Annual Meeting Posters
Abstract Book II - Wrist
AM Poster 136: Radiological Evaluation of the ScaphoLunate InterCarpal Ligamentoplasty in Cadavers

Category: Wrist

Hand and Wrist
N/A - not a clinical study

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Hypothesis
We performed a cadaveric study to evaluate radiological performance of a technique for scapholunate intercarpal ligamentoplasty designed for treating reducible scapholunate dissociation.

Methods
We created scapholunate instability in 12 fresh adult cadaveric forearms by sectioning the dorsal scapholunate interosseous ligament and the dorsal intercarpal ligament. All wrists showed scapholunate diastasis, dorsal intercalated segmental instability and posterior scaphoid subluxation. We performed scapholunate intercarpal ligamentoplasty in six wrists and Garcia-Elias three-ligament tenodesis in another six. Wrists were examined radiographically both after ligament sectioning and after ligamentoplasty to compare static and dynamic scapholunate gaps and scapholunate and capitolunate angles.

Results
Improvement was statistically significant in all wrists, reflecting a return to normal values. Posterior scaphoid subluxation was also corrected. There was no significant difference between the two treatment groups.

Summary Points
Our findings suggest that ligamentoplasty

- restore scapholunate joint stability
- restore normal carpal anatomy
- reduced scapholunate dissociation
- similar to Garcia-Elias three-ligament tenodesis in terms of restoration of carpal alignment
Bibliography
Hypothesis
We report the preliminary results of the ScaphoLunate InterCarpal Ligamentoplasty with a minimum follow-up of 12 months. A preconstrained palmaris longus graft is used to reconstruct the dorsal scapholunate interosseous ligament and the dorsal intercarpal ligament, thus countering dissociative scapholunate instability and preventing ligamentous loosening. The procedure takes into account recent biomechanical conceptions involving the stabilizing role of the dorsal intercarpal ligament.

Methods
26 patients (20 men, 6 female) with a mean age of 40 year-old (22 – 57) were operated on in a single center by senior hand surgeons. Indications were symptomatic chronic reducible scapholunate dissociation in the absence of chondral lesion. There were 15 static instabilities and 11 dynamic. All the patients were operated on with the same procedure and were evaluated (pain, motion, strength, function, X-rays) with a mean follow-up of 36 months (12 – 54).

Results
Pain decreased from 4.5 (rest) and 6.7 (load) to 0.4 and 1.9 on VAS scale (/10). At the follow-up, the average wrist motion was 55° extension, 56° flexion, 17° radial deviation, and 32° ulnar deviation. Grip Strength was 89% compared with the contralateral side. Function measured with the DASH score (/100) and the PRWE (/100) had improved respectively from 57 and 56 to 20 and 18. There was a significant decrease in the scapholunate angle from 76° to 62°, and in the scapholunate gap. Static gap was reduced from 3.2 mm to 2.3 mm and dynamic from 4.6 mm to 3.0 mm. Posterior scaphoid subluxation was systematically corrected with the exception of 4 cases of rapid recurrence (3 months) of static instability by ligament loosening.

Summary Points
ScaphoLunate and InterCarpal ligamentoplasty showed satisfactory clinical and radiological results in this study. This procedure reduces scapholunate dissociation and restores normal
carpal anatomy. Extended studies are needed to determine the long-term benefits of this reconstructive procedure. It is very important scaphoid can be « easily » reduced during surgery.

**Bibliography**
Hypothesis
Traditionally, proximal pole scaphoid fractures are treated dorsally. In cases of nonunion without AVN minimization of dorsal soft tissue trauma is key. Surprisingly, no study has specifically posed to evaluate the biomechanical strength of retrograde fixation of fractures of the proximal pole. The primary goal of this study is to investigate the biomechanical strength of retrograde fixation of fractures of the proximal pole as compared to antegrade. Our hypothesis is that retrograde fixation will be similar in cyclic load testing and load to failure to antegrade fixation of the scaphoid.

Methods
Fourteen cadaveric scaphoids underwent proximal pole osteotomy. Fixation was performed in an antegrade or retrograde fashion based on randomization with careful attention given to achieving a central position within the proximal pole fragment. Each specimen underwent cyclic loading from 80 N to 120 N at 1 Hz until 2 mm of fracture displacement occurred or 4,000 cycles was reached. The specimen that reached the 4,000-cycle limit were loaded to failure.

Results
Average load to failure was similar between antegrade and retrograde screw fixation (396.5 N versus 394.6 N) (p = 0.353). In all, 3 failures occurred during the cyclic loading phase of testing. 2 of these failures occurred in the antegrade group (at 2,529 and 3,212 cycles) with a single failure in the retrograde group (at 3,700 cycles). This difference did not reach statistical significance. The average screw length was 25.5 mm for the antegrade group and 23.3 mm for the retrograde group which was not statistically different. Screw cutout was the method of failure for each of the specimen.

Summary Points
For fixation of the proximal pole of the scaphoid, retrograde screw fixation is biomechanically equivalent to antegrade in this study. We have demonstrated that surgical technique does not have to be limited by fear of poor biomechanical fixation. Screw length appears to be similar between the groups. While in this ex vivo testing scenario fixation strength was similar, this has
yet to be proven in vivo or with clinical outcomes. Without exposure of the proximal pole of the scaphoid critical examination of radiographs are required to ensure central position of the screw and guidewire within the proximal pole of the scaphoid. Surgeons can now make their decision for fixation technique based on approaches to bone grafting, concern for tenuous blood supply, and surgeon experience without fear of poor biomechanical properties.
Hypothesis
Patients undergoing wrist ligament repair/reconstruction procedures for carpal instability conditions such as scapholunate dissociation are most frequently younger patients and often require revision or salvage procedure surgeries for ongoing symptoms or the development of osteoarthritis.

Methods
We examined insurance datasets to identify patients who had undergone wrist reconstruction procedures for carpal instability from 2005-2014 in Medicare. Patients were identified by CPT-25320 (capsulorrhaphy or reconstruction wrist open, e.g. capsulodesis, ligament repair, tendon transfer or graft). We then queried this patient cohort to identify the number of patients requiring revision or salvage procedures. This consisted of 13 different surgeries to include various carpectomies, arthrodeses, and wrist arthroscopies. Survival curves were generated using Kaplan-Meier Survival Analysis. Average reimbursements to include all charges from the day of surgery were calculated.

Results
A total of 2949 Medicare patients with at least 3 months of follow up underwent reconstruction procedures. The overall revision rate for the cohort was low (5.9% of Medicare). The most common revision procedure was an additional reconstruction operation (CPT-25320) while the most common salvage procedure was proximal row carpectomy (CPT-25215). The overall 8-year survival rate for all age groups was 91.5% (95% CI 89.3%-93.8%) for Medicare. This varied by age group as older patients had higher survival rates. The best survival was Medicare patients over the age of 80 years (97.3%). The average reimbursement for the index procedure was $4,107.67. The average reimbursement for revision procedures was $3,760.95 for Medicare.
Summary Points

- Our hypothesis was proven to be false.
- Reconstruction procedures have high survival rates over the short to medium term with an overall survival rate of 91.5%.
- Younger patients have a higher likelihood of undergoing subsequent revision/salvage procedures.
- These procedures occur more frequently in older patients and have better outcomes than would be traditionally expected. This may be due to imprecise procedural coding or truly better surgical results.
- CPT code 25320 may be too ambiguous as a research tool. The code is probably used for a diverse group of procedures making it a poor indication of surgeon effort and RVU quantification.
Hypothesis
The purpose of this study was to evaluate three radiographic methods for determining ulnar variance and to compare each direct measurement in a cadaver model. We hypothesized that assessing ulnar variance from the lateral wrist radiograph would be more accurate compared to measurements made using a posterior-anterior (PA) film.

Methods
Ten fresh frozen above-elbow cadaver specimens were fixed in neutral rotation using Kirschner wires. Fluoroscopic PA and lateral wrist images were obtained for each in a standardized fashion. Subsequently, a dorsal approach was used to access the wrist and the ulnar variance was directly measured by two independent investigators using digital calipers. This was performed with both the cartilage intact and denuded. Ulnar variance was measured radiographically using the lateral, perpendicular, and central reference point (CRP) methods (Figure 1). The reliability of each set of measurements was assessed by the intraclass coefficient, and agreement between radiographic and direct measurements was evaluated by the Bland-Altman method. Differences of 1 mm were deemed to be clinically significant.

Results
Each method of determining the ulnar variance demonstrated near perfect agreement by the intraclass coefficient, indicating excellent inter-rater reliability. The lateral radiograph method correlated highly with the directly measured ulnar variance with the cartilage denuded with an average measurement difference of 0.06 mm (95% CI: -0.34, 0.47). No radiographic measurement technique correlated with the ulnar variance with the cartilage intact within the 1 mm cut-off (Figure 2).
Summary Points

- Ulnar variance measured by the lateral wrist radiograph technique correlates highly with the directly-measured bony ulnar variance.
- No method was able to accurately account for the articular cartilage at the lunate facet or distal ulnar fossa.
- The lateral radiograph allows for more reliable standardization of wrist position compared to the PA view; however, this study highlights the inherent limitations of utilizing static radiographic images in the evaluation of ulnar variance.
AM Poster 141: A Biomechanical Comparison of Single vs Dual Screw Constructs in a Cadaveric Scaphoid Nonunion Model

Category: Wrist

Hand and Wrist
N/A - not a clinical study
Grant received from: Acumed LLC, 2017

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Hypothesis
To compare the biomechanical properties and mechanism of failure of a single mini headless compression screw with two micro headless compression screws in a cadaveric scaphoid nonunion model.

Methods
A cadaveric scaphoid nonunion model was created in 9 matched pairs of wrists by removing a 3mm wedge of bone from the midpoint of the scaphoid waist. Fixation was performed with either a single 3.5mm headless compression screw placed along the central axis of the scaphoid or two 2.5mm headless compression screws placed in converging fashion in the coronal plane. Specimens were potted in an acrylic cast with the distal pole oriented 45 degrees from the horizontal to mimic the native position of the scaphoid. Each group underwent vertical loaded using a test stand (Mark-10 ESM303) to determine stiffness, load to failure, load to 1mm displacement, load to 2mm displacement, and maximal displacement at failure. Failure analysis was performed by assessing presence of vertical and rotational stability following failure. Parametric data was compared using the Student t test and non-parametric data using the Fisher exact test.

Results
Load to failure demonstrated no statistically significant difference between single and dual screw configurations (p=0.8). Stiffness during load to failure, displacement at failure, and load to 2mm displacement were not statistically different (p=0.8, p=0.3, p=0.9, p=0.1). The dual screw
construct maintained rotational stability significantly more than the single screw construct (p=0.02).

Summary Points
- This study demonstrates equal construct stiffness in load to failure when comparing single mini versus dual micro screw fixation in a cadaveric scaphoid nonunion model.
- Single screw constructs failed due to a loss of rotational stability while double screw constructs failed by either gap closure with preservation of vertical and rotational stability, or complete screw cutout.
- Dual headless compression screw fixation should be considered when there are concerns about rotational stability in scaphoid fracture nonunions.
AM Poster 142: Impact of Septated First Dorsal Compartments on Symptomatic DeQuervain's Disease

Category: Wrist

Hand and Wrist; Diseases and Disorders
Level 4 Evidence

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Hypothesis
Septation of the first dorsal compartment would be more prevalent in a population of patients with symptomatic de Quervain’s tenosynovitis treated with surgical release compared to a human cadaver cohort that had not previously undergone surgical intervention for this disease.

Methods
A retrospective review was performed consisting of 79 consecutive patients (85 wrists) treated with first dorsal compartment release by two fellowship-trained hand surgeons for a diagnosis of deQuervain’s tenosynovitis. The number of corticosteroid injections prior to surgical release was recorded as was the presence of first dorsal compartment septation encountered intraoperatively. Correlation between the number of steroid injections and the presence of septation was evaluated. Additionally, 48 matched cadaver upper extremities (96 wrists) were dissected to evaluate for the presence of first dorsal compartment septation in a cohort of upper extremities that had not previously undergone surgical release of the first dorsal compartment. The prevalence of septation was compared between matched wrists (left versus right). Additionally, this was evaluated in the surgically-treated clinical cohort compared to the cadaver cohort that had not undergone prior surgical release.

Results
In the clinical cohort, 52 (61.2%) of 85 wrists undergoing surgical treatment for deQuervain’s tenosynovitis contained a septated first dorsal compartment. Seventy-two wrists received one or more steroid injections prior to surgery, of which 61.1% of cases contained a septum. There was no correlation between the presence of a septated first dorsal compartment and the number of steroid injections prior to surgical release. In the cadaver portion of the study, 70
(72.9%) of 96 matched cadaver wrists contained septated first dorsal compartments, which was observed bilaterally in 32 (67%) of 48 specimens. Twenty-six wrists (27.1%) were not septated. Overall, there was no significant difference in the prevalence of septated first dorsal compartments between groups.

**Summary Points**

- The majority of wrists contained a septated first dorsal compartment.
- There was no difference in this prevalence between the cohort of patients treated surgically for deQuervain’s tenosynovitis compared to a cadaver sample that had not undergone prior surgical release.
- There was no correlation between the presence of a septated first dorsal compartment and the number of steroid injections administered preoperatively in the clinical cohort.
Hypothesis
Asymptomatic, incidental extensor carpi ulnaris (ECU) tendon abnormalities are frequently noted on imaging studies of the wrist. We wanted to investigate if variations in gross tendon anatomy existed that could possibly account for these findings on MRI and ultrasound (US) imaging.

Methods
The upper extremities of eleven (6 male and 5 female) preserved cadavers were dissected and the ECU tendon and dorsal ulnar wrist were examined. The tendons were inspected for anatomic variations, degenerative changes, and any other pathologies. The presence of intratendinous splits arising within the ECU tendon was noted and measured. The length of splits and distances of the splits from its insertion and the edge of the extensor retinaculum were recorded.

Results
17 ECU tendons were dissected and examined as 5 ECU tendons were excluded due to poor preservation of that extremity. Eleven of the 17 specimens demonstrated at least one split in the distal tendon: Seven had 1 split, 1 had 2 splits, and 3 had 3 splits. A linear regression was calculated and showed no correlation between age and number of tendon splits ((F(1,15) = .082, p < .778), R^2 = .005).

Summary Points
- 64% of specimens showed a longitudinal split in the distal ECU tendon. The anatomic location of these frequent splits corresponds to imaging abnormalities on MRI and US in prior studies.
- Whether these longitudinal tendon splits represent normal anatomic variants or a common degenerative process that leads to an asymptomatic tendon split with time and mucoid degeneration is still unclear.
- More research into ECU signal changes distinguishing between central degenerative signal changes and longitudinal splits is required.
Bibliography

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
In this study, the presence or absence, incidence, and degree of extensor pollicis longus (EPL) tendon injury were surveyed by visual confirmation of the EPL at the time of osteosynthesis for distal radius fractures.

Methods
The subjects were 25 patients (5 males and 20 females; mean age: 56 years) with distal radius fracture that had a dorsal roof fragment. During osteosynthesis using a volar locking plate, the third compartment was exposed in order to determine the EPL injury. The survey items in this study were: incidences of the forms of EPL injury (1: absent, 2: tendon floor fibrillation, and 3: laceration), and the presence or absence of periosteal rupture on the EPL tendon floor. In addition, on the final follow-up, the presence or absence of EPL rupture, the range of wrist motion, grip strength, Visual Analog Scale (VAS) score, Quick Disabilities of the Arm, Shoulder and Hand (Q-DASH) score, and the Mayo wrist score were investigated.

Results
During the operation, EPL injury was classified as: 1) absent (12%), 2) tendon floor fibrillation (52%), or 3) laceration (36%). In the EPL tendon floor, periosteal rupture was observed in all patients. The mean postoperative follow-up period was 8 months (6-12 months) and no EPL rupture was observed in any patient. The wrist range of motion was 71° for flexion, 75° for extension, 84° for pronation, and 85° for supination, and the grip (% compared with the unaffected side) was 79%. The VAS, Q-DASH and Mayo scores were 1, 10 and 93 respectively.
Summary Points

• This study showed a high incidence of EPL tendon injury at the time of distal radius fractures (88%).
• To the ambient environment of the damaged tendon may be useful in terms of the prevention of tendon injury.
Hypothesis
The upper limb surgery under the ultrasound-guided brachial plexus block is becoming popular due to its safety, effectiveness, and convenience. However, the uneven distribution of anesthesiologists become social problem, especially hand surgery, ultrasound-guided brachial plexus block by surgeons has been widespread. We report the surgical treatment of distal radius fractures under the ultrasound-guided brachial plexus block performed by surgeons in our hospital.

Methods
The subjects were 101 patients (41 males and 60 females, average age 61.6 years) who underwent surgery for distal radius fractures under ultrasound-guided brachial plexus block administered by orthopedists at our university or related facilities between January 2014 and June 2016. Brachial plexus block was administered through the supraclavicular approach. For local anesthetics, 20 mL of 0.75% ropivacaine or 0.5% levobupivacaine and 5-10 mL of 1% lidocaine were used. The time from initiation of anesthesia to initiation of surgery, mean operative time, the presence or absence of additional anesthesia, and complications were evaluated.

Results
The mean time from brachial plexus block to initiation of surgery was 35.7 (20-68) minutes, and the mean operative time was 90.5 (35-217) minutes. Surgery was completed with brachial plexus block alone in 62 patients (61.4%), and additional anesthesia was necessary in 39 patients.
Furthermore, general anesthesia was employed in 6 patients (5.9%). No serious complications occurred.

