current disability. Statistical comparisons (paired t-test, non-parametric ANOVA, and Pearson correlations) were conducted as appropriate to analyze difference between actual and recalled QuickDASH scores within each time point, between each time point, and to quantify the impact of patient age, diagnosis, treatment, and current disability on recall accuracy.

Results: Mean differences between recalled QuickDASH scores and actual scores were all less than the QuickDASH minimal clinically important difference (MCID) of 13 points: 3 months (-7.14, $p<0.01$), 6 months (0.79, $p=0.79$), 12 months (-2.27, $p=0.43$), and 24 months (-2.79, $p=0.26$). There were no statistically significant differences in recall accuracy across the four groups according to time since IOV ($p=0.77$). Recalled QuickDASH scores were highly correlated with actual baseline values in each group ($rp=0.74$). Recall accuracy was correlated with neither patient age nor current QuickDASH scores ($rp=0.04$). There was no statistically significant difference in recall accuracy between any of the diagnoses ($p=0.31$) or when comparing recall accuracy between patients who underwent invasive vs. conservative management ($p=0.10$).

Summary:

- Patients accurately recall prior levels of upper extremity disability accurately for up to 2 years using the QuickDASH questionnaire.
- Age, disease type, treatment modality, and current disability do not affect the ability to accurately recall prior levels of function on the QuickDASH questionnaire.
- Although data collected prospectively remain optimal, our data suggest research conducted using recalled QuickDASH scores produce reliable assessment of disability due to common upper extremity diagnoses.

References:

1. Calfee RP, Adams A. Clinical research and patient-rated outcome measures in hand surgery. J Hand Surg Am. Elsevier Inc.; 2012 Apr;37(4):851–5.
2. Wilson J, Baker P, Rangan A. Is retrospective application of the Oxford Shoulder Score valid? J Shoulder Elbow Surg. Elsevier Ltd; 2009;18(4):577–80.
3. Pellisé F, Vidal X, Hernández A, Cedraschi C, Bagó J, Villanueva C. Reliability of retrospective clinical data to evaluate the effectiveness of lumbar fusion in chronic low back pain. Spine. 2005 Feb 1;30(3):365–8.
4. Howell J, Xu M, Duncan CP, Masri B a, Garbuz DS. A comparison between patient recall and concurrent measurement of preoperative quality of life outcome in total hip arthroplasty. J Arthroplasty. 2008 Sep;23(6):843–9.
5. Angst F, Schwyzer H-K, Aeschlimann A, Simmen BR, Goldhahn J. Measures of adult shoulder function: Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) and Its Short Version (QuickDASH), Shoulder Pain and Disability Index (SPADI), American Shoulder and Elbow Surgeons (ASES) Society Standardized Shoulder. Arthritis Care Res. 2011 Nov 7;63(S11):S174–S188.
6. Gummesson C, Ward MM, Atroshi I. The shortened disabilities of the arm, shoulder and hand questionnaire (QuickDASH): validity and reliability based on responses within the full-length DASH. BMC Musculoskel Dis. 2006 Jan;7:44.

Table 1: Patient Demographics, Diagnosis and Treatment

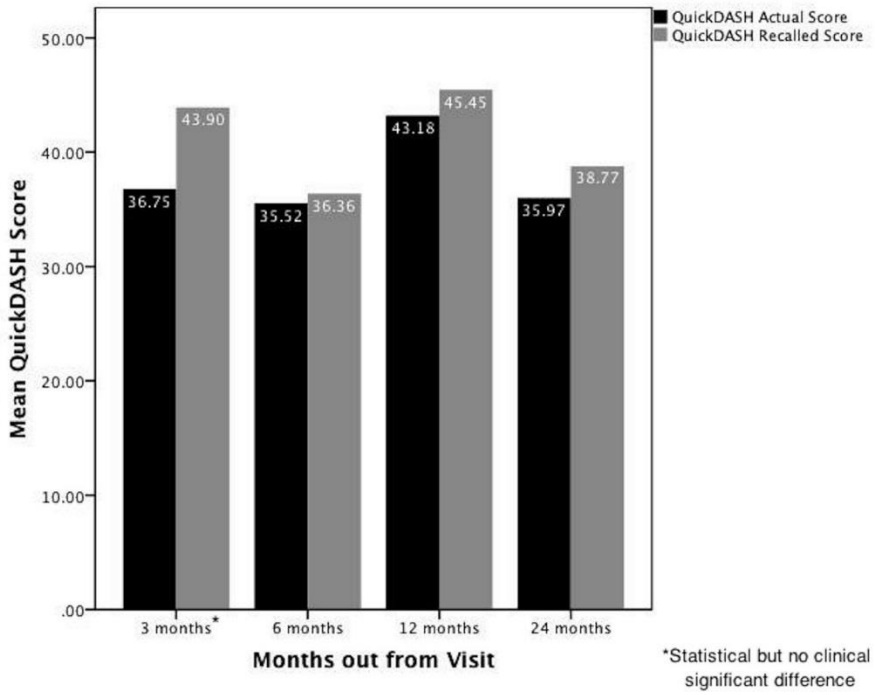
Variable	Time After Initial Evaluation			
	3 Months	**6 Months**	**12 Months**	**24 Months**
Male (%)	10 (28.6%)	16 (45.7%)	12 (34.3%)	15 (42.9%)
Age at follow-up	55.0 (±11.5)	55.9 (±13.1)	54.9 (±15.7)	54.7 (±14.1)
Actual Baseline QuickDASH	36.75 (±23.04)	35.52 (±24.14)	43.18 (±24.27)	35.97 (±22.45)
Current QuickDASH	22.27 (±24.77)	22.86 (±24.93)	26.10 (±26.25)	15.58 (±21.63)
Diagnosis*				
Arthritis	3	6	8	4

Trigger Finger	11	6	9	6
DeQuervain's	3	3	4	3
Dupuytren's	3	1	1	3
Carpal & Cubital Tunnel Syndrome	9	12	13	16
Cyst/Mass	5	7	2	3
Other	2	2	1	2
Treatment				
Surgery	3	13	6	7
Steroid Injection	13	8	16	10
Braces/Medication	12	9	10	14
No Treatment	4	3	3	2
Other⊥	3	2	0	2

* 7 patients had multiple diagnoses

⊥ 3 needle aponeurotomies, 2 aspiration, 1 sclerotherapy, 1 unknown

Figure 1. Mean QuickDASH Scores at Each Time Inverval



●Ownership Interests: OrthoHelix, LLC; Tornier

●Consulting fees: OrthoHelix, LLC; Acumed, LLC

♦ Nothing of financial value to disclose

RF Paper 28: Repeat Emergency Room Visits for Hand and Upper Extremity Injuries

Session VI - 2:25 - 2:30 PM

Category: Evaluation/Diagnosis/Clinical Treatment
Keyword: Other
Level 3 Evidence

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♦Walter Bratchenko, MS
♦Glen Jacob, MD
♦Linda Chen, MS
♦Virak Tan, MD

Hypothesis: Concerns regarding access to care and over-utilization of resources has led to scrutiny of inappropriate patient referral to university-based hospital emergency departments (ED). We hypothesize that 1) a majority of these patients did not require urgent or emergent care, 2) most utilized the ED as outpatient clinics, and 3) there's a disproportionate number of un- or under-insured patients.

Methods: We retrospectively reviewed all hand and upper extremity-related ED visits during a 9-year period. Patients who walked-in to our emergency department after documented evaluation by an outside ED within 30 days, for the same complaint, were included in this review. Direct transferred patients were also included. Demographics, diagnosis, referral instructions from the initial institution, date and time of ED visit, treatment received, and insurance status were recorded. Clinical urgency of diagnosis was quantified on an ordinal scale.