**Summary Points**

According to our results, the operation could be completed with brachial plexus block alone and additional local infiltration anesthesia or intravenous anesthesia in 94.1% (95 cases). However, 6 cases (5.9%) shifted to general anesthesia. Although it needs training, we consider that hand surgery including distal radius fractures treatment under the ultrasound-guided brachial plexus block is possible. On the other hand, cooperation or a cooperative system with anesthesiologists is necessary for surgeons to administer this anesthesia.
Hypothesis
Distal radius fractures represent the second most frequent type of fracture in patients over 60 years of age, with important consequences, both functional and socioeconomic. At present, in the literature there are no comparative studies between the different treatments, conservative versus surgical, although their incidence is high and the great impact they represent. Improvements in implant design and increased activity and independence of elderly patients have raised the question of how unstable distal radius fractures should be treated in this population group. Actually, we do not have sufficient knowledge to affirm that the surgical treatment of unstable distal radius fractures in elderly patients is safe and effective.

The objectives of this study are to determine the functional and radiological results of comminuted distal radius fractures (c3) in patients older than 70 years treated by open reduction and internal fixation.

Methods
We present an observational retrospective follow-up study analyzing the clinical, radiological and functional results of 23 patients older than 70 years who went under surgery on distal radius fractures type C3 of AO classification. The radiological assessment was performed following the system of Sarmiento modified by Lidstrom y Frykman. The functional assessment was made following the scale of Gartland y Werley modified by Sarmiento. The tests used for the patient's self-evaluation were the PRWE (patient-rated wrist evaluation) and the DASH score.

Results
Surgical treatment of distal comminuted fractures in the elderly generally provides good or excellent results (65%) with a Gartland scale index of 6.58 (0-20) and QDASH of 19.3 (0-81). In clinical control at 3 months the loss of supination with respect to the non-affected side are 2.3 degrees and -2.24 and 3 of extension and flexion respectively, being the latter the only one that presents statistical significance. Radiologically we only found significant radial shortening (3.4 mm) with respect to the immediate postoperative period.
Summary Points
Surgical treatment of distal radius type C3 fractures according to the classification of OA in patients older than 70 years provides good or excellent results, so in these cases, our recommendation would be to follow a surgical treatment.

Bibliography
AM Poster 147: Reliability and Reproducibility of the Classification of Scaphoid Waist Fractures Using Computer-Tomography

Category: Wrist

Hand and Wrist; Diseases and Disorders
Level 4 Evidence

Rasmus W. Jørgensen, MD

Hypothesis
Conventional radiographs have been shown to yield unreliable results in classifying scaphoid fractures. Computer-Tomography (CT) has been claimed to be the tool of choice in determining the treatment. The use of CT for diagnosing fractures and healing of scaphoid fractures has shown only moderate interobserver reliability. We have therefore undertaken a study of the reliability and reproducibility of the classification of waist fractures of the scaphoid among specialists of orthopedic surgery with a particular interest in hand surgery.

Methods
From 2009 to 2014 CT scans were routinely obtained in patients with fractures of the carpal scaphoid shown on radiographs. Among 186 positive CT scans 116 were excluded as the fracture was more than 4 weeks old or due to incomplete dataset of the CT. Among the remaining 70 scans we identified 51 scaphoid waist fractures. Sagittal and coronal planes of the long axis of the scaphoid were available in all scans. 7 orthopedic surgeons with a particular interest in hand surgery independently scrutinized the scans classifying each in undisplaced, minimally (2mm displaced. Selecting between operative or non-operative treatment showed a Kappa of 0.58. Overall reproducibility was 0.75 when classifying between 2mm displaced fractures.

Summary Points
- Only moderate interrater reliability was found when choosing between non-operative and operative treatment.
- Reproducibility was substantial when classifying between <2mm displaced fractures as well as choosing operative or non-operative treatment.
Hypothesis
The reported prevalence of a sub-compartment housing the extensor pollicis brevis (EPB) tendon within the first dorsal compartment varies widely in the literature, especially regarding the rates of occurrence between genders and among those with and without DeQuervain’s. Based upon direct intra-operative observation, we hypothesized that the prevalence of a septated compartment is far greater than previously reported, particularly in those with DeQuervain’s disease.

Methods
A prospective analysis of consecutive patients who underwent first dorsal compartment release was performed. Patients were divided into two groups: those with DeQuervain’s tenosynovitis (“DeQuervain” group) and a control cohort without a primary diagnosis of DeQuervain’s (“non-DeQuervain” group). The intra-operative anatomic findings of a single compartment or a separate sub-compartment were recorded. The prevalence of a septated compartment was calculated and compared between genders and both patient groups utilizing the Fisher’s Exact Test.

Results
A total of 102 consecutive patients were included (56 in the “non-DeQuervain” and 46 in the “DeQuervain” groups) with a female predominance (74.5%). Overall, 79.4% of patients had a separate sub-compartment for the EPB. In the DeQuervain cohort, 89.1% had two compartments while 71.4% of non-DeQuervain patients had a sub-compartment (p = 0.08). Males and females had a similar rate of double compartments (80% and 82.4%, respectively) (p = 0.79).
Summary Points

• The prevalence of a septated first dorsal compartment of the wrist is considerably higher than previously reported, most notably in patients afflicted with DeQuervain’s tenosynovitis.
• This higher rate of septation occurs with a similar prevalence in both males and females.
• Owing to its consistent presence, the dual first dorsal compartment should be regarded as an expectant anatomic component of the normal wrist, apt to constrict and inflame the enclosed tendons and contribute to the occurrence and severity of DeQuervain’s disease.

Bibliography


Hypothesis
Cost is an increasingly important consideration in orthopaedic surgery, including fixation of distal radius fractures. In order to deliver better value-based care, we must better understand implant costs. We hypothesized the extraarticular fracture patterns (25607) would have a lower implant charge than intraarticular fractures (25608 or 25609), and aimed to determine risk factors for increased cost.

Methods
Our institution’s billing databases were reviewed from 1/2016 through 6/2017 for patients undergoing outpatient distal radius fracture fixation, and stratified by CPT codes (25607 = extraarticular, 25608 = 2-piece intraarticular, 25609 = 3 or more piece intraarticular). Implant charge and components (including plates, screws, external fixators, and bone graft) were noted, as was gender, age, insurance status, surgeon type (hand vs. trauma subspecialty, and attending vs. fellow), and location (Level 1 trauma center, or community hospital). Along with descriptive statistics, multivariable regression was used to determine implant cost drivers. Significance was set at \( p < 0.05 \) a priori.

Results
147 patients underwent outpatient distal radius ORIF (CPT 25607: 44/29.9%; CPT 25608: 56/38.1%, CPT 25609: 47/32.0%). Implant charges were significantly lower for 25607 ($3,334) than 25608 ($3,940) and 25609 ($3,862). The extraarticular fractures required significantly fewer distal screws/pegs (5.4) than simple intraarticular fractures (6.3) or complex (6.2, \( p = 0.01 \)). Significantly more 25609 cases required bone graft (25.5%) than 25607 (9.1%) or 25608 (12.5%, \( p < 0.001 \)).
Multivariable regression analysis revealed an increased implant charge associated with fracture pattern (25608 by $873, p=0.001, and 25609 by $581, p=0.03), while cases performed at the trauma center were associated with a lower charge, by $615 (p=0.01). There was no charge difference associated with insurance status, gender, hand vs. trauma subspecialty, or fellow status.

Summary Points
- Fixation of extraarticular fractures required fewer points of distal fixation, and were associated with lower implant charges than fixation of more complex intraarticular fractures. Increased articular comminution (25609) required more bone graft.
- There was no difference in implant cost between Hand- and Trauma-subspecialty surgeons.
- These data may be used to help construct pricing for distal radius fracture bundles and potential cost savings.

Bibliography
Hypothesis
Kienböck's disease is a rare condition in children or adolescent patients, and incidence of these is reported to be less than 1% of the whole of cases. Because of age-related potential for spontaneous remodeling and revascularization, surgical method for young patients should be different from for adult cases. For children, temporary fixation of the scaphotrapeziotrapezoidal (STT) joint would be not only effective but also simple and less invasive, but for late teenagers with epiphyseal closure, radial shortening osteotomy (RSO) would be more reliable.

Methods
We treated 6 cases of children or adolescent patients (younger than 20 years old) of Kienböck’s disease. All patients presented in Lichtman stage IIIa. As a treatment, temporary fixation of the STT joint were performed in 3 patients (bilateral in 1). The ages of the patients in this group were 11, 14 and 16 years old. A period of fixation ranged from 8 to 12 weeks. RSO was performed in the remaining 3 patients. The ages of the patients in this group were 14, 15 and 18 years old. Shortening length was 3mm and volar locking plate was used as internal fixation. For an evaluation of blood circulation improvement in the lunate, MRI images (T1WI) were compared pre- and postoperatively. Carpal height ratio and Ståhl index in AP view of X ray image, the range of motion (ROM) of the wrist and grip strength were also measured and compared pre- and postoperatively.

Results
In 11 and 14 year-old-patients underwent temporary fixation of the STT joint, improving blood circulation of the lunate was confirmed with MRI. But in a 16-year-old patient, intensity change was not confirmed with MRI at the time of 20 months postoperatively. As a second surgery, RSO
was performed and improving blood circulation was confirmed at the time of 25 months after second operation. In all patients underwent RSO primarily, improving blood circulation of the lunate was confirmed with MRI postoperatively. Carpal height ratio, Stähl index, the ROM of the wrist and grip strength were improved in all patients except 1 patient who underwent secondarily RSO.

Summary Points
- The choice of operation for young patients of Kienböck’s disease should be decided by having epiphyseal plate closure or not.
- Temporary fixation of the STT joint can be useful in the patients before the epiphyseal closure.
- In contrast, RSO is recommended after the epiphyseal closure.

Bibliography
AM Poster 152: Decreased Grip Strength and Dynamic Body Balancing in Women with Distal Radial Fractures

Category: Wrist

Hand and Wrist; General Principles
Level 3 Evidence

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Hypothesis
Patients with distal radial fractures (DRF) are at risk for future fragility fractures; however, their physical characteristics and tendencies for falls are not well studied. In this study, we aimed to study the physical characteristics of female patients with distal radial fractures and compared them with those of women without fractures.

Methods
This case-control study was approved by institutional review board and performed at eight hospitals and included 128 female patients with DRF who underwent surgery, with their DRF signifying their first fragility fracture (fracture group). Concurrently, 128 age- and sex-matched participants who lived near the hospital and had no history of fragility fractures were selected as controls (control group).

All participants underwent assessments of grip strength and a body balancing ability test. Measurements were assessed twice in the fracture group, at two weeks and six months postoperatively, and once in the control group. The body balancing ability test included four assessments: Functional Reach Test, Timed Up and Go test (TUG), 2 Step test (2ST), and Timed Uni-pedal Stance test. Participants also completed questionnaires about general health quality, physical activity, and comprehensive health information, including treatment for compromised balance or osteoporosis. The values in the fracture group at 2 weeks and 6 months after the surgery were compared to those in the control group, by using Student’s t test followed by application of Bonferroni correction. Logistic regression analyses were used to analyze the odds ratios of DRF.
Results
There were no significant differences (p > 0.05) in age, height, body weight, body mass index, and anamnesis between the groups. Relative to the control group, the fracture group demonstrated reduced grip strength in all age groups at both assessments. Additionally, in DRF subjects, prolonged TUG was observed at two weeks postoperatively in all age groups and at six months in those aged 55–74 years, while 2ST was significantly reduced at both assessments in those aged between 65–74 years. Logistic regression analyses demonstrated that alcohol consumption, higher values of TUG and lower values of 2ST and grip strength were significantly positively correlated with fracture risk.

Summary Points
• Women with DRF demonstrated reduced grip strength and dynamic body balancing ability as measured by TUG and 2ST at two weeks and six months postoperatively.
• Reduced grip strength and dynamic body balancing ability were identified as significant risk factors for DRF, suggesting these measurements can be useful screening tools to identify future fracture risk.

Bibliography
AM Poster 153: Comparison the Clinical Outcomes of Distal Radius Fractures with Distal Ulnar Fractures Versus Without Distal Ulnar Fractures

Category: Wrist

Hand and Wrist
Level 4 Evidence

Ayaka Kaneko
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Hypothesis
Distal ulnar fractures often concomitantly occur with distal radius fractures. However, their treatment method is still controversial, since there is no evidence how distal radius fractures affect wrist pain and function after the treatment of distal radius fractures. In this study, we investigated the clinical outcomes of distal radius fractures, and compared these outcomes between distal radius fractures with distal ulnar fractures and without distal ulnar fractures.

Methods
Of 177 cases with a distal radius fracture who underwent surgery in our department between October 2012 and April 2017, 163 who could be followed up for 3 months or more after the operation were included as the subjects. Subjects were divided into three groups; 1. Without fractures group (F (-); 74 cases, male: 28, female: 46, age 59.8 years); 2. With ulnar styloid fracture group (S (+); 66 cases, male: 23, female: 43, age 63.9 years); 3. With distal ulnar fractures excluding ulnar styloid fractures group (D (+); 23 cases, male: 3, female: 20, age 67.7 years). Functional outcomes included Visual Analogue Scale (VAS) score, Quick Disabilities of the Arm, Shoulder and Hand (Q-DASH) score and Mayo wrist score were investigated and compared among these 3 groups.
Results
VAS scores were 1.4 ± 1.8 in F (-), 1.2 ± 1.4 in S (+), and 0.6 ± 0.8 in D (+); Q-DASH scores were 10.4 ± 15.9 in F (-), 9.6 ± 11.0 in S (+), and 7.7 ± 8.2 in D (+); Mayo wrist scores were 92.6 ± 10.7 in F (-), 97.5 ± 8.7 in S (+), and 92.0 ± 6.3 in D (+). Thus, there was no significant difference in Q-DASH score and Mayo Wrist score among the three groups. Of interest, the VAS score in D (+) was significant low compared to this in F (-) (p < 0.05).

Summary Points
• These results suggest that ulnar styloid fractures or distal ulnar fractures associated with distal radius fractures may not affect the clinical outcomes evaluated by Q-DASH score and Mayo Wrist score.
• However, distal radius fracture patients without distal ulnar fractures tend to have more wrist pain compared to other two groups.
• At the time of distal radius fractures, it is a well-known fact that ulnar side of the wrist also is likely to be injured. In our consideration, it should be evaluate the soft tissue injuries in the patients who have ulnar-sided wrist pain after bone healing.
AM Poster 155: Postoperative Pain is Correlated with Scaphoid Dorsal Translation Following Scapholunate Ligament Reconstruction

Category: Wrist

Hand and Wrist; Diseases and Disorders; General Principles
Level 4 Evidence

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Hypothesis
Dorsal scaphoid translation (DST) has been demonstrated to occur in patients with complete scapholunate interosseous ligament (SLIL) tears. We hypothesized that the presence of static DST can be used to predict patient post-operative outcomes of SLIL reconstruction.

Methods
A cohort of 14 patients scheduled to undergo SLIL reconstruction surgery were studied prospectively. Pre-operative data included radiographs (PA, lateral, and pencil grip PA views), self-reported measure of average pain on a numerical rating scale (NRS) of 0-10, and the Patient Rated Wrist Evaluation Survey (PRWE). Post-operatively, the same data were collected at each subsequent follow up. SL angle, RL angle, SL gap, and dorsal translation were measured for the pre-operative and the latest post-operative follow up radiographs. Each post-operative radiographic measurement was correlated with the post-operative NRS pain score. Each correlation was calculated using Spearman’s correlation coefficient, using an alpha value of p = 0.05. Mean NRS pain scores were compared using Wilcoxon rank-sum tests using an alpha value of p=0.05.

Results
The presence of post-operative dorsal scaphoid translation (DST) correlated very strongly (rho=0.88) with post-operative pain. SL angle (rho=0.07), RL angle (rho=0.03), and SL gap (rho=0.13) all showed no correlation with patient reported pain. DST, SL angle, and SL gap all showed no correlation with PRWE. There was a significant decrease in NRS pain scores after surgery (p<0.001).
Summary Points

- DST in post-operative radiographs has a strong correlation with patient reported pain outcomes following SLIL reconstruction.
- Scapholunate gap, scapholunate angle, and radiolunate angle showed no correlation with short-term pain outcomes.
- Further biomechanical studies are needed to assess which reconstructive techniques provide better correction of DST.

Bibliography

AM Poster 156: The Incidence of Complications After Volar Locking Plate Fixation of Distal Radius Fractures

Category: Wrist

Hand and Wrist; Elbow and Forearm

Level 4 Evidence

Alyssa Cook, BA
Paul Baldwin, MD
John Fowler, MD

Hypothesis
The null hypotheses are that there is no difference in the rates of post-ORIF FPL rupture between Soong grades and there is no difference in FPL rupture rate when comparing surgical training or plate designs.

Methods
A retrospective review was performed from January 2012 to December 2015. Subjects identified using CPT codes (25607, 25608, and 25609). Chart reviews were performed on 750 patients. Exclusion criteria were lack of VLP fixation, lack of post-operation follow-up, lack of available imaging and use of external fixation. Complications (tendon rupture, tenosynovitis, plate removal, CRPS, stiffness, persistent pain) were assessed at each post-operative visit. A hand-fellowship trained orthopaedic surgeon determined Soong grade. Data was collected on patients’ age, injury date, operation date, plate type, and gender. T, chi-square, Wilcoxon rank, Fischer exact tests and linear regression modeling between complications and non-complication groups with Bonferroni corrections along with odds ratios used to delineate significance between significant variables.