Results: 401 patients met the inclusion criteria for the study. 92% were treated by a junior-level orthopaedic resident and discharged from the ED. Of the studied population, 60% were uninsured, 31% had Medicaid, and 9% had commercial insurance, compared to our state's distribution of 16%, 8%, and 76%, respectively ($p<0.05$). Patients who were directly transferred had more severe injuries ($p<.01$) and were more likely to need admission for operative treatment($p<.001$) compared to ED walk-in patients. Of the 355 ED walk-in patients, 318(90%) presented on weekdays and 301(85%) arrived between 6a-6p. Upon discharge from the outside ED, 170 patients were instructed to follow-up with an "orthopaedist", 180 to follow-up specifically at our institution, and 5 presented because no diagnosis was made initially. For transfer patients, 37% arrived during the daytime and 35% on weekdays, $p<.001$. For patients with urgent/emergent diagnoses, an average of 2 days (range, 0-14; SD, 3) elapsed after initial evaluation by the outside ED. For patients with non-urgent/semi-elective diagnoses, an average of 5 days (range, 0-29; SD, 6) elapsed, $p<0.001$.

Summary: Most hand and upper extremity patients seen in our emergency department after presenting to another ED did not have a condition that warranted urgent or emergent evaluation and treatment. Additionally a vast majority of these patients presented during regular business hours, when outpatient offices are open. With limited resources, it is incumbent that appropriate treatment and follow-up plan from the initial institution be in place so that patients do not have to re-visit another ED for the same problem.

♦ Nothing of financial value to disclose

RF Paper 29: The Influence of Patient Insurance Status on Access to Outpatient Orthopaedic Care for Flexor Tendon Lacerations: Implications for the Patient Protection and Affordable Care Act

Session VI - 2:30 - 2:35 PM

Category: Other
Keyword: Hand
Level 2 Evidence

♦Reid W. Draeger, MD
♦Brendan C. Mackinnon-Patterson, MD
♦Erik C. Olsson, MD
♦J. Megan Patterson, MD

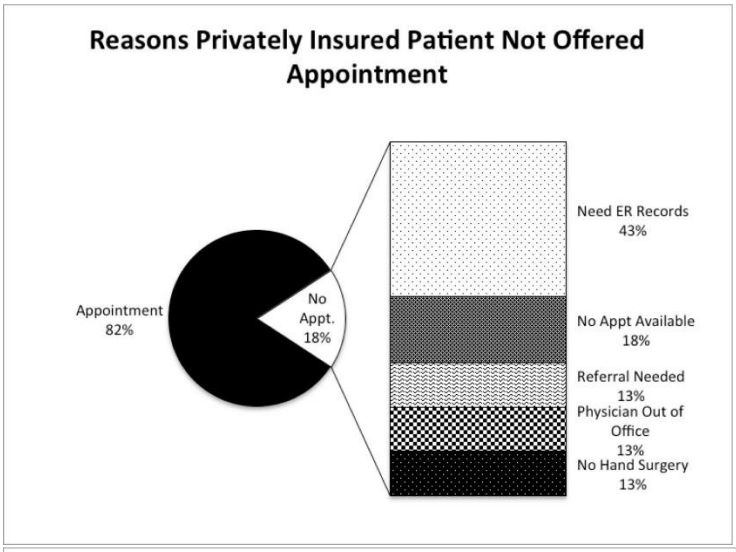
Hypothesis: A hypothetical patient with Medicaid insurance will be less likely to receive an outpatient orthopaedic appointment for an acute flexor tendon laceration than an identical hypothetical patient with private insurance.