Results
A total of 522 subjects met inclusion criteria (361 females, 161 males). Patients with complications averaged 54 years of age compared to 52 years of age in patients without complications (p=0.31). Complication rates were not significantly different between genders. Flexor tenosynovitis was the most common complication (21%). No FPL ruptures occurred. Soong grades between patients with and without complications were not significantly different (p=0.53). Soong grades did not significantly differ between flexor tenosynovitus and other complications (p=0.07). The odds of flexor tenosynovitis occurring compared to other complications was higher if the orthopaedic surgeon was hand vs trauma trained (0.42 vs 0.06) or if the plate was from Acumed vs other plates (1.5 vs 0.15). Overall complication rates did not differ by surgeon type or plate design when modeled together.
Summary Points

- In this series of 522 distal radius fractures that underwent ORIF with VLP, there were no FPL ruptures.
- The lack of FPL ruptures in this large series may reflect improved plate design technology and increased awareness regarding this complication.
- Soong grade did not differ significantly between patient complication groups.
- Lack of significant difference in Soong grades may reflect difficulties in applying this system to a large patient database, to non-rupture tendinopathies or a need to factor in other demographic features.
- Hand surgeons had higher odds of flexor tenosynovitis vs other complications, possibly reflecting higher awareness of this complication or more complex cases.
- Differences in complications based on plate design may be related to which plates are used for more distal fracture patterns.

Bibliography

AM Poster 157: Characterization of the Dorsal Ulnar Corner in Distal Radius Fractures: Implications for Surgical Decision Making

Category: Wrist

Hand and Wrist; General Principles
Level 4 Evidence

Joseph Zimmer, MD
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Hypothesis
The dorsal ulnar corner of four part distal radius fractures constitutes a small but important component of the sigmoid notch and radiocarpal articular surface that may not be adequately captured with current surgical techniques.

Methods
After obtaining IRB approval, a retrospective review was conducted to identify post-menopausal patients with low energy distal radius fractures that were treated surgically. Patients with low energy injuries (defined as a fall from standing height or less than 5 feet) with pre-operative CT scans were included. Patients with injuries sustained from high energy trauma were excluded. The DICOM data from each CT scan was loaded into and analyzed with the Amira 5.0 3D reconstruction software program to visualize intra-articular fracture patterns and isolate fracture fragments. The dorsal ulnar corner fragment was isolated in each CT scan and measured (dorsal surface height and width; articular surface width and depth). Each measurement was then normalized to the patient’s lunate depth to control for variability in distal radius sizes. Measurements were plotted and compared to produce mean and standard deviation values for the dorsal ulnar corner fragment dimensions.

Results
A total of 22 patients met the inclusion criteria and each of their CT scans was analyzed. Average dimension measurements of the dorsal ulnar corner were: dorsal surface height: 13.80 ± 4.39mm; dorsal surface width: 11.02 ± 3.94 mm; articular surface width: 7.87 ± 4.14mm; articular surface depth: 4.90 ± 2.32 mm. All measurements were normalized by using the patients’ lunate depth measurement, which averaged 17.56 ± 1.44 mm. Normalized articular surface width was 0.44 ± 0.22 and depth 0.28 ± 0.14, expressed as ratios.
Summary Points

- The dorsal ulnar corner average less than 5 mm in depth of the articular surface and is less than 8 mm wide. This accounts for 28% of the volar-dorsal width of the distal radius at the lunate facet.
- Previous biomechanical studies of extra-articular fracture models have suggested that screws extending 75% of the articular surface depth are sufficient [1], however, our modeling suggests that, on average, this will not capture the dorsal ulnar corner.
- The data will improve understanding of the morphology and size of the dorsal ulnar corner fracture fragment, which is critical to understanding the optimal method of operative fixation.
- This information can also be used to develop more accurate distal radius intra-articular fracture models for biomechanical studies.

Bibliography

AM Poster 158: Do You Fix the Distal Ulnar Fracture with Distal Radius Fracture?

Category: Wrist

Hand and Wrist
Level 4 Evidence

Koshiro Shimasaki, MD
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Hypothesis
In our hospital, the treatment of distal ulnar fractures (DUF) is decided according to distal radius ulnar joint (DRUJ) instability test results after the internal fixation of distal radius fractures (DRF). Whether to choose surgical or non-surgical treatment methods for DUF associated with DRF is controversial, but we hypothesized that outcomes after non-surgical and surgical treatments of DUF are similar.

Methods
We enrolled 230 patients with 231 DRFs fixed with volar locking plates (VLP) between April 2012 and March 2017. The exclusion criteria were: only DRF without DUF, less than 6 months after surgery, and ulnar styloid fractures only. Finally, 26 patients were enrolled. After DRF fixation with VLP, instability at the DRUJs were examined, and we divided the patients into non-surgical group (group N), comprising patients without instability at the DRUJ, and surgical group (group S), comprising patients with instability at the DRUJ and fix it by several operative procedure. Ulnar variance (UV), volar tilt (VT), and radial inclination (RI) were measured in plain anteroposterior (AP) views using imaging software after the surgery and at the final observation. Ranges of motion (ROMs) and percentage of grip strength of the intact side were compared between the groups. Student’s t-test and Pearson’s Chi-square test were used for evaluation, with p<0.05 indicating statistical significance.

Results
Group N included 15 hands (average age of the patients 70.0 years; classification levels AO23-A:2 hands, B:1 hand, and C:12 hands; Biyani types 2,3,4:5 hands) and group S included 11 hands (average age of the patients 74.9 years; classification levels AO23-A:5 hands, and C:6 hands; Biyani types 1:1 hands, 2:2 hands, 3:1 hand, 4:7 hands).
Every patient ultimately achieved bone union. The average postoperative reduction losses in group N were 0.5 mm in UV, 1.2°in VT, and 2.7°in RI. The average ROMs at the wrists were 57°in
volar flexion, 56° in dorsal flexion, 87° in forearm pronation, 88° in forearm supination, and the grip strength intact percentage was 77%. In group S, the average reduction losses were 1.2 mm in UV, 0.9° in VT, and 0.7° in RI. The average ROMs at the wrists were 60° in volar flexion, 67° in dorsal flexion, 89° in forearm pronation and supination, and the grip strength intact ratio was 76%. Only dorsal flexion showed a significant difference (p=0.01)(Table1).

Summary Points
- There is no significant difference between group S and N when stability of the DRUJs after internal fixation of DRFs is achieved.
AM Poster 159: Avascular Necrosis of the Scaphoid-Preiser Disease: Functional Outcomes of 37 Cases

Category: Wrist

Hand and Wrist; Diseases and Disorders
Level 4 Evidence

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Hypothesis
There currently is no established treatment standard for patients with idiopathic avascular necrosis of the scaphoid, or Preiser Disease. The aim of this study was to evaluate our 30 year experience with operative interventions performed and subsequent outcomes for patients diagnosed with Preiser Disease.

Methods
A retrospective review of all patients diagnosed with Preiser Disease between 1987 and 2017 who underwent operative intervention was conducted. All patients had preoperative MRI confirming the diagnosis of avascular necrosis of the scaphoid. Post-operative functional outcomes were evaluated and Mayo wrist scores were collected.

Results
A total of 37 patients were identified, 24 were female and 13 were male. Mean age was 36 years at time of surgery, average follow up was 38 months. 21 patients underwent a revascularization procedure of which 18 had a vascularized bone graft (VBG) and 3 had a vascularized pedicle transfer. For vascularized bone graft, two patients underwent a medial femoral trochlea (MFT) flap, 14 patients underwent vascularized bone graft from the distal radius, two patients underwent non-distal radius vascularized bone graft (one pisiform, one hamate). The patient who underwent pisiform bone graft developed a nonunion requiring a 4CF. Five patients underwent scaphoidectomy with four-corner fusion (4CF). Six patients underwent proximal row carpectomy (PRC). Two patients underwent arthroscopic debridement only, two patients underwent iliac crest non-vascularized bone graft and one patient underwent proximal scaphoidectomy with silastic arthroplasty. The majority of patients in all groups reported no change or improvement in wrist pain compared with preoperative symptoms based on the Mayo Wrist score at final follow up. Functional outcomes were improved in the revascularization
group compared to the other procedures, with 95% returning to work compared to 69%, respectively.

Summary Points

- There lacks a treatment algorithm of Preiser disease and best surgical treatment remains controversial.
- This study concludes that successful revascularization may avoid the need for wrist salvage procedures and will allow patients to return to work.
- The results for vascularized articular grafts were not successful in this small series.

Bibliography

AM Poster 160: Does Splinting after Distal Radius Fracture Fixation Matter?: A Prospective Cohort Analysis of Post-Operative Plaster Splint Versus Soft Dressing

*Category: Wrist*

Hand and Wrist; General Principles; Practice Management

Level 2 Evidence

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Asif Ilyas, MD

**Hypothesis**
The effect of post-operative dressing and splinting after distal radius fracture (DRF) open reduction and internal fixation (ORIF) is not well understood. A prospective cohort analysis was performed to assess differences in functional and radiographic outcomes with use of plaster splinting or soft dressing following DRF ORIF. The hypothesis was that there would be no difference in outcome with type of splinting after DRF ORIF.

**Methods**
All patients undergoing DRF ORIF with locking volar plates were consecutively enrolled. Pre-operative demographic, and post-operative radiographic and functional outcomes were collected 2 weeks and 3 months post-operatively. Functional data included range of motion (ROM), pain on visual analog pain scale (VAS), Patient Rated Wrist Evaluation (PRWE), and Quick-DASH scores. Radiographic data included loss of fracture reduction.

**Results**
There were 139 patients enrolled (79 plaster splinting, 60 soft dressing). By the first post-operative visit (POV) there were 2 cases of loss of reduction with plaster splinting and 1 with soft dressing, but otherwise no difference in DASH, PRWE, or VAS pain scores. By the final POV, there were 2 cases of loss of reduction with plaster splinting and 3 with soft dressing. The soft dressing group showed an overall greater ROM in extension by 9.7, flexion by 10.9, and supination by 4.8 degrees over the plaster splint group. There were no statistically significant differences in PRWE or DASH scores at either POV’s, and only a minor improvement in VAS of 0.5 for the soft dressing group by the final POV.
Summary Points
The hypothesis was “essentially” upheld. Applying only a soft dressing following DRF ORIF demonstrated slight improvements in ROM and VAS by final follow-up, with no significant differences in functional outcomes or radiographic outcomes. No additional benefit for applying a plaster splint was identified. The use of a plaster splint after DRF ORIF should be re-considered due to its lack of clinical advantage and potentially increased time and cost of application.
AM Poster 161: Proximal Row Carpectomy with Resurfacing of Both Lunate Fossa and Proximal Capitate Using a Femoral Osteochondral Graft: A Case Report

Category: Wrist

Hand and Wrist; Diseases and Disorders
Level 5 Evidence

João Paulo Mussi
Rainer Andrea Falcone
Christophe Camps
Alexandre Durand, MD
Germain Pomares
Thomas Jager, MD

Hypothesis
The treatment of the panarthritic wrists in the young patients due to traumatic injuries is challenging even for experienced surgeons, especially when both lunate fossa and capitate head are committed with considerable arthritis being the most acceptable option is the total wrist fusion. We present a case-report of an alternative technique of proximal row carpectomy associated with a bifocal osteochondral graft to treat a SNAC wrist type IV in a young patient.

Methods
We performed in a 23 years-old male patient a proximal row carpectomy associated with a bifocal osteochondral graft from the lateral femoral condyle to resurface an important arthritic degeneration of both capitate head and lunate fossa due to a sequel of an open trans-styloid trans-scaphoid perilunate fracture-dissociation. Pre-operatively, he had 20kg of grip strength (50% compared with the contralateral side), 65 degrees of flexion-extension motion (35/30) and pain of intensitiy of 10/10 in the visual analogic scale.

Results
At the 18-month follow-up, the patient is pain-free with the 60 degrees of flexion-extension motion (30/30), 22kg of grip strength (61% when compared with the contra-lateral side), completely integrated graft and no signs of degeneration of the resurfaced area at this follow-up period.
Summary Points
We conclude that, despite being only one case, the resurface of the capitate head and lunate fossa by osteochondral graft can be an alternative for young patients with advanced arthritis preserving some motion of the wrist.

Bibliography
Hypothesis
Ulnolunate distance (ULD) is the principal parameter of ulnar impaction syndrome, which is one of the major causes of ulnar-sided wrist pain. Traditionally, the ulnolunate abutment has been thought to be aggravated by forearm pronation because of the increase in ulnar variance (UV) during pronation. However, pronation does not aggravate ulnolunate impaction in every person. We hypothesized that in three-dimensional (3D) space, the ULD might be greater in pronation because the ulnar head is dorsally translated.

Methods
Twenty-one three-dimensional reconstructions of computed tomographies (CTs) of wrists taken in supination and pronation were used. ULD was measured in each position by part comparison analysis, and ULD change from supination to pronation was calculated. UV change from supination to pronation and the amount of translation of the ulnar head (TUH) from supination to pronation were measured directly by superimposing reconstructions of the supinated wrist and the pronated wrist (Figs 1 and 2).

Results
The mean ULD in pronation (2.1 mm) was significantly greater than that in supination (1.7 mm) (p = 0.009). The mean ULD change from supination to pronation was 0.4 ± 0.6 mm. UV increased in 11 cases and decreased in 10 cases while changing from supination to pronation. The mean UV change from supination to pronation was 0.03 ± 0.6 mm. The mean amount of TUH from supination to pronation was 4.0 ± 2.2 mm. There was no significant correlation between the ULD change and the UV change. The ULD change had a significant positive linear relationship with the amount of TUH (Pearson’s correlation coefficient = 0.525, p = 0.014).
Summary Points
Our results can be summarized in three major findings.

• First, the mean ULD is greater in pronation than in supination.
• Second, the mean UV change is minimal during forearm rotation.
• Third, ULD change during forearm rotation is related to the amount of TUH rather than UV change.

Our study demonstrated that ULD change during forearm rotation is determined by the amount of TUH rather than by UV change. It may suggest that the TUH is a physiological mechanism which prevents ulnolunate impingement during pronation. In addition, our method of overlaying 3D reconstructions has the advantage that we can directly compare the positions of the ulna or the radius with respect to the other bone in different forearm rotations.

Bibliography
AM Poster 163: Prognostic Factors of Arthroscopic Debridement for Central Triangular Fibrocartilage Complex Tears in Active Young Adults

Category: Wrist

Hand and Wrist
Level 4 Evidence

Young Hak Roh, MD
Seok Woo Hong

Hypothesis
Although arthroscopic debridement is considered the treatment of choice for central triangular fibrocartilage complex (TFCC) lesions, there has been debate about the effectiveness of this procedure. We hypothesized that certain demographic, clinical, and radiologic features would be associated with unsatisfactory outcomes of the procedure.

Method
A total of 71 patients who had been arthroscopically diagnosed with central TFCC tears were treated with arthroscopic debridement. Demographic, and arthroscopic findings were examined and analyzed. The response to treatment, including pain numeric rating scale (NRS) on an ulnar provocation test, Disability of the Arm, Shoulder, and Hand (DASH) score, and satisfaction with treatment, was assessed at 12-month follow-up.

Results
The mean pain NRS (6.6 ± 3.6 to 2.4 ± 2.0, p < 0.01) and DASH (59.3 ± 15.0 to 33.7 ± 14.1, p < 0.01) scores exhibited significant clinical improvement at 12-month follow-up. In terms of satisfaction, 43 patients (70.5%) were satisfied (enthusiastic or satisfied) and 18 (29.5%) were dissatisfied (noncommittal or disappointed). In the satisfied group, there were 24 flap and 19 wearing tears, whereas in the dissatisfied group, there were 4 flap and 14 wearing tears (p = 0.02). The extent of ulnar plus variance on preoperative radiographs also differed between the two groups (0.5 ± 1.2 vs. 1.7 ± 1.1, p < 0.01). There were no significant differences in age, gender, hand dominance, or work level between the groups. After controlling for confounding variables, the wearing type tears (odds ratio [OR]: 3.4) and greater ulnar plus variance (OR: 2.0) were associated with a higher likelihood of dissatisfaction after arthroscopic TFCC debridement.
**Summary Points**

- Although clinical outcome scores showed significant improvement after arthroscopic debridement for central TFCC tears, wearing type tears and greater ulnar plus variance were associated with dissatisfaction and poor postoperative outcomes after the procedure.
- Knowledge of the factors that affect unsatisfactory outcomes may be used when discussing consent or making indication in patients for whom arthroscopic TFCC debridement is being considered.

**Bibliography**

AM Poster 164: Relationship Between Q-DASH Score and Mayo Wrist Score as Postoperative Evaluation in Distal Radius Fractures

Category: Wrist

Hand and Wrist
Level 4 Evidence

Nana Nagura
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Kiyohito Naito

Hypothesis
Postoperative evaluation in wrist injury is roughly divided into patient-reported outcome (PROs) and Clinician-reported outcome (CROs), but there is no clear criterion for which evaluation method to use. The study aimed to examine the relationship between Q-DASH score (PROs) and Mayo wrist score (CROs) as postoperative evaluation in distal radius fractures.

Methods
161 patients (male: 53, female: 108, mean age; 62.6 years) underwent surgical treatment for distal radius fractures with internal fixation by volar locking plates from June 2013 to May 2017 in our university. Q-DASH score and Mayo wrist score were assessed at final examination of follow up.

Results
Mean follow up periods was 10.4 months in this study. Mean Q-DASH score and Mayo wrist score were 9.5 ± 13.0, 93.1 ± 9.3 (the outcome was Excellent in 136, Good in 15, Fair in 6, Poor in 4), respectively. There was a significant correlation between Q-DASH score and Mayo wrist score (p < 0.0001, r = -0.8).

Summary Points
- In this study, Q-DASH score was correlated with the Mayo wrist score despite evaluation for the general upper limb function.
- The treatment outcome of distal radius fractures may not necessarily needed to evaluate by both Q-DASH score and Mayo wrist score, since range of motion of wrist and grip strength are inferred to greatly affect upper limb functions.
Hypothesis
Hand surgeons identify occult dorsal ganglion cysts (ODGCs) on MRI equally as often as radiologists. If the surgeon indicates the possible presence of a cyst when ordering an MRI then the radiologist is more likely to identify an ODGC.

Methods
We used procedural codes to retrospectively identify patients who may have had surgery for an ODGC from a single hand surgery center over a six year period. We further confirmed the diagnosis and treatment by chart review. Patients were excluded from the study if an MRI was either not taken or available for review. For each subject, the radiology report was reviewed to assess identification of the ODGC, and the hand surgeon’s clinic note was also reviewed to assess identification of the ODGC on the MRI. The MRI was also evaluated to determine whether the hand surgeon included “ganglion cyst” in the history in order to detect if this helped the radiologist see the ODGC. The dimensions of the ODGC were independently measured on the MRI. The estimated ODGC volume was calculated, and statistical analysis was performed to determine if the size of the ODGCs that were missed by the radiologist were significantly different than the ODGCs identified by the radiologist.

Results
After applying inclusion and exclusion criteria, a total of 25 patients and 26 MRIs were analyzed. The radiologist identified the ODGC in 20 of the 26 MRIs (77%), whereas the hand surgeon identified all the ODGCs. The surgeon indicated “ganglion cyst” when ordering an MRI in 13 of the 20 (65%) ODGCs that the radiologist identified and 2 of the 6 (33%) ODGCs the radiologist missed. The averages of the measurements of the ODGCs were: 0.81cm medial-lateral length, 0.68cm proximal-distal length, and 0.33cm anterior-posterior length. The average volume of the ODGCs was 0.25cm³. The volume of the ODGCs missed by radiologists were smaller on average than those the radiologists identified, although this was not considered statistically significant (0.05 +/- 0.06 cm³ vs. 0.31 +/- 0.3 cm³) (p<0.05).
Summary Points

• Radiologists may miss the presence of an occult ganglion cyst on an MRI of the wrist approximately ¼ of the time
• Smaller cysts are more frequently missed
• We recommend hand surgeons review all imaging in search for an occult ganglion cyst independently of the radiologist report
AM Poster 166: Distal Scaphoid Excision in Treatment of Symptomatic Scaphoid Non-Union: Systematic Review and Meta-Analysis

Category: Wrist

Hand and Wrist
Level 4 Evidence

Cory K. Mayfield
Daniel J. Gould, MD, PhD
Marie Dusch, MD
Amir Mostofi, MD

Hypothesis
Current treatment options for the management of persistent scaphoid nonunion are limited to salvage procedure that removes the entire proximal carpal row or scaphoid excision and partial wrist fusion. We hypothesized that distal scaphoid excision provides a simpler alternative with comparable functional and patient derived outcomes and a faster recovery without eliminating more extensive salvage procedures.

Methods
The MEDLINE and PubMed databases were searched for the use of distal scaphoid excision in scaphoid nonunions. We included studies that reported on either the functional or patient-centered outcomes following distal scaphoid excision for symptomatic scaphoid non-union. We excluded those with less than 6 months of follow-up, non-English studies, those without full-text available, those that performed distal scaphoid excision for the treatment of other conditions aside from symptomatic scaphoid non-union, those that utilized any form of wrist or carpal arthrodesis in conjunction with scaphoid excision, and those that did not provide individual patient data.

Results
Six articles described the outcomes of 70 patients with an average of 11.7 patients per study. Functional outcomes were assessed using flexion-extension arc, radial-ulnar deviation and grip strength. These measures improved by an average of 98.95%, 58.96% and 131.08%, respectively. Patient-derived outcomes included the Modified Mayo Wrist Score (MMWS), which improved by 92.6%, and the Distability of the Arm, Shoulder and Hand (DASH), which improved 137.17%. Complete relief of pain was found in 68.75% with 20.83% of patients experiencing pain with strenuous activity. The average postoperative Visual Analog Scale (0-10) was 0.71. 93.33% of patients were able to return to work with average time of return being 6.89
weeks. Complete satisfaction was reported by 87.80% of patients. Complications included progression into four corner fusion or PRC and newly developed midcarpal arthritis.

Summary Points

- Distal scaphoid excision for symptomatic scaphoid nonunions results significant improvement of functional outcomes including flexion-extension arc, radial-ulnar deviation and grip strength.
- Patient-derived outcomes including MMWS, DASH and VAS all demonstrated significant improvements from preoperative measurements.
- Current literature suggest that distal scaphoid excision may be a favorable, low-risk treatment for scaphoid nonunion without eliminating more extensive salvage options such as four corner fusion and proximal row carpectomy.
AM Poster 167: DeQuervain’s Tenosynovitis Release With Excision of the First Dorsal Compartment: Novel Surgical Technique and a Single Surgeon Case Series

Category: Wrist

Hand and Wrist; Diseases and Disorders; General Principles

Level 4 Evidence

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Michael Aversano, MD
Michael S. Guss, MD
Omri Ayalon, MD
Nader Paksima, DO, MPH

Hypothesis
Incision of the dorsal side of the tendon sheath in release of De Quervain’s (radial styloid) tenosynovitis has traditionally been advocated to prevent the risk of volar tendon subluxation. We describe a novel technique of complete excision of the first dorsal compartment tendon sheath. Additionally, we report on a case series of patients who underwent this first compartment excision. In contrast to simple incision, we propose that this technique provides a more definitive release of the compartment without risk of subluxation or bowstringing and provides a more complete release of a separate extensor pollicis brevis sub-sheath.

Methods
In this novel technique, after longitudinal incision of the first dorsal compartment sheath and examination for any sub-sheaths, the dorsal and volar ridges of the sheath are excised using sharp dissection. Post-operatively, no immobilization is used, and immediate motion is started. 80 patients (84 wrists) underwent surgical release of the first dorsal compartment for de Quervain’s tenosynovitis with this novel protocol over a four-year period from 2013 to 2017. Patients were followed up for an average of 4.5 months. Mean age at operation was 49 years. There were 66 females and 14 males. Records were assessed for any complications including reoperation, tendon subluxation, persistent pain, recurrence, wound complications, scar tenderness, and superficial radial sensory nerve injury. Finkelstein test and range of motion at final follow up were assessed.

Results
No patient had any recurrence, reoperation, or tendon subluxation after release with this technique. Persistent pain was noted in 7 patients (8.3%), scar tenderness in 6 (7.1%), and
superficial radial sensory nerve paresthesia in 1 (1.2%). Positive Finkelstein test was noted in 3 patients (3.6%) and mean range of motion was 71 degrees of flexion and 69 degrees of extension.

Summary Points
- Excision, in contrast to incision, of the first dorsal compartment sheath is a safe and effective technique for de Quervain's tenosynovitis release
- Patients who underwent complete excision of the sheath with no post operative immobilization had excellent outcomes with no recurrence and no additional surgeries
- Complete excision of the sheath is an effective technique for avoiding tendon subluxation and achieving complete release

Bibliography
Hypothesis
It has been suggested that de Quervain’s disease patients with a septated dorsal compartment may be more prone to failure of nonsurgical treatment. In light of this issue, we hypothesized that the prevalence of intracompartmental septation in the patients with de Quervain’s disease was higher than previously reported prevalence of the cadavers and lower than that of the patients who underwent surgery.

Methods
We performed ultrasonographic examination of 112 wrists from 103 consecutive patients (31 men, 72 women; age 18–81 years; mean age ± standard deviation 48.1±15.8 years) admitted to our clinic with de Quervain’s disease over the 4-year period. The sonographic appearance of the first dorsal compartment was evaluated on transverse images at the time of the initial diagnosis of de Quervain’s disease. If a hypoechogenic structure was visible between the APL and EPB tendons, then we classified it as an “intracompartmental septum-like structure”. To investigate the relationship between patient characteristics and subcompartmentalization of the first dorsal compartment, the prevalence of intracompartmental septum-like structures was compared between men and women, older (=40 years old) and younger (=39 years old) patients, and between pregnant or lactating women and the other patients using Chi-squared tests. The comparison between men and women was performed in two different populations; all the patients and the patients excluding pregnant or lactating women.

Results
There were 19 men and 44 women in the older age group, and 12 men and 28 women in the younger group. In total, the prevalence of intracompartmental septum in the patients with de Quervain’s disease was 61.6% (69/112). Of the 69 wrists with intracompartmental septum-like structure, 53 (76.8%) showed this structure completely through the level of radial styloid, and 16 (23.2%) showed it partially on the level of distal radial styloid, respectively. There were no
significant differences in the prevalence of dorsal compartment septation between any two groups categorized by patients’ demographics.

Summary Points

- The prevalence of intracompartmental septation in the patients with de Quervain’s disease was higher than previously reported prevalence of the cadavers and lower than that of the patients who underwent surgery.
- This result was consistent with the previous report that the patients with a septated dorsal compartment might be more liable to de Quervain’s disease and more prone to failure of nonsurgical treatment.
- The prevalence had no significant difference among patients’ demographics
AM Poster 169: Effects of Distal Scaphoid and Triquetrum Excision on the Range of Dart-Throwing and Circumduction Motion Motion and Midcarpal Instability after Radioscapholunate Fusion: A Biomechanical Study

Category: Wrist

Hand and Wrist
N/A - not a clinical study

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Hypothesis
Subsequent excisions of the distal scaphoid and triquetrum improve the range of wrist motion after radioscapholunate (RSL) fusion, but little is known about the kinematic effect on the dart-throwing and global circumduction motions. We hypothesized that these additional carpal excisions after RSL fusion could increase both dart-throwing and global circumduction motion without causing significant midcarpal instability in cadaver wrists.

Methods
Seven fresh-frozen cadaver upper extremities were mounted on a custom testing apparatus after isolation and axial preloading of the tendons of the flexor carpi radialis, flexor carpi ulnaris, extensor carpi radialis, and extensor carpi ulnaris. Sequential loadings of the flexor carpi ulnaris and extensor carpi radialis simulated the active dart-throwing motion, and passive circumferential loading produced the wrist circumduction motion. An electromagnetic tracking system was used to measure the range of wrist motion. All specimens were tested in four stages: intact, simulated RSL fusion, RSL fusion with distal scaphoid excision, and RSL fusion with excision of the distal scaphoid and total triquetrum. We evaluated the stability of the midcarpal joint by conducting passive mobility testing of the distal carpal row in the radial, volar, ulnar, and dorsal directions. The acquired data were analyzed statistically using analysis of variance and multiple comparison tests.
Results
After RSL fusion, the arc of the dart-throwing motion decreased to a mean of 46% of the baseline value; additional excision of the distal scaphoid and triquetrum increased the mean ranges to 50% and 62% of baseline, respectively (Table 1). The wrist circumduction motion was markedly diminished by RSL fusion, and increased after distal scaphoid and triquetrum excision (Table 2). Distal scaphoid excision significantly improved the range of wrist motion in the radial direction, while triquetrum excision significantly increased the wrist movement toward the ulnopalmar direction. The midcarpal stability was gradually decreased in each stage, but did not significantly differ between stages; no specimen showed midcarpal dislocation.

Summary Points
• Subsequent distal scaphoid and triquetrum excision after RSL fusion significantly improved both dart-throwing and circumduction motions in the experimental model.
• No significant midcarpal instability was observed in cadaver wrists that had undergone RSL fusion and distal scaphoid and triquetrum excision.

Bibliography
Hypothesis
Since proximal pole fractures of the scaphoid are frequently overlooked, the poor vascularity in the proximal pole fragment often leads to nonunion, and the indication for this treatment has not been well clarified. One of the established strategies to manage the scapho-lunate instability was the ARASL (Arthroscopic Reduction and Association of the Scaphoid and Lunate) Procedure. We hypothesized that ARASL technique with non-vascularized bone graft could manage the proximal pole scaphoid nonunion with considerable success.

Methods
Between 2012 and 2016, 21 consecutive patients with proximal pole scaphoid nonunion were treated with ARASL technique with Herbert-type screw, and a non-vascularized cancellous (distal radius) bone graft (Fig.1 and 2). The preoperative radiographs of were classified according to the Schernberg classification of the fracture site of the scaphoid, twenty-one cases were classified as type I fractures (most proximal), and two were type II. Avascular changes were recognized in the proximal pole in MRI or preoperative radiographs in four patients. There were eight patients with grade 1 and two patients with grade 2 scapholunate ligament injury according to arthroscopic Geissler’s classification. Functional outcomes were evaluated using DASH score, ROM, grip strength and the visual analog scale (VAS). Radiographic outcomes were focused on the DISI correction and union of fracture site. Patients lost to follow-up were excluded from our study.

Results
They were 6 males and 15 females aged from 19 to 55 years. Bone union was radiographically confirmed in 19 patients and the union time is 16 weeks (10-28 weeks). These 19 patients got significant improvement in the mean DASH score, visual analog scale pain score, grip strength and ROM. Two cases of failure were managed with revision surgery of four corner fusion and achieved union at the last follow-up.

Summary Points: Based on the average 3 years result from this study, our method of ARASL procedure with non-vascularized bone graft for scaphoid proximal pole nonunion obtained
satisfactory clinical and radiographic outcomes. Of note, ARASL technique is not appropriate for type III fracture because it is near the waist of scaphoid, which ARASL technique is not able to be performed.

**Bibliography**
AM Poster 171: Biomechanical Effects of Ulnar Rotational Deformity in a Monteggia Fracture-Dislocation Model

Category: Wrist

Hand and Wrist; Elbow and Forearm; Diseases and Disorders
N/A - not a clinical study
Grant received from: JSPS KAKENHI Grant JP17K18021

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Hypothesis
In the current biomechanical study, we hypothesized that rotational deformity of the proximal ulna decreases the range of forearm rotation and radial head stability in a Monteggia fracture-dislocation model.

Methods
We used five fresh cadaver upper limbs amputated above the elbow, preserving the ligaments around the elbow and the interosseous membranes. The limbs were solidly fixed on a customized jig. An electromagnetic tracking device was used to measure the three-dimensional coordinates of the radial head. We measured radial head displacement with a load of 20 N in the anterior direction in neutral forearm rotation and the range of maximum forearm rotation with a torque of 2 Nm. We simulated Monteggia fracture-dislocation by sectioning the annular ligament and performing an ulnar osteotomy. We produced various rotational deformities at the proximal one-third of the ulna (20º and 40º of pronation and supination). The radial head displacement ratio was calculated as the percentage of the radial head displacement relative to the radial head diameter. The displacement ratio was compared between specimens with an intact elbow and sectioned annular ligament for each ulnar rotational deformity. Finally, we analyzed the correlations between the range of forearm rotation and ulnar rotational deformity.

Results
The displacement ratio in specimens with a sectioned annular ligament was significantly greater than that with intact elbow, and we found significant increase of displacement ratio at 20º of pronation (27%, p<0.05) and 40º of supination (31%, p<0.01) in specimens with a sectioned
annular ligament than in specimens without ulnar deformity (Fig. 1a). The radial head was
displaced anteriorly with pronation deformity and laterally with supination deformity (Fig. 1b).
The range of forearm pronation and supination was significantly correlated with the magnitude
of ulnar rotational deformity (Fig. 2).

Summary Points
- In this Monteggia fracture-dislocation model, radial head instability was increased by
  ulnar rotational deformity.
- The radial head was significantly displaced in the anterior direction with ulnar pronation
  deformity and in the lateral direction with ulnar supination deformity.
- The magnitude of ulnar rotational deformity and restriction of forearm rotation motion
  were positively correlated.

Bibliography
1: Colaris JW, Oei S, Reijman M, Holscher H, Allema JH, Verhaar JA. Three-dimensional imaging of
children with severe limitation of pronation/supination after a both-bone forearm fracture. Arch
2: Tynan MC, Fornalski S, McMahon PJ, Utkan A, Green SA, Lee TQ. The effects of ulnar axial
3: Dumont CE, Thalmann R, Macy JC. The effect of rotational malunion of the radius and the ulna
4: Kim E, Moritomo H, Murase T, Masatomi T, Miyake J, Sugamoto K. Three-dimensional analysis
of acute plastic bowing deformity of ulna in radial head dislocation or radial shaft fracture using a
Y. Biomechanical study of isolated radial head dislocation. BMC Musculoskelet Disord. 2017 Nov
21;18(1):470.
AM Poster 172: Acute Scaphoid Fracture Fixation Using Two Headless Compression Screws

Category: Wrist

Hand and Wrist
Level 4 Evidence

Amanda L. Walsh, MD

Hypothesis
Single screw fixation may not provide adequate stability for complex, multidirectional motion in scaphoid fractures1,2,3. We assess the feasibility of two screw placement based on radiographic analysis and fracture healing.

Methods
This is a retrospective, consecutive case series of acute scaphoid fractures fixed with two screws. We utilized two 2.0 mm headless compression screws for internal fixation of acute scaphoid fractures to provide torsional control. In the coronal plane, the screws were placed along the central axis. In the sagittal plane, the screws were placed dorsal and volar to the central axis (figure 1). The guidewire for the volar screw is placed first which is the position limiting screw against the dorsal rim of the radius with wrist in flexion. The dorsal guidewire is placed approximately 3 mm away from the first. The screws are inserted simultaneously to avoid fracture gapping at the opposite end of the scaphoid. The definition of union was defined by absence of radiographic fracture line on scaphoid view and complete pain relief in the anatomic snuffbox. We measured radiographic parameters including scaphoid width, screw lengths and the distance between the two screws (GE Centricity Enterprise Viewer V3.0).