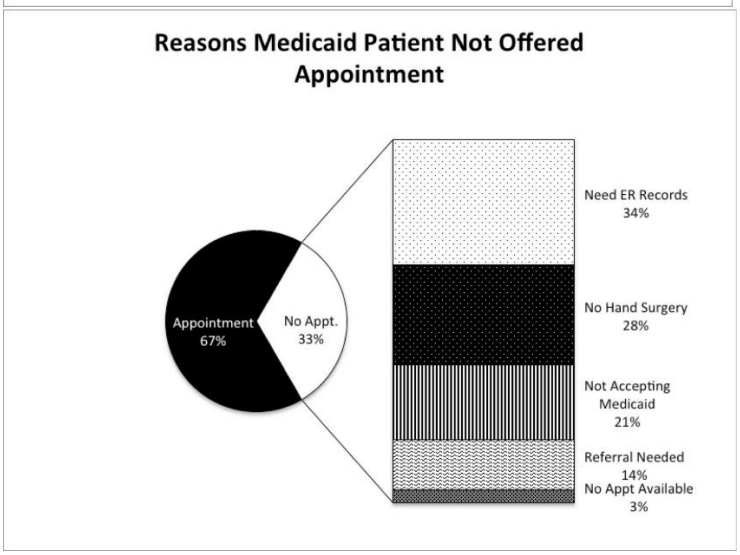
Methods: One hundred randomly chosen North Carolina orthopaedic practices were contacted on two occasions separated by three weeks. For each call the research team read a script to the practice presenting a scenario of a fictitious 28-year-old male with an acute flexor tendon laceration. Insurance status was presented as Medicaid in one call and private insurance in the other call. The primary outcome measure recorded was whether or not an appointment was offered. Appointment offerings between Medicaid and private insurance groups were compared using a Chi-squared test. An alpha value of 0.05 was considered significant.

Results: Thirteen of the 100 practices were excluded because they claimed to not perform hand surgery regardless of the insurance scenario presented, leaving 87 practices. The patient in the scenario with Medicaid was offered an appointment significantly less often (67%) than the patient in the scenario with private insurance (82%)($p=0.02$). The patient with private insurance had greater than double the odds of being offered an appointment by an orthopaedic surgery practice than the patient with Medicaid (Odds Ratio:2.2, 95% Confidence Interval:1.1,4.5). Reasons for appointment denial for private insurance and Medicaid are illustrated in Figures 1 and 2. The Medicaid patient was more likely to be denied an appointment due to lack of a hand surgeon at a practice (28% of appointment denials) than privately insured patients (13% of appointment denials). Five of the 8 practices that denied an appointment to the patient with Medicaid due to lack of a hand surgeon offered an appointment to the privately insured patient.

Summary:

- A patient with private insurance has twice the odds of receiving an outpatient orthopaedic clinic appointment for an acute flexor tendon laceration than an identical patient with Medicaid.
- Reasons for appointment denial were more commonly attributed to lack of hand surgeon availability for Medicaid patients with 5 of 8 practices that denied an appointment to a Medicaid patient citing lack of hand surgeon availability providing an appointment to an identical patient with private insurance.
- The Patient Protection and Affordable Care Act will likely result in a large increase in patients covered by Medicaid. A shift in policy to decrease barriers to orthopaedic care for Medicaid patients will maximize results for acute flexor tendon lacerations.





♦ Nothing of financial value to disclose

RF Paper 30: Hand Dominance versus Stick Dominance in Youth Hockey

Session VI - 2:35 - 2:40 PM

Category: Other
Keyword: Hand
Level 2 Evidence

♦Owen L. Ala, MD
♦Lee Swiderek, BS
♦Eric Benson, MD

Hypothesis: Most American hockey players use a right hockey stick in contrast to other countries where most hockey players use a left stick. We hypothesize that most Americans use the wrong hockey stick and that a right hand dominant hockey player should use a left hockey stick and vice versa to gain an inherent performance advantage by having the dominant hand controlling the stick.