Results
There are 12 patients included in our case series. The average measured scaphoid width was 12.1 mm. The average distance between the two screws was 2.6 mm. The average lengths of the volar and dorsal screws are 22.1 mm and 19.6 mm, respectively. All patients achieved union and returned to pre-injury function. One proximal pole scaphoid fracture had propagation of fracture between the two screws during second screw insertion but healed uneventfully. The width of all the scaphoids were wide enough to accept two screws, and the fracture propagation did not occur for the waist fractures. The smallest scaphoid width was 10.7 mm with screw distance of 1.4 mm (Figure 2). There were no postoperative complications.
Summary Points

- There is sufficient scaphoid bone stock for placement of two headless compression screws and allow for fracture healing in our preliminary study.
- Depending on the size of the proximal fragment, surgeons should be cautious with the second screw insertion for potential fracture propagation.

Bibliography

AM Poster 173: Outcomes Evaluation of the Medial Femoral Trochlea Osteocartilagenous Flap for Reconstruction of the Proximal Lunate in Advanced Kienbock’s Disease

Category: Wrist

Hand and Wrist
Level 4 Evidence
Grant received from: Curtis National Hand Center Institutional Grant

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Hypothesis

We hypothesize that medial femoral trochlea osteocartilaginous free flap (MFT) reconstruction of the proximal lunate improves patient reported outcomes (PRO) and halts radiographic progression of carpal collapse in patients with advanced Kienbock’s disease, without significant detriment to wrist range of motion or patient-reported knee outcomes.

Methods

19 patients at a single institution who underwent MFT reconstruction for advanced Kienbock’s disease were evaluated. Mean age was 28 years (range 16-47). Preoperative Lichtman staging was 3A in 11 patients, and 3B in 8 patients. Suture anchor repair of a coronal split of the lunate was required for 15 patients. Follow-up data were recorded pre-operatively and at a minimum of 6 months (mean 21 months). Completeness of each patient’s data set varied by time point and outcome measure. However, post-operative patient reported outcomes measures were available in 15 patients (79%), including Disabilities of the Arm, Shoulder, and Hand (DASH) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores for assessment of the upper and lower extremity, respectively. Clinical examination data included range of motion and grip strength. Radiographic measures included radioscaphoid angle and carpal height ratio. Intergroup means were compared using a two-tailed student’s t-test.

Results

MFT reconstruction of the lunate resulted in a statistically significant improvement in mean DASH score (34 pre-op, 10 post-op, p=0.0003). WOMAC score increased from 0 to 5% (p=NS). Neither active wrist flexion (40 pre-op, 39 post-op), extension (43 pre-op, 38 post-op), nor grip strength (58 lbs pre-op, 54 post-op) were significantly impacted by the procedure.
Radioscaphoid angle (65 pre-op, 67 post-op) and carpal height ratio (0.47 pre-op, 0.47 post-op) were unchanged. Surgical complications included an extensor tendon rupture and cutaneous infection, each related to a lunotriquetral K-wire.

Summary
• MFT reconstruction of the lunate resulted in a significant improvement in DASH score over a mean follow-up of 21 months. The mean post-operative DASH score of 10 is low. There are no prior reports of upper extremity patient-reported outcomes for this procedure.
• Knee donor site morbidity, as measured by the WOMAC PRO instrument, is low at 5%.
• Radiographic progression of carpal collapse was halted by this procedure, as evidenced by stabilization of the radioscaphoid angle and carpal height ratio.
• No significant detrimental effect on range of motion was detected.
• MFT reconstruction is a reasonable option with good outcomes in young patients with advanced Kienbock’s disease.
AM Poster 174: Wrist Reduction Instruction with Simulation Technology (WRIST) Interdisciplinary Emergency Medicine and Orthopedic Surgery Experimental Study

Category: Wrist

Hand and Wrist
N/A - not a clinical study

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Hypothesis
Distal radius fractures account for one sixth of adult fractures and one third of pediatric fractures in Emergency Departments (ED). Prior studies have found that one third of distal radius fractures reduced in the ED are inadequately reduced. Use of distal radius fracture reduction simulation models has been demonstrated to improve performance with this procedure amongst novice orthopedic trainees. We hypothesized that we could improve distal radius fracture reduction performance by ED providers by developing and implementing an interdisciplinary simulation-based training intervention.

Methods
After obtaining IRB approval, 20 junior-level ED residents and advanced practice providers (each participant with less than 5 distal radius fracture reductions in clinical experience) were enrolled. Learner performance was objectively assessed using a commercial Colles' fracture simulator model and a mini-C arm by measuring angulation in the sagittal and coronal planes on fluoroscopic images of the post-reduction fracture. Subjects completed a first (baseline) simulated reduction and a second (repeat) simulated reduction without experimental instruction. The subjects then watched an instructional video that explained and demonstrated expert performance of a distal radius fracture reduction. Subsequently, the subjects performed a third simulated reduction. The mean differences in coronal and sagittal angulations from the degrees of post-reduction angulation considered acceptable for distal radius fractures (i.e., 10° dorsal angulation in the sagittal plane and 5° radial angulation in the coronal plane) were compared across the subjects' three reductions with a one-way ANOVA.
Results
The mean difference in radial angulation in the coronal plane from acceptable angulation (i.e., 5° radial angulation) was 17.4° for the first reduction, 12.9° for the second reduction, and 9.6° for the third reduction. The mean difference in dorsal angulation in the sagittal plane from acceptable angulation (i.e., 10° dorsal angulation) was 32.5° for the first reduction, 28.5° for the second reduction, and 14.8° for the third reduction. The subjects demonstrated improvements from baseline to third simulations of 7.7° (P=0.0813) and 17.7° (P=0.0004) in angulation in the coronal and sagittal planes, respectively (Figure 2).

Summary Points
• Subjects demonstrated improvements from baseline to third simulations of 7.7° (P=0.0813) and 17.7° (P=0.0004) towards acceptable post-reduction angulation in the coronal and sagittal planes, respectively.
• Results suggest that novice ED providers can improve their reduction skills with use of a Colles' fracture model and video didactic training from senior orthopedic clinicians.
• This study is the first experimental, interdisciplinary simulation-based fracture reduction training initiative between orthopedic surgery and emergency medicine.

Bibliography
Hypothesis
Our null hypothesis is that no factors are associated with unplanned reoperation after ulna shortening osteotomy (USO). Secondarily, we aimed to determine the rate and type of reoperation procedures, and to report on persistence of symptoms as mentioned at last clinical follow-up.

Methods
In this retrospective study, we included all patients older than 18 years of age who underwent an ulna shortening osteotomy at 2 level I trauma centers and 1 community hospital between January 2003 and December 2015. Medical records of patients were assessed for our explanatory variables, unplanned reoperations and reporting of symptoms. We used bivariate (Student t-test and Fisher’s exact test) and multivariable analyses to identify factors associated with unplanned reoperation after ulna shortening osteotomy.

Results
Among 94 patients who underwent 98 ulna shortening osteotomies, there were 34 unplanned reoperations (35%). Nineteen patients underwent removal of hardware (19%), 6 had a non-union (6.1%) and 9 patients (9.2%) underwent additional surgeries (Table 1). Surgery on their dominant limb (P=0.007), trauma (P=0.003) and prior surgery to the ipsilateral wrist (P=0.008) were associated with unplanned reoperation. In multivariable analysis, factors independently associated with unplanned reoperation were the dominant side being affected (odds ratio 3.9; 95% CI 1.36-11) and traumatic origin (odds ratio 3.4; 95% CI 1.1-11). Bivariate analysis identified younger age (P=0.0039) and prior surgery of the affected wrist (P=0.015) as factors associated with unplanned hardware removal. More operations for refixation due to non-union of the osteotomy were performed in patients with a transverse osteotomy compared to patients with an oblique osteotomy (P=0.018) (Table 2). At the final follow-up, 21 out of 94 patients (22%) reported persistent ulna-sided wrist pain.
Summary Points

- One in three patients will undergo an unplanned reoperation after ulna shortening osteotomy, most often due to hardware irritation or non-union of the osteotomy.
- Persistent ulnar sided wrist pain occurs in about 1 in 5 of patients, regardless of reoperation.
- Awareness of these factors may be helpful for pre-operative discussions and surgical decision-making.
AM Poster 176: A Comparative Study of Sauvé-Kapandji and Darrach Procedures for Post-Traumatic Conditions

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
1) There are no differences in long-term patient-reported functional outcomes between the Darrach and the Sauvé-Kapandji procedure for post-traumatic DRUJ dysfunction.
2) There are no differences in long-term patient-reported pain and satisfaction, radiographic outcomes, rate and types of reoperation between these two procedures.

Methods
All patients who underwent a Darrach (n=57; 67%) or Sauvé-Kapandji procedure (n=28; 33%) for post-traumatic DRUJ derangement at two level I trauma centers and one community hospital between January 2003 and December 2015 were included. Fifty-two patients (61%) were available for written correspondence or telephone interview to complete patient rated outcomes surveys at a median of 8.4 years after their procedure (IQR 3.4-12). Radiographic measurements consisted of ulnar distance, radio-ulnar distance and ulnar gap (only in Sauvé-Kapandji group) (Figure 1). Medical records were assessed for rate of unplanned reoperations and types of reoperation. Bivariate analysis (Student t-test and Mann-Whitney U Test) was performed to identify any association between our explanatory and our response variables.

Results
There were no significant differences in outcomes measured by PROMIS UE Physical Function, pain, or satisfaction between patients who had a Darrach procedure or a Sauvé-Kapandji procedure (Table 1). Radiographically, the mean post-operative ulnar distance was 18 ± 7.3mm after a Darrach procedure and 33 ± 6.3mm after a Sauvé-Kapandji procedure (Figure 1). The median radio-ulnar distance was 5.5mm (IQR 2.6-8.7) in the Darrach group and 8.4mm (IQR 7.2-11) in the Sauvé-Kapandji group. The average ulnar gap after a Sauvé-Kapandji procedure was 10 ± 3.5mm. A total of 20 patients (24%) underwent an unplanned reoperation (18% in Darrach group vs 36% in Sauvé-Kapandji group; P=0.10). Three patients who had a Darrach underwent revision to an Aptis DRUJ arthroplasty.
Summary Points

- Darrach and Sauvé-Kapandji procedure show comparable long-term patient reported outcomes in treatment of post-traumatic DRUJ dysfunction.
- Reoperation rate of both procedures is relatively high (18% vs 36%, P=0.10).
AM Poster 177: Risk Factors of Extensor Pollicis Longus Rupture after Distal Radius Fracture

Category: Wrist

Hand and Wrist
Level 3 Evidence

Youn-Tae Roh, MD
Il-Jung Park, MD, PhD

Hypothesis
A rupture of extensor pollicis longus tendon is a common complication that may occur after distal radius fracture. Knowing the risk factors will help prevent this complication.

Methods
We retrospectively reviewed 30 patients of extensor pollicis longus tendon rupture after distal radius fracture from February 2010 to March 2016. Three times more patients for the control group with matched sex, age and type of fracture without extensor pollicis longus tendon rupture were chosen during the same period. We statistically analyzed systemic risk factors of spontaneous tendon rupture, such as low bodyweight, diabetes mellitus, rheumatoid arthritis, thyroid disease, systemic steroid use, local steroid injection around wrist, quinolone, and statins.

Results
The incidence of extensor pollicis longus tendon rupture was significantly higher in the group of steroid use than in the control group. The use of steroid in patient with distal radius fracture may be a potential risk factor for extensor pollicis longus tendon rupture. Patients of distal radius fracture with steroid use need precaution if they have symptoms of extensor pollicis longus tendon rupture.

Summary Points
- We retrospectively reviewed 30 patients of extensor pollicis longus tendon rupture after distal radius fracture.
- Three times more patients for the control group with matched sex, age and type of fracture without extensor pollicis longus tendon rupture were chosen.
- The use of steroid in patient with distal radius fracture may be a potential risk factor for extensor pollicis longus tendon rupture.
- Patients of distal radius fracture with steroid use need precaution if they have symptoms of extensor pollicis longus tendon rupture.
Bibliography
AM Poster 178: Non-Operative Treatment of Distal Radius Fractures: A Biomechanical Comparison of Fiberglass Cast and 3D Printed Cast

Category: Wrist

Hand and Wrist
N/A - not a clinical study

Paul Hoogervorst

Hypothesis
New developments in 3-dimensional printing make it possible to fabricate a patient-specific cast to immobilize the fractured distal radius (Figure 1). These casts can be customized to the individual patient and are anatomically accurate. The recyclable nylon material is light and waterproof so patients can bathe and shower in them. This could improve patient satisfaction while maintaining the same immobilizing qualities.

This biomechanical study tests the hypothesis that 3D-printed short arm casts have similar immobilizing properties for a distal radius fracture compared to those of traditional fiberglass casts.

Methods
Flexor tendons of all cadaveric specimens were bundled and a 1cm dorsal wedge osteotomy of the distal radius was performed. The volar cortex was left intact simulating a 2-3 week old fracture. 16 paired specimens from 8 cadavers were casted using two 4-inch fiberglass cast (FC) rolls on one side and casted using the 3DPC on the contralateral specimen. A three-dimensional motion-tracking system (OptoTrak) was used to measure relative motion at the osteotomy site via markers embedded in both fracture elements.

All specimens were evaluated fluoroscopically on AP and lateral views before and after each round of mechanical testing. Normality was assessed using the Shapiro-Wilk test and the paired Student t-test was used for comparisons between the two groups.

Results
When comparing the mean difference for the radiological measurements before and after testing, no statistically significant differences were calculated between FC and the 3DPC groups (Table 1).

Motion of the fracture elements in relation to each other during flexion-extension testing ranged from 0.03-0.89mm and 0.09-1.09mm for FC and 3DPC respectively. Motion during pronation-supination testing ranged from 0.04-3.48mm and 0.07-2.22mm for the FC and 3DPC respectively. Lastly, motion during the 3-point bending test ranged from 0.01-0.83mm and 0.02-2.1mm for the FC and 3DPC respectively.
Only for the 3-point bending test a statistically significant difference (p = 0.037) between the FC and the 3DPC was found (Table 1).

**Summary Points**
- No statistically significant differences in radiological outcomes between fiberglass casts and 3D printed casts were identified.
- Only the mean difference in optically measured fracture motion during the 3-point bending test was found to be statistically significant (p = 0.037).
- The absolute motion of the fracture elements was minimal. 3D printed casts seem to have equal immobilization properties compared to traditional fiberglass casts.
- The results of the current study support future prospective randomized clinical trials comparing both casting techniques.
AM Poster 179: Evaluation of Computed Tomography Imaging in Patients with Extensor Pollicis Longus Tendon Rupture after Distal Radius Fracture

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
Although rupture of the extensor pollicis longus (EPL) tendon is a well-known complication after minimally displaced distal radius fractures (DRFs), the underlying mechanism is unclear. We hypothesized there are particular parameters of computed tomography (CT) imaging in patients with EPL tendon rupture after DRFs.

Methods
Since 2012 to 2015, we treated 7 consecutive patients with EPL tendon rupture after DRF (4 men and 3 women, mean age: 58 years). Duration from fracture onset to tendon rupture ranged 9 days to 9 weeks. All fractures were treated conservatively because of minimum fracture displacement (dorsal tilt of the radius ranged -3 to 13 degrees). All patients underwent CT examination of the injured wrist during the initial visit due to insufficiency of active extension of the affected thumb.

We recorded the distance between the fracture line and dorsal articular margin of the distal radius and whether there was a fracture fragment and callus formation around the Lister’s tubercle. We measured the height of the Lister’s tubercle and the depth and width of EPL groove. (Fig 1) Simple linear regression analysis was conducted to elucidate the association between the CT parameters and the duration between the tendon rupture and fracture onset.

Results
A fracture line passing the Lister’s tubercle was found in all of the 7 patients. Fracture fragment or callus formation at the 3rd extensor compartment was identified in four patients. The sagittal plane CT images revealed that the distance between the distal end of the radius and the fracture
line averaged 8 mm. The average height of Lister’s tubercle was 3.8 ± 1.3 mm, the depth of EPL groove averaged 1.4 ± 0.7 mm, and the width of EPL groove averaged 4.3 ± 1.4 mm. Linear regression analyses revealed that the depth of EPL groove had a significantly negative correlation with duration between the tendon rupture and fracture onset (R^2=0.68, p<0.05). The width of EPL groove had a positive correlation with the period of the tendon rupture following occurrence of the fracture (R^2=0.59, p<0.05).(Fig 2)

Summary Points
- We quantitatively investigated the relationship between onset of tendon rupture and CT parameters around the Lister’s tubercle.
- Increase of the EPL groove depth and decrease of the EPL groove width significantly corresponded with earlier onset of EPL tendon rupture.
- Despite a small number of patients, the present study may support the morphologic change of EPL groove and Lister’s tubercle to be contributing to the onset of EPL tendon rupture followin

Bibliography
2: Roth KM. Philip EB, Brandon EE et al., Incidence of extensor pollicis longus tendon rupture after nondisplaced distal radius fracture J Hand Surg 2012; 37A: 942-947
Hypothesis
Total wrist arthroplasty (TWA) has greater risk of perioperative complications, requires longer inpatient length of stay (LOS), and is more expensive than wrist fusion (WF).

Methods
This study screened 35 million hospital discharges between 2010 to 2014 using the National Inpatient Sample (NIS). The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes were used to identify patients who underwent WF (ICD 81.25) and TWA (ICD 81.73). Major and minor perioperative complications were identified using ICD-9-CM diagnosis codes. Mean cost and LOS were calculated and compared using the Kruskal Wallis H test. Univariate and multivariate logistic regression were employed to compare risks of complications, as well as the likelihood of high-end hospital charges and prolonged length of stay. High-end hospital charges and prolonged length of stay were defined as those greater than the 75th percentile of their respective means.

Results
We identified 845 patients who underwent WF and 298 patients who underwent TWA. Females comprised 42.3% of the WF sample and 68.4% of the TWA sample (p<0.001), with the mean patient age for the WF and TWA samples being 50.7 years (SD=17.81) and 62.3 years (SD=14.15), respectively (p<0.001). Osteoarthritis was the leading indication for both WF (24.1%, 204) and TWA (44.3%, 132; p<0.001). Patients who underwent TWA did not sustain any minor complications compared to 4.0% (34) of WF patients. A major complication was sustained by 11.4% (34) of TWA patients compared to 17.2% (145) of WF patients (p=0.018). Most major complications involved the implanted device, which was found in 8.4% (25) of TWA cases and 16.0% (135) of WF cases (p<0.001). Multivariate analysis revealed no differences in risk of major complications or complication of implant between procedures. The mean hospital charges for TWA were $18,512 (SD=9,336) compared to $15,306 (SD=9,645) for WF (p<0.001). Multivariate
analysis demonstrated that patients who underwent WF were less likely to have a high-end hospital charge compared to TWA patients (OR=0.223, 95% CI=0.151-0.327). Furthermore, the LOS for patients who underwent TWA was 2.02 days (SD=1.90) compared to 1.95 days (SD=1.71) for WF patients (p=0.845). Multivariate analysis revealed that there was no difference between the two procedures with regards to prolonged LOS.

**Summary Points**
- Major and minor complications occur significantly more frequently following WF than TWA, but adjusted risk analyses demonstrated no differences in complications between the two procedures.
- TWA was considerably more expensive than WF.
- TWA and WF have similar LOS.

**Bibliography**
AM Poster 181: A Comparison of Radiographic Outcomes between Three-Dimensional Preoperative Planning and Conventional Planning in the Osteosynthesis of Distal Radius Fractures

Category: Wrist

Hand and Wrist; Elbow and Forearm
Level 2 Evidence

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Hypothesis
To assess the usefulness of three-dimensional (3D) digital pre-operative planning, we compared the radiographic parameters of the distal radius from 3D planning and conventional planning after osteosynthesis of distal radius fractures. We hypothesized that the use of 3D digital planning may improve radiographic outcomes for reduction and decrease the risk of correction loss.

Methods
Twenty-eight wrists were treated with 3D preoperative planning as the plan group. Another twenty-eight wrists were treated with conventional preoperative planning as the control group. Both groups were treated with volar locking plates. The patients were randomly divided into two groups according to the order of hospital visits. In the plan group, 3D digital preoperative planning and a surgical simulation were performed in order to determine the reduction and placement of the implants in addition to the plate/screw size prior to surgery (Figure 1). In the control group, preoperative planning was performed using conventional posterior-anterior and lateral views of the radiographs. Ulnar variance, volar tilt, and radial inclination were measured after surgery and compared with healthy side wrist. Intra-class correlation coefficients (ICC) of radiographic parameters, i.e., radial inclination, ulnar variance, between operated and healthy side wrists were evaluated at one week, three and six months after surgery. In addition, loss of corrections for radiographic parameters were compared between plan and control groups. The loss of corrections were defined as the differences between the measurements at one week and the measurements at three or six months.
Results
The results of correlations are shown in Table 1. Both groups showed significant correlations for the ulnar variance at all periods of follow-up. There were significant correlations for the volar tilt in the plan group after one week and three months. There were significant correlations for the radial inclination in the plan group for all periods of follow-up. The ICCs were higher in the plan group compared to the control group at all time points. The loss of corrections for ulnar variance were smaller in the plan group compared to the control group (P values were 0.04 and 0.05 for three and six months after surgery). There were no significant differences between the plan and control groups in the loss of correction for the radial inclination and the volar tilt.

Summary Points
• 3D preoperative planning offers better reduction accuracy and reduces correction loss of ulnar variance in the osteosynthesis of distal radius fractures.
Hypothesis
Although volar locked plating (VLP) of distal radius (DR) fractures is common, complications remain a considerable concern for upper extremity specialists using modern techniques.

Methods
Complications following VLP of DR fractures were collected prospectively from 8/1/2005 to 3/1/2017. Inclusion criteria were DR fractures treated with a VLP, documented post-operative complication, and a minimum three months of follow up. Exclusion criteria were skeletal immaturity, initial treatment by an outside provider, non-operative or operative management other than VLP, and history of prior ipsilateral DR fracture.

Available radiographs were reviewed; fractures were characterized using the AO classification. Chart review revealed demographic data, mechanism of injury, comorbidities, and complication treatment. Each complication was categorized and described by severity. Severe complications required operative treatment and/or resulted in permanent impairment, moderate complications required non-operative treatment and ultimately resolved, and mild complications resolved without intervention. In patients with multiple complications, all were reported. However, overall severity was defined by the single complication (primary) with the highest severity.

A review of available current procedural terminology (CPT) data for uncomplicated operative distal radius treatment was performed in order to calculate an overall complication rate. This data was restricted to 2/1/2007 and 3/1/2017 due to limitations in the CPT recording system.

Results
37 patients (27 females; 39 radii) suffered from 72 complications following VLP (Figure 1). The rate of complicated VLP from 2/1/2007 to 3/1/2017 was 12.9% (36/278).
For those with complications, mean age was 48.5 ± 13.5 years (range: 19 to 78 years) and mean follow up was 13.7 ± 9.0 months (range: 3 to 36 months). Radiographic union occurred at an average of 77.4 ± 38.4 days (range: 31 to 195 days). A majority (28/39 – 71.8%) had type C fractures (Table Ia).

The most common complications were hardware requiring removal (18) and malunion (6). There were only three tendon ruptures. There were 25 unplanned returns to the operating room in 24 radii (22 patients). The most common of these procedures was removal of hardware (18). Patients with severe complications were more likely to have AO type C fractures and had longer follow up (Table Ib) than those with mild/moderate complications.

**Summary Points**
- Modern VLP of DR fractures has a complication rate of 12.9%.
- Hardware requiring removal is currently the most notable complication of VLP.
- Tendon rupture has become a rare event with modern techniques.
- AO type C fractures are more likely to result in severe complications.

**Bibliography**
AM Poster 183: Measurement of the Distance Between the Volar Aspect of the Radial Metaphysis and the Lunate Rotation Center on a Lateral View X-Ray of the Wrist

*Category:* Wrist

Hand and Wrist
N/A - not a clinical study

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**Hypothesis**
The relation between the lunate and the volar cortex of the radial shaft is an index of radiocarpal instability after volar displacement of an intraarticular comminuted fracture of the distal radius. A line extending along the volar aspect of the radial metaphysis is considered to roughly bisect the radial articular surface and the lunate. However, detailed measurement study has not been reported. We measured the distance between a line extending along the volar aspect of the distal radial diaphysis and the lunate rotation center on a lateral view X-ray of the wrist.

**Methods**
A total of 91 lateral wrist radiographs of adults aged 16-92 years were randomly extracted from the medical records of our institution for the period 2010 to 2017. Fractures, osteoarthritis, tumors, and rheumatoid arthritis were excluded. A lateral wrist radiograph was defined by the pisoscapheocapitate relationship, in which the palmar cortex of the pisiform should lie between the anterior surface of the distal pole of the scaphoid and the capitate. Three points on the proximal articular surface of the lunate were randomly selected and the center of a circle passing through the 3 points was defined as the lunate rotation center. A line parallel to the axis of the distal radius was drawn along the volar aspect of the distal third of the radial diaphysis. We measured the distance between the lunate rotation center and the extended line along the volar aspect of the radius. A lunate center posterior to the line was expressed as a minus value and a center anterior to the line was expressed as a plus value. Data were expressed as the mean±standard error.
Results
The mean age was 56.7±2.1 years old. Of the 91 wrists, 35 were men and 56 were women; 44 were right side and 47 were left side. Most of the lunate rotation center was located at the center of the distal articular surface. The distance between the lunate rotation center and a line extending along the volar aspect of the distal diaphysis of the radius was 0.13±0.15 mm.

Summary Points
- Most of the lunate rotation center was located at the center of the distal articular surface.
- The lunate rotation center was approximately on a line extending along the volar aspect of the distal radial diaphysis.

Bibliography
Hypothesis
De Quervain’s disease, a common pathology of the first dorsal compartment of the wrist, involves the abductor pollicis longus (APL) and extensor pollicis brevis (EPB) tendons. Especially, an EPB subcompartment has been suggested to be associated with refractory symptoms in the patients with intracompartamental septum (reference 1-3). Our hypothesis was that de Quervain’s disease patients with intracompartamental septum showed sonographic abnormality in EPB subcompartment rather than APL subcompartment.

Methods
Over a three year period, 89 wrists of 80 consecutive patients clinically diagnosed with de Quervain’s disease in our clinic were recruited. Previous diagnosis and/or treatment of these pathologies in other institute were excluded. Sonographic study was performed immediately after the physical examination using software from the Avius ultrasound system (Hitachi-Medico Co. Japan). Sonographic evaluation was focused on the first dorsal compartment in the longitudinal and transverse images. Images were created on a display showing a side-by-side comparison of the right and left forearm for viewing the same position. All physical examination and sonographic evaluation were performed by a senior hand surgeon with 16 years of experience in surgery and 5 years of experience in ultrasound. All patients were diagnosed as de Quervain’s disease if they met the following clinical findings. (1) pain over the radial aspect of the wrist, and tenderness on the radial styloid process, (2) a positive Eichoff’s test.

Results
Fifty three of 89 wrists showed intracompartamental septum between APL and EPB. Of the 53 wrists with intracompartamental septum, 44 showed this structure completely through the level of radial styloid, and 9 showed it partially on the level of distal radial styloid, respectively. Twenty-one of the 53 wrists showed intrasheath and/or peritendinous hypervascularity of APL subcompartment, and 41 of the 53 wrists did that of EPB subcompartment, respectively. Twenty-five of the 53 wrists showed the thickening of the extensor retinaculum of APL subcompartment,
and 52 of the 53 wrists did that of EPB subcompartment, respectively. All the 36 wrists without intracompartmental septum-like structure showed the thickening of extensor retinaculum, and 27 of them showed intrasheath and/or peritendinous hypervascularity.

Summary Points
- Majority of the patients with intracompartment septum (98%) showed the sonographic abnormality of EPB subcompartment. However, substantial number also showed that of APL subcompartment (47%).
- De Quervain’s disease patient did not always show hypervascularity on Doppler sonography.
- It is safer to consider not only EPB but also APL subcompartment as an object for surgical release or corticosteroid injection.

Bibliography
Hypothesis
Although a shared decision-making model is emphasized for patient-centered care, patients experiencing an acute trauma may have limited time and resource for their involvement in the decision-making and may encounter decisional conflict. The purpose of this study was to evaluate whether a decision aid can reduce decisional conflict in patients undergoing plate fixation for a distal radius fracture (DRF) and to investigate factors that may affect the decisional conflict.

Methods
We prospectively enrolled 46 patients who presented with an acute DRF and chose to undergo plate fixation. We randomized these patients into two groups. The test group was given a decision aid in addition to regular information and the control group regular information only. The decision aid consisted of the purpose, procedure and effect of the surgery, the precautions and complications after the operation, and other treatment options that can be performed when the operation is not performed. We compared decisional conflict scale (DCS) and satisfaction in the decision-making for surgery between the two groups at 2 weeks after surgery. In addition, we evaluated factors that may affect the decisional conflict, such as age, dominant hand, comorbidities, fracture severity, and administration of a decision aid.

Results
The test group showed significantly lower DCS (18.2 vs. 22.6, P = 0.005) than the control group. Satisfaction in the decision-making was not significantly different between the two groups. In the multivariate analysis for factors affecting the DCS, younger age and administration of a decision aid were independently associated with better DCS.
Summary Points

- A decision aid is proposed to provide information and to involve patients more comfortably in the decision-making process.
- This study demonstrates that a decision aid can reduce decisional conflict in patients undergoing plate fixation for a DRF, although it may not increase satisfaction in their decision-making.
- As older patients have higher decisional conflict in the decision-making for surgery, they might benefit with administration of a decision aid.

Bibliography

Hypothesis
Intra-articular fragments less than 15 mm height of volar aspect of the lunate facet are at risk for loss of fixation after volar locking plate fixation for the volar Barton fractures. We hypothesized that volar marginal rim fragments (VMR) are observed in other types of intra-articular fractures of the distal radius. We attempt to classify the fragments and investigated the incidence of VMR. Additionally, we evaluated the sizes of the fragments.

Methods
Eighty cases of the distal radius intra-articular fractures treated operatively were enrolled in this study. According to the Medoff's classification, the volar rim fragments locating within the volar articular surface of the distal radius and including the ulno-volar corner were detected on plain radiograph and computed tomography. Additionally, we defined the maximum depth of VMR as half depth of the sigmoid notch. All cases were classified under the AO classification. At the same, the cases classified into volarly displaced group (i.e. AO type B3 and volarly displaced AO type C) and dorsally displaced group (i.e. dorsally displaced AO type C). The incidences of VMR were calculated for each type of fracture and compared among each type of fracture statistically (Fisher's exact test, p<0.05). The sizes of fragments were measured on plain radiograph and the rate of VMR less than 15 mm height was calculated.

Results
VMR fragments were observed in 14 cases of all cases (18%). Among 8 cases of AO type B3, 3 cases of VMR was observed (38%). Among 71 cases of AO type C, 11 cases of VMR was observed (16%). There was no significant difference in the incidence of VMR between AO type B3 and type C fracture (p=.145). Among 20 cases of the volarly displaced group, 10 cases of VMR were observed (50%). Among 59 cases of the dorsally displaced group, 4 cases of VMR were observed (5.2%). The volarly displaced group had higher incidence rate of VMR than dorsally displaced group (p=.42×10-6). VMR has average 9.1mm of width (from 6.3 to 12.6mm), 7.1mm...
of height (from 2.5 to 18.2mm), and 7.9mm of depth (from 2.2 to 11.4mm). Thirteen fragments for all VMR cases were less than 15 mm height (93%).

Summary Points
- VMR were observed in both the volar Barton fractures and the volarly displaced complete intra-articular fractures.
- Some cases of VMR were observed in the dorsally displaced complete intra-articular fractures.
- VMR were typically small height and at risk for loss of fixation.

Bibliography
AM Poster 187: Results with a Three-Ligament Tenodesis Versus a Scapholunate and Intercarpal Ligamentoplasty

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
To compare clinical and radiological results of patients with chronic scapholunate dissociation treated with a three-ligament tenodesis (3LT) versus a scapholunate and intercarpal ligamentoplasty (SLICL).

Methods
20 patients with a mean age of 43 years were treated with a 3LT procedure and 26 patients with a mean age of 44 years with a SLICL procedure. All patients presented chronic reducible scapholunate dissociation in the absence of chondral lesions. The two groups of patients were operated on by senior surgeons, at the same facility, in two different periods of time. All patients were evaluated (pain, motion, strength, function, X-rays) with a mean follow-up of 28 months (12-49) in the 3LT group and 36 months (12-54) in the SLICL group.

Results
In the both groups, we found a significant improvement in pain levels, grip strength and functional scores (DASH and PRWE). The SLICL group reported significantly less pain and greater grip strength when compared with the 3LT group. Patients in the SLICL group had a more notable improvement in their DASH and PRWE scores. The mean range of motion in flexion-extension was 82° (102.5° preoperative) in the 3LT group and 113° (115° preoperative) in the SLICL group. In the 3LT, we did not note a significant improvement of the mean static and dynamic scapholunate gap (3.6 and 4.8 mm postoperatively versus 3.9 and 4.9 mm preoperatively), as well as the scapholunate angle (75° versus 72°). In the SLICL group, we noted a significant improvement of the mean static and dynamic gap (2.3 and 3.0 mm postoperatively versus 3.2 and 4.6 mm preoperatively), as well as the angle (62° versus 73°). In the 3LT group, 4 patients had developed osteoarthritis.
Summary Points
The SLICL procedure for scapholunate ligament reconstruction compared with the 3LT technique had better clinical and radiological preliminary results.

Bibliography
Hypothesis
Patients who consume opioids before surgery and smokers will report less pain relief after ulnar shortening osteotomy (USO). USO for idiopathic UIS compared with USO for positive UV after distal radius fracture (DRF) provide similar pain relief.

Methods:
Sixty-nine patients with UIS were analyzed preoperatively and after USO. Data included demographics, social history, radiographic parameters, osteotomy site, concomitant injury and repair of TFCC. Pearson correlation analyzed continuous variables, Student t-test determined difference in pain between dichotomous variables.

Results:
DETERMINANTS OF PAIN BEFORE SURGERY:
- Male patients, dominant side, worker’s compensation and smokers had significantly more pain at baseline.
- Among patients with UIS after DRF less volar tilt correlated with more pain.
- The following factors were not associated with increased pain before surgery: BMI, Age, opioid use, Ulnar Variance, Radial Inclination, Radial Height, type of diagnosis (Idiopathic versus DRF), TFCC injury and Type of TFCC injury.
- Predictors of pain relief after ulnar shortening osteotomy
- Opioid use before surgery, workers compensation patients, smokers demonstrated less pain relief after USO
- TFCC repair and classic diaphyseal osteotomy demonstrated less pain relief
- Preoperative UV and amount of shortening correlated with pain relief after USO. This correlation was present for patients with idiopathic UIS and patients after DRF
The following factors were not associated with pain relief after USO: Age, BMI, postop UV, gender, Diagnosis (UIS versus after DRF), TFCC injury.