Methods: A novel test was created that simulates the back and forth motion of the hockey stick when handling a puck by moving the wrist into extreme supination and pronation (Image 1). The study tested a pediatric population ages 5-10 who had never participated in a stick sport (baseball, golf, hockey, etc.) to prevent stick dominance bias. Participants were tested with the stick in the left and right stick positions, and asked to hit targets placed on two platforms. The number of repetitions in twenty seconds and accuracy were recorded. Researchers were blinded to the participant's hand dominance. Consents to participate were obtained from the parents of each participant. Repeated measures ANCOVA (analysis of covariance) was used to compare the number of hits with right-stick vs. left stick, controlling for hand dominance, age, and gender as covariates.

Results: Fourty participants were recruited ages 5 to 10 years old (average age being 7.2 years). There were 13 male and 27 female participants of which 6 were left handed verses 34 right handed participants. Of the 34 right handed participants, all but 3 performed better with the hockey stick in the left position with a 95% confidence interval of 2.3 to 4.2 ($p<0.0001$). All 6 left handed participants performed better with the hockey stick in the right position with a 95% confidence interval of 2.2 to 6.7 ($p<0.0001$). ANCOVA was used to simultaneously fit gender, age, and hand dominance to difference in repetitions and strikes on target between right and left sticks. Gender ($p=0.61$) and age ($p=0.73$) were not significant predictors of difference; however, hand dominance ($p<0.0001$) was the only significant predictor (Figure 1).

Summary: Right handed hockey players should use a left hockey stick and left handed players should use a right hockey stick. The hand situated at the top of the hockey stick exerts a greater degree of control and accuracy, making the dominant hand the logical choice; therefore, most Americans are using the wrong handed stick.

References:

1. Daniel M. Abrams and Mark J. Panaggio. A model balancing cooperation and competition can explain our righthanded world and the dominance of left-handed athletes. J. R. Soc. Interface published online 25 April 2012.
2. Puterman, J. Schorer, J. Baker, J. Laterality differences in elite ice hockey : An investigation of shooting and catching orientations. Journal of Sports Sciences, December 2010; 28(14): 1581-1593.
3. Goldstein, S., & Young, C. (1996). Evolutionary stable strategy of handedness in major league baseball. Journal of Comparative Psychology, 110, 164–169.
4. Grondin, S., Trottier, M., & Houle, C. (1994). Preference manuelle et laterale et style de jeu au hockey sur glace [Handedness and laterality and style of play in ice hockey]. Revue des Sciences et Techniques des Activite´s Physiques et Sportives, 35, 65–75.
5. Michaud-Paquette, Y., Pearsall,D. J., & Turcotte, R. A Whole-body predictors of wrist shot accuracy in ice hockey: a kinematic analysis. Sports Biomech. 2011 Mar;10(1):12-21.

Image 1. Study participant performing test with a left hockey stick (stick held to the left of his body). He alternates back and forth between hitting the white target on the box to his right then he hits the red target on the box to his left. Notice the extreme supination and pronation of his top hand (right hand). The test is designed to mimic the supination and pronation and back and forth motions used while playing ice hockey.

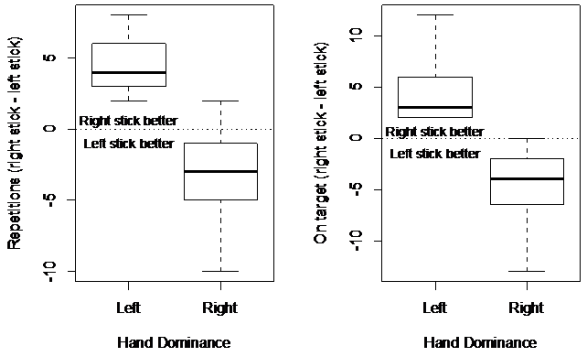


Figure 1. Results of all participants separated by hand dominance. Both repetitions in 20 seconds and on target hits in 20 seconds where performed better by left hand dominate participants using a right stick or a right hand dominance participant using a left stick.

♦ Nothing of financial value to disclose