Summary Points
Preoperative Variables:
- Smokers, patients involved in worker’s compensation and patients with complaint on the dominant side have higher pain scores at baseline
- The only radiographic parameter that correlated with increased pain in patients with UIS after DRF was volar tilt
- UV did not correlate with pain. This reflects a binary relationship between UV and UIS: positive UV may cause of UIS but more positive UV doesn't necessarily cause more pain.
- Postoperative Variables:
  - Patients that used opioids on daily basis before surgery, smokers and worker’s compensation patients had significantly less pain relief after USO. To optimize results, patients should be heavily counseled to stop smoking and to reduce intake or eliminate opioids before surgery
  - TFCC repair had a detrimental effect on pain relief. Patients that required TFCC repair may have more severe disease. However, most TFCC injuries in UIS are degenerative; therefore, repairing them may not provide benefit in UIS.
  - Metaphyseal osteotomy patients reported more pain relief than diaphyseal osteotomy
  - Pain relief was similar in patients with idiopathic UIS and patients with positive UV after DRF
Hypothesis
Untreated scaphoid fracture nonunion often leads to radiocarpal joint arthrosis with management based on the vascularity of the proximal fragment. In the scaphoid nonunion with an avascular proximal pole, traditional bone grafting and internal fixation often leads to fibrous union or persistent nonunion. Several techniques for vascularized bone grafting of avascular scaphoid nonunion (ASN) have been described, including free vascularized bone grafts and other short vascular pedicles incapable of restoring anatomic osseous alignment in the presence of humpback deformity. We describe an alternative technique for treating ASN. Through a single incision a radial pedicled vascular graft supplied by the 1,2 intercompartmental supraretinacular artery is positioned volarly, providing a strut to eliminate flexed collapse of the nonunion. We hypothesize that this approach can be advantageous for scaphoid nonunion presenting with osteonecrosis, humpback-type deformity that requires volar wedge grafting, and in cases when intraoperative visualization reveals an avascular proximal pole despite preoperative MRI.

Methods
A short-term retrospective review was performed for 45 patients with ASN confirmed with MRI or documented intra-operative observation. Patients were not excluded if they had previous surgical intervention or evidence of humpback deformity. All patients had preoperative radiographic evaluation using plain x-ray and MRI with and without contrast as well as intra-operative confirmation of avascular pole. Patients were followed up to one year with radiographs taken at each visit. Patient characteristics, time to union (estimated secondary to timing intervals of office visits), outcomes, and complications were analyzed.

Results
Forty-three (96%) patients healed at a mean of 13 weeks. Complications include one pin tract infection resolved successfully with oral antibiotics and transient dysesthesia of the radial sensory nerve in four patients which resolved spontaneously by three months. In four cases, CT scans were required to confirm bony union. Of the two patients who remained unhealed, one
had visible non-union between the graft and the avascular proximal pole. The second graft was extruded from its position within the scaphoid. Both eventually underwent proximal row carpectomy. Two additional patients had persistent pain with progression of radiocarpal arthritis.

Summary Points
- This technique provides predictably good results for the management of avascular scaphoid fracture nonunion.
- Notable advantages include performance through a single incision, employment of an already established vascularized bone graft, no requirement for microvascular free graft reconstruction, and the ability to adjust intraoperatively in the event of unexpected avascularity without requiring an extended operative time or additional equipment.
AM Poster 190: The Limitation of the Fixation of the Tiny Fragment of the Lunate Fossa with a Single Volar Locking Plate in the Distal Radius Marginal Fractures

Category: Wrist

Hand and Wrist
N/A - not a clinical study

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Hypothesis
In the distal radius marginal fractures, the osteosynthesis of the lunate fossa fragment (LF) is an important process, but the size of the fragment that can be fixed with the volar locking plate (VLP) alone has not been demonstrated so far. We demonstrate the limitation of the fixation with the VLP alone for the marginal fractures with different shapes by using three-dimensional computer-assisted design (3D-CAD).

Methods
We made seven bone models with different anatomy and three locking plates: Biomet DVR (plate D), Acumed Aculoc distal (plate A), and Medartis ADAPTIVE 2 (plate M). To specify each bone, the prominence of the volar rim in sagittal plane was digitalized as volar offset (VO). The models of the plate were made by scanning them with screws mounted. In the 3D-CAD, the plate was installed on the bone just below the watershed line. If the screws protruded intraarticularly, the plate was moved until the screws did not protrude where the plate was applied at the most distal installable position. After the 3 plates placement to all bones, we measured the distance of volar cortex between the screw insertion site and the articular surface in the sagittal plane as the fragment length (FL), which indicated the smallest bone fragment size that could be fixed. We also measured the volar protrusion of the plate (VP) from the bone.
Results
The average VO was 9.3 mm. Intraarticular screw protrusion occurred when plate D was installed on bones with VO greater than 9 mm. The screw protrusion was resolved when the plate was relocated more proximally (FL > 9.8 mm). In plates A and M, protrusion did not occur and FL was > 7.1 mm. In plates A and M, bones with VO > 8mm showed VP of more than 2 mm.

Summary Points
- These results demonstrated bone fragments less than 9.8 mm cannot be fixed with a proximal VLP, and fixation of bone fragments measuring 7.0 mm or less is impossible with the VLP alone.
- This study also clarified the problem of plate installation caused by the differences in bone anatomy; The screws tend to protrude intraarticularly when applying the plate distally on the bone with large volar rim. Moreover, protrusion of the VLP, which can cause flexor tendon irritation, should be carefully examined when fixing bones with a small volar rim.
Hypothesis
Recurrence rates of 6% and 21% have been reported for arthroscopic excision and open excision, respectively. This study aimed to determine the distribution of wrist ganglia and reoperation rate along with factors associated with reoperation.

Methods
We retrospectively identified patients that had a ganglion excision of the wrist at one institutional system using Current Procedural Terminology codes. All adult patients that were treated between 2002 and 2016 at a single institutional system were included. A medical chart review was conducted to collect demographic information and treatment outcomes. A reoperation was defined as a repeated excision of a ganglion that occurred in the same location as the prior ganglion. We included 1124 patients with a mean age of 41.1±14.5 years. Of the 1124 patients, 346 were men. Most patients were treated with open excision (n=1096) compared to arthroscopic excision (n=28). To identify factors associated with reoperation we performed a bivariate analysis. The patients that underwent reoperation after open excision were matched to controls in a 1:2 manner based on age, race, sex, and location of ganglion.

Results
There were 435 ganglia located in the volar wrist, 656 located in the dorsal wrist, and 33 were in diffuse locations within the wrist. The overall reoperation rate was 3.4%. The reoperation rate for volar arthroscopic excisions was found to be 3.6%, while the reoperation rate for volar open excisions was 3.7%. While there were no reoperations for dorsal arthroscopic excisions, the reoperation rate for dorsal open excisions was 3.2%. There were not enough arthroscopic excisions for adequate statistical comparison. The entire cohort was followed for a median of 7.7 years (IQR: 4.3-11.7). Patients who had undergone an arthroscopic excision were followed for a median of 6.4 years (IQR: 3.3-10.6). The most common postoperative complication was pain. Other complications consisted of immediate recurrence, swelling, and numbness.
Summary Points

- Recurrence rate of ganglion excision at 7 years is about 3%.
- The most common complication is persistent wrist pain.

Bibliography

AM Poster 192: DIC Ligament Injuries in Patients With SL Dissociation

Category: Wrist

Hand and Wrist Level 3 Evidence

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Hypothesis
There is limited data on the role of MRI imaging and secondary scapholunate (SL) stabilizers, as our understanding of SL injury primarily comes from in vitro studies (1-5). We tested the primary null hypothesis that there is no association between DIC or DRC ligament injury and a SL distance of 2 mm or greater on MRI. In addition, we aimed to report the prevalence of DIC and DRC ligament injury in patients with SL dissociation on MRI.

Methods
We performed a retrospective search of our database containing all encounters from two level I trauma centers and 1 community hospital in an urban city in the USA between 2002-2015 to identify patients who underwent an MRI scan of the wrist after trauma, and who were diagnosed with a SL ligament injury based on the MRI. We performed a pilot study with 31 MRI’s to determine the required sample size a priori and determined that we needed a total of 90 inclusions for this study.

We recorded basic demographic data, and two attending fellowship-trained musculoskeletal radiologists reviewed the MRI scans on a picture archiving and communications system and evaluated the wrist for SL widening, and evaluated the integrity of the SL ligament, dorsal intercarpal (DIC) ligament, and dorsal radiocarpal ligament (DRC) by consensus. They graded the ligament integrity as normal, low-grade injury (sprain or partial tear), or full-thickness tear. We used bivariate analysis to identify the association between static SL diastasis and demographic characteristics, DIC-, or DRC injury.

Results
Of the 90 patients we assessed, 48 patients (53%) had an SL-distance of 2 mm or greater on MRI. Of the 48 patients with this static SL dissociation, 28 (58%) had a partial or total tear of their DIC or DRC (Table 1). Patients with static SL dissociation on MRI scans were older than patients without (median age 52 vs 42 years, table 1).
Patients with static SL diastasis have DIC ligament injury on MRI scan more often than patients without static SL diastasis (31% vs 12%; table 1). This was also the case for the DRC ligament: compared to patients without static SL diastasis, more patients with SL diastasis had injury of their DRC ligament (52% vs 14%; table 1).

**Summary Points**

- The dorsal extrinsic ligament is more frequently injured in patients with static SL diastasis.
- MRI can be used to delineate dorsal extrinsic ligament injury, and may have direct application for clinical management.

**Bibliography**

Hypothesis
The purpose of this study was to determine the patient and injury factors that are predictive of functional outcomes after volar locking plate (VLP) fixation of distal radius fractures (DRF), as defined by the Patient-Rated Wrist Evaluation (PRWE). Patient characteristics that were hypothesized to be predictive of higher (worse) PRWE scores were: tobacco use, diabetes, hyperlipidemia, psychiatric diagnosis, pain syndrome, workers’ compensation, and higher demand occupation.

Methods
This study involved 394 patients (aged 16-87) who underwent VLP for DRF. Total PRWE scores (range 0-100; lower is better) were collected prospectively with three-month postoperative scores considered final follow up. Three month PRWE scores were used to categorize patients into “Good” (top 10%), “Intermediate,” or “Poor” (bottom 10%) final outcome groups. A chart review was performed to identify all of the patient and injury factors outlined in the previous section, that were predictive of outcome.

One-way Anova was used to analyze the relationships of the continuous variables to the PRWE scores categorized as Good, Intermediate, and Poor. Chi-square was used to analyze the relationships of the non-parametric variables to the PRWE scores. A P value of less than 0.05 was used to define statistical significance in all analyses. A Bonferroni correction for multiple comparisons was used.

Results
The mean age of the study cohort was 56 years. Mean PRWE score was 0 for the Good group, 19 for the Intermediate group, and 77 for the Poor group (P<0.001). Number of hand therapy visits and psychiatric diagnosis showed statistical significance and were predictive of a Poor PRWE.
score (P<0.001, P<0.001). While age and BMI were statistically significant across the three groups (P=0.03, P=0.03), there was no clinical significance.

Summary Points
- Out of all the patient factors that were analyzed, only a greater number of hand therapy visits and having one or more psychiatric diagnoses were predictive of a Poor PRWE score.
- When considering psychiatric diagnosis, the difference in scores was both statistically and clinically significant and should be considered when counseling patients with a mental health diagnosis about expectations after VLP for DRF, and adequate support in the perioperative period.

Bibliography
Hypothesis
The purpose of this study was to evaluate the radiographic, functional, and clinical outcomes of patients with scaphoid malunion, at a minimum of 4 years post-injury.

Methods
All patients with malunited scaphoid fractures who presented to our institution between November 2005 to November 2013, inclusive, were identified and contacted. In total, 41 patients completed four different validated patient rated outcome questionnaires (8 females: 33 males). The average age was 36 years (range: 16-73) and the average time to follow up was 7.6 years (range: 4 – 11.8). A short-arm thumb spica cast was used to treat 36 patients and 5 required surgical management.

A subset of this group, comprised of 22 patients (4 females:18 males), also underwent clinical testing and CT imaging. The average age of this group was 41 years (range: 16-64), and the average time to follow up was 7.3 years (range: 4.4-11.8). A short-arm thumb spica cast was used to treat 20 of these patients and 2 required surgical management. Each subject’s health record, radiographs, and CT scans were reviewed and patients with a scaphoid height-to-length ratio (H/L) greater than 0.6 on the most recent CT imaging were deemed eligible for our study.

Results
Patient-rated outcome questionnaires showed minimal pain and disability and did not correlate with malunion severity (p = 0.20-0.54). Within this subgroup, there was no significant difference between injured and uninjured wrists in terms of range of motion (flexion p = 0.66, extension p = 0.48, radial deviation p = 0.36, ulnar deviation p = 0.30) or grip strength (p=0.84). Radiographic follow-up demonstrated Kellegren-Lawrence grade 1 arthritic changes at the radial styloid, scaphoid fossa, or scapho-trapezio-trapezoidal joints in 11 patients. There was no significant
correlation between the degree of scaphoid malunion and the radiographic development of arthritis.

**Summary Points**

- Patients with malunited scaphoid fractures demonstrated radiographic changes compatible with mild early arthritis on CT imaging but overall good clinical results on midterm follow-up.
- We could not demonstrate a correlation between the severity of scaphoid malunion and any of the measured outcomes thereby questioning the significance of a malunion in a united scaphoid at mid-term follow-up.
- Long-term cohort studies with complete follow-up are required to determine the long-term effects of malunion in this population.

**Bibliography**

Hypothesis
Distal radius fracture (DRF) is one of fragility fractures caused by falling down. Sarcopenia is an age-related decline in skeletal muscle mass as well as muscle function. We hypothesized that the patients with DRF would have decreased in the skeletal muscle mass.

Methods
We prospectively enrolled consecutive patients with DRF resulting from a low-energy fall. Fractures due to high-energy injuries were excluded. We also excluded patients who had systemic diseases causing muscle atrophy. Forty-nine consecutive patients from 54 to 88 years with DRF are enrolled. The body mass index (BMI), serum 25-hydroxyvitamin D (25 (OH) D) were investigated. They also underwent dual-energy x-ray absorptiometry (DXA) scans of the whole body. Body composition was analysed using DXA analysis software. The bone mineral density (BMD) of the lumbar spine and hip were determined by DXA. Skeletal muscle index (SMI) was calculated as appendicular skeletal muscle mass (ASM) divided by the square of the height (kg/m2). Additionally, the SMI of the legs was calculated. Reference values for class 1 and class 2 sarcopenia were defined as values 1 and 2 SD below the sex-specific means of the study reference data for young adults aged 18 - 40 years.

Results
Table 1 showed the physical characteristics and BMD in this study. Age were 70.3 ± 10.0 years, BMI were 21.4 ± 4.0 kg/m2, 25 (OH) D were 17.6 ± 8.5 ng/ml. The BMD of lumber spine and hip were 0.68 ± 0.14 g/cm2 and 0.53 ± 0.12 g/cm2. The young adult mean of BMD of lumber and hip were 66.8 % and 66.9 %. Table 2 showed the total SMI and leg SMI in this study. The total SMI were 5.80 ± 9.9 kg/m2 (-1.48 SD), and leg SMI were 4.36 ± 0.77 kg/m2.
Summary Points

- The BMI were normal. The 25 (OH) D level were low to be deficiency.
- The BMD of lumber spine and hip were low and they were diagnosed as osteoporosis.
- The total SMI were declined and they were diagnosed class 1 sarcopenia. The leg SMI of this study were as low as that reported of patients with hip fracture.
- It is necessary for the patients with DRF to reduce the risk of falling down and to prevent secondary fracture by oral intake of vitamin D and appropriate exercise.
AM Poster 197: How Well do Teardrop Angle and Anteroposterior Distance Measure Volar Lunate Facet Displacement after Distal Radius Fracture and Volar Plate Fixation?

Category: Wrist

Hand and Wrist
Level 4 Evidence
Grant received from: AO trauma research grant

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Sjoerd Meijer
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Hypothesis
In distal radius fractures and operated distal radius: (1) Do teardrop angle and anteroposterior (AP) distance correlate with overall volar lunate facet displacement measured in a 3D model? (2) Do teardrop angle and AP distance correlate with (a) proximal-distal displacement, (b) ventral-dorsal displacement, (c) radial-ulnar displacement of the volar lunate facet? (3) Do teardrop angle and AP distance correlate with gap surface area in a 3D model, and gap, and step-off measured on sagittal CT scans?

Methods
We included 36 patients with a distal radius fracture with a separate volar lunate facet fragment on CT scan who were also treated with a volar locking plate. All patients had post-fracture and post-surgery radiographs and CT scans available. On radiographs we determined the teardrop angle and anteroposterior distance. On digital 3D models, created from the CT scans, we measured proximal-distal, dorsal-volar and ulnar-radial displacement of the volar lunate facet fragment and calculated the overall vector displacement. We also outlined the gap and calculated its surface area. On CT scans we measured sagittal step-off and gap with the arc method. We used Pearson correlations to compare continuous variables. Apriori power analysis indicated that a sample of 35 participants would provide 80% statistical power, with alpha set at 0.05, to find a correlation of 0.46 or higher.
Results
Teardrop angle, and AP distance measured on radiographs were not associated with overall 3D displacement of the volar lunate facet. Greater teardrop angle after fracture was associated with greater distal (r 0.49, P=0.0025) and volar (r 0.54, P=0.0007) displacement of the volar lunate facet, but not after surgery. After surgery greater AP distance was associated with greater surface area of the articular gap (r=0.65, P<0.001), greater CT sagittal step-off (r=0.36, P=0.031) and gap (r=0.61, P<0.001).

Summary Points
• After injury, teardrop angle is associated with volar lunate facet displacement, but not after surgery.
• Increased AP distance is mainly associated with articular incongruity after volar plate fixation.
• This knowledge can potentially reduce the number of CT scans pre-operatively, is useful in low resource settings and during follow-up.
AM Poster 198: Evaluating Outcomes Following Open Distal Radius Fractures

Category: Wrist

Hand and Wrist; General Principles
Level 4 Evidence

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Hypothesis:
The majority of open distal radius fractures are low energy injuries with minimal soft tissue contamination and can be treated with a single irrigation and debridement combined with definitive fixation.

Methods
We performed a retrospective review of all open fractures of the distal radius treated at single Level 1 trauma center over a 10 year period. Inclusion criteria were patients >18 years with open fracture of distal radius. Exclusion criteria included polytrauma, transfers from outside hospitals with previous surgical procedures, ipsilateral arm fractures, and periprosthetic fractures. The primary outcome measure was the number of minor vs. major complications. The demographic and clinical characteristics of patients across treatment and outcome groups were compared using Fisher’s exact test. Fishers exact test and logistic regression models were used to describe the relationships between outcome and treatment. Firth’s likelihood approach was used in the logistic regression analysis, adjusting for potential confounding factors.

Results
90 patients were identified with a mean age of 59 years. High (50%) and low (50%) energy injuries were evenly distributed. 61 (67%) of fractures were Gustillo I, 19 (22%) Gustillo II and 10 (11%) Gustillo III. The majority of fractures were intra-articular (53% Type C). Most fractures underwent definitive ORIF 67 (74%). Twelve (13%) underwent definitive external fixation, 8 (9%) staged external fixation and 3 (4%) CRPP. Mechanism of injury and type of treatment were the only variables shown to be associated with an increased rate of complications. Patients sustaining high energy injuries had a significantly greater incidence of major complications vs. those sustaining ground level falls (p=0.01). A higher incidence of both major and minor complications was seen in patients undergoing definitive external fixation and staged external fixation vs. definitive ORIF (p=0.001). No association was found between complications and Gustillo-Anderson classification, age, gender, antibiotic choice...
or comorbidities. Regression analysis demonstrated that healthier patients (i.e. lower CCI) had a higher rate of definitive operative fixation (CCI 0-83% vs. CCI 4-7 61% (p=0.02)), however, no association was found between age, mechanism of injury, Gustillo-Anderson Classification or AO classification on the treatment selected.

Summary Points

- Mechanism of injury (high energy) and type of fixation (definitive ex-fix or staged ex-fix) were the only independent variables associated with a higher complication rate
- Gustilo-Anderson classification was not associated with a higher rate of complications.
- Open distal radius fractures can be safely treated by a single stage irrigation and debridement with definitive open reduction and internal fixation.

Bibliography

Hypothesis
Preiser’s disease treatment is still much discussed and not well established. The purpose of this study was to examine the outcomes of vascularized bone grafts (VBGs) from the distal radius with external fixation for the treatment of Preiser’s disease.

Methods
Seven patients with Preiser’s disease who underwent VBGs surgery based on the 1,2 intercompartmental supraretinacular artery, were placed in an external fixator for 10 weeks after grafting. Diagnosis was based on radiographic findings of sclerosis, fragmentation, and scaphoid collapse in the absence of any clear antecedent trauma. The initial diagnosis was stage I, II avascular necrosis by Herbert scale in one case, stage III in two cases, stage IV in three cases. All patients underwent preoperative magnetic resonance imaging (MRI) scans that confirmed the diagnosis of avascular necrosis of the scaphoid. The average patient age was 53 years old and the mean follow-up period was 28 months. Postoperative evaluations included a pain evaluation (visual analogue scale), X-ray, MRI, disability of the arm, shoulder and hand (DASH) evaluation, and modified Mayo wrist scoring.

Results
There was a significant improvement in mean visual analogue scale pain scores from 67 to 12. The average DASH score also improved from 27.81 to 8.51. Six MRIs showed evidence of revascularization, with improvement T1 or T2 signal. However, MRIs in stage IV was incomplete revascularization of the proximal pole. Two patients were rated as excellent, 3 as good, 2 as fair and poor by modified Mayo wrist scoring.
Summary Points

- The clinical results of 6 cases in VBGs with external fixation were satisfactory. Mean visual analogue scale and DASH scores also significantly improved.
- VBGs with external fixation are an efficacious treatment for in Preiser’s disease and are thus a recommended surgical treatment.
- Herbert stage IV avascular necrosis should be considered another option like osteochondral flap.

Bibliography

AM Poster 200: Prevalence of the Absence of the Palmaris Longus Tendon in the Brazilian Population

Category: Wrist
Hand and Wrist; Congenital and Pediatric Problems
Level 4 Evidence

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Hypothesis
The prevalence of absence of the long palmar tendon in a multiracial population is the same as that reported in uniracial populations

Methods
We performed a single cross-sectional study with a sample size of 564 volunteers (298 males and 266 females), ageing from 18-65 years. They were clinically assessed for the absence of palmaris longus tendon by Schaeffer’s and Thompson's tests bilaterally.

Results
The prevalence of absence of the long palmar tendon in the volunteers was 23.8% (134 volunteers). The unilateral absence occurred in 68 (12.0%) volunteers and bilateral absence in 66 volunteers (11.7%). There was no statically significant association between gender or laterality and the prevalence of absence of palmaris longus tendon (p>0,05)

Summary Points
- Palmaris longus tendon have been used as a graft source in tendinous reconstruction surgeries in the upper limb
- Palmaris longus tendon have been used in surgeries of tendon transfers surgeries in the upper limb
- The literature shows a great anatomical variation.
Bibliography
AM Poster 201: Distal Radius Fracture – Postoperative Pain as the Predictor for the One-Year Subjective Outcome

Category: Wrist

Grant received from: Local hospital grants (region Skane, Sweden)

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Hypothesis
For most patients with distal radial fracture the outcome is good but 15-20 % have suboptimal subjective results as long as one year after the injury (1). The aim of this study was to identify early factors predicting poor outcome, to be able to prevent complications before they become manifest.

Methods
At our hospital, all patients with distal radius fractures >18 years are prospectively registered since 2002 and one year after the injury a subjective outcome questionnaire (quick-DASH) is distributed. Between 2003-2012, an additional questionnaire was sent to patients 18-65 years after the first weeks regarding socioeconomic background, previous pain experience and how the present injury was perceived. The two questionnaires were merged and analyzed by regression analysis using Matlab and SPSS.

Results
Using a linear model, approximately 30 % of the outcome was explained by the predictors. The self-evaluated pain level at the time of injury was by far the single best predictor of the one-year qDASH outcome. Patients with high early pain levels had higher risk of scoring high qDASH. When dividing the qDASH responses into either pain or function, the pain level seemed to be the best predictor in both categories. Other factors such as comorbidities and education level had minor impact on the outcome.

Summary Points
- The level of pain experienced by the patient the first weeks after the fracture seems to be the most important factor to predict a high qDASH-score at one year.
- Identification of patients with early pain and early intervention appears important.
The results of this study will be used for early intervention in patients with high initial pain levels.

Bibliography
AM Poster 202: Arthroscopically Assisted Bone Grafting Reduces Time to Healing of Stable Scaphoid Non-Unions Compared to Percutaneous Screw Fixation Alone

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
Minimally invasive techniques have been recently advocated for stable scaphoid non-unions without humpback deformity, regardless the presence of cystic formations or nonunion interface < 10 mm. The purpose of this study was to determine whether arthroscopic treatment gave superior results in healing as compared to percutaneous screw fixation alone.

Methods
164 consecutive patients with scaphoid non-union were retrospectively analyzed. 5 patients received treatment with vascular grafting. 143 patients were treated with open grafting either from iliac bone or from distal radius, leaving 16 patients treated with minimally invasive techniques. The Mini Acutrak headless fully threaded compression screw system of Acumed, (Hillsboro, Oregon, USA) was used in all cases. The approach was volar in the percutaneous and dorsal in the arthroscopically assisted technique.

Healing was assessed clinically and radiographically at the minimum of 12 weeks follow-up (range 4-56 weeks). In the group treated percutaneously (n=8), the mean time from injury to operative treatment was 2.3 months (range 2 – 4 months) and it was 27.3 months (range 3-180 months) in the group treated arthroscopically (n=8). All patients were men except one women in the percutaneous group. The mean age was 42.5 years in the group treated percutaneously, 22 years in the arthroscopically treated group, (range 20-66) and (range 16-32), respectively. Data were calculated with two-tailed Mann-Whitney U test based on associated p-value of p<0.05 which was considered statistically significant.
Results
There were no recorded complications in any of the groups. All patients treated arthroscopically received simultaneously cancellous bone grafting from Listers tubercle of the radius bone and they all healed at mean of 7.8 weeks (range 5-18). The percutaneous technique we used was without bone grafting. One patient in the percutaneous group did not achieve bony healing and was planned for re-operation with the open grafting technique but declined further treatment. The remaining 7 patients healed at mean of 10.8 weeks (range 7-24). Mann Whitney U test showed the U value of 11, the critical value of U to be 13 (p<0.05) and therefore significantly faster healing in the arthroscopically treated group.

Summary Points
- Despite shorter time from injury to operation in the percutaneous group, arthroscopically treated patients achieved faster healing.
- Local bone grafting may be considered as the main reason for the difference in the healing outcome.
- Younger population age in the arthroscopically treated group could influence the result.
AM Poster 203: Predictors of Non-Union Following an Acute Fracture of the Scaphoid

Category: Wrist

Hand and Wrist
Level 3 Evidence

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Hypothesis
Non-union following a fracture of the scaphoid can be a significant cause of morbidity in a young and active population. Although proposed risk factors for non-union have been put forward in the literature, the current data is somewhat limited. The aim of this study was to identify risk factors for non-union following a fracture of the scaphoid.

Methods
We identified 286 patients from two one-year prospective trauma databases who sustained an acute fracture of the scaphoid. There were 24 patients who had inadequate follow-up data, leaving a total of 262 (92%) patients for analysis. Demographic data, time to presentation, management, complications and subsequent surgeries were noted. We recorded all potential predisposing factors including chronic medical co-morbidities, alcohol excess, smoking, fracture classification and radiographic markers for displacement on initial injury radiographs. The main outcome measure was non-union which was defined as absence of trabeculae crossing at the fracture site with a persistent fracture gap and tenderness at 12-16 weeks post injury.

Results
Of the 262 patients who sustained an acute fracture of the scaphoid, the mean age was 33 years (range, 13-87), 117 (67.6%) were male and 85 (32.4%) were female. The most common fracture type was the Herbert type B2 waist fracture (n=70, 26.7%). The overall number of type A injuries was 127 (48.4%), with type B accounting for 135 (51.3%) fractures. There were 58 (22.1%) fractures displaced >1mm. There were 42 (16%) patients who underwent acute primary fixation, with 16 (6.1%) managed with acute open reduction internal fixation and 29 (11.1%) with percutaneous fixation. Union occurred in 240 (91.6%) patients, with non-union diagnosed in 22
(8.4%) patients. Risk factors for non-union were male gender (11.3% vs 2.4%; p=0.016), smoking (15.8% vs 5.6%; p=0.023), Herbert type B3 proximal pole fractures (46.7%; p<0.001), an increased radiolunate angle (p=0.007) and a delay to treatment (p=0.013). Multivariate binary logistic regression analysis identified Herbert B3 proximal pole fractures (p=0.01) and an increased time to treatment (p=0.02) as independent predictors of non-union.

Summary Points

- Non-union rate for acute scaphoid fractures of just under 10% is consistent with the literature
- Almost 1 in 2 proximal pole fractures develop non-union, with a delay to definitive management also predictive of non-union
- Prompt and appropriate management of these injuries is essential and further work is needed to see if union rates could be improved with early operative intervention in those patients at increased risk of non-union
Hypothesis
Early percutaneous screw fixation is increasingly used to manage acute scaphoid fractures as it provides a quicker return to work and sports, but little is known about the long-term subjective outcomes following surgery. The aim of this study was to report the long-term outcomes and complication rates following early percutaneous fixation of acute fractures of the scaphoid.

Methods
A prospective trauma database was searched to identify all skeletally-mature patients with scaphoid fractures managed with early percutaneous fixation over a thirteen-year period from 1997-2010. Medical records were retrospectively reviewed and complications documented. Long-term follow-up was by a questionnaire based telephone review. The Patient-Reported Wrist Evaluation (PRWE) was the primary outcome measure. Secondary outcomes included subjective ratings of pain, stiffness and satisfaction, the Quick Disability of the Arm, Shoulder and Hand (QuickDASH) instrument, and the EuroQol EQ-5D-5L questionnaire as a standardised measure of general health status.

Results
116 patients (88% male) with a mean age of 28.5 years (range, 15-62) at time of injury were identified. Thirteen patients (11%) had an identified complication during their recovery, with twelve patients requiring further surgical intervention. Six patients developed a non-union, with 3 patients having persistent non-union despite further with ORIF and bone grafting. Six patients had a prominent symptomatic screw that was either subsequently removed or one that underwent early revision. There was an association between mechanism of injury and development of a complication (p=0.007), with higher than expected rates of falls from height in the complication group. At a mean follow-up of 9.9 years (range, 6.4-19.0; n=50 currently), six patients (12%) reported persistent pain in their wrist with a mean VAS score of 0.6/10. Stiffness
was more prevalent at 24%. Ninety-six percent of patients were satisfied with their wrist, with a median satisfaction rating of 10/10 (completely satisfied). The mean PRWE score was 7.4 ±14.6 (range, 0.0-84.5) and mean QuickDASH score was 3.6 ±7.8 (range, 0.0-45.0). The median EQ-5D-5L impairment index value was 1.000 (no impairment), and the mean self-perceived global health rating (EQ-VAS) was 82/100.

Summary Points
- Patients managed with early percutaneous fixation of acute scaphoid fractures report excellent long-term subjective outcomes with minimal persistent pain, low complication rates and high satisfaction
- The long-term outcomes are comparable to other management approaches but offer a quicker return to work and sport
AM Poster 205: Non-Bridging External Fixation vs. Volar Locked Plating for Distal Radial Fracture Fixation

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
Non-bridging external fixation (NBEF) and volar locked plating (VLP) are recognised techniques in the management of distal radial fractures, but with no comparative data currently available. The aim of this study was to compare the early complications, and the longer-term functional outcomes, of NBEF versus VLP for fractures of the distal radius.

Methods
We identified from a prospective database all patients with a fracture of the distal radius managed using either NBEF or VLP. Partial articular fractures and intra-articular fractures requiring open reduction were excluded. Demographic data, fracture classification, management, complications and subsequent surgeries were recorded. The primary short-term outcome measure was complications, determined using a combination of prospective and retrospective note review. The primary long-term functional outcome measure was the Patient Rated Wrist Evaluation (PRWE).

Results
There were 202 patients with a mean age of 58yrs (17-88) and 160 (79%) were female. A fall from standing height accounted for 82% (n=165) of all injuries, with one or more co-morbidities in 53% (n=106) patients and a mean BMI of 25 (15-39). There were 139 (69%) OTA type-A fractures and 63 (31%) a type-C. There were 156 patients who underwent NBEF and 46 VLP. The overall rate of complications was comparable between the two groups (32.1% NBEF vs 17.4% VLP; p=0.053), with the higher rate for NBEF associated with an increased rate of superficial infection (19.2% vs 0%; p<0.001). Neurological complications were more frequent following VLP (8.7% vs 1.3%; p=0.029), with the majority (n=5) acute carpal tunnel syndrome. At
a mean of four years (3.6-4.6; n=88) post injury there was no significant difference in the PRWE (p=0.252), QuickDASH (p=0.444), or overall satisfaction (p=0.105) between the two groups.

Summary Points

- NBEF and VLP have a comparable complication rate following distal radius fracture fixation, with superficial pin site infection associated with NBEF and neurological complications more frequent following VLP
- In the longer term there is no patient reported functional advantage for either technique
- Given the increased costs associated with VLP and with no longer-term advantage found, NBEF may be a more cost-effective option for managing these fractures
Hypothesis
Arthroscopic repair of triangular fibrocartilage complex (TFCC) lesions would yield better outcomes, in terms of patient reported outcomes and clinical data, as compared to open repair or debridement of TFCC lesions.

Methods
The PubMed and EMBASE databases were queried for all articles with the term “triangular fibrocartilage complex” or “TFCC” in the title. All studies that presented patient reported outcomes or clinical data as it related to specific types of surgical repair (ie. debridement, open, or arthroscopic repair) were included into the study. Data was collected from Disability of the Arm, Shoulder, and Hand scores (DASH), pain visual analog scale (VAS), modified mayo wrist scores (MMWS), range of motion (ROM), and grip strength. Weighted averages were calculated from the continuous data.

Results
A total of 1762 articles were screened and 22 studies were included for a total of 533 wrists. DASH scores were 17.6 (N=72), 24.1 (N=63), and 17 (N=203), in the debridement, open repair, arthroscopic repair groups, respectively. VAS pain scores were 2.7 (N=106), 1.5 (N=39), 2.8 (N=95), respectively. MMWS scores were 89.4 (N=72), 80 (N=99), 81.1 (N=179), respectively. ROM flexion/extension was 122 (N=41), 132.7 (N=99), 123.8 (N=154) degrees, and pronation/supination was 164 (N=41), 154.2 (N=60), 154.8 (N=117) degrees, respectively. Lastly, grip strength was 96.7% (N=31), 81.8% (N=179), 83.1% (N=262) of the contralateral hand, respectively.

Summary Points
- Overall, patients had improvement regardless of surgical technique employed, as measured by patient reported outcomes, and clinical data.
- There is no consensus on superiority of any one surgical technique over the others.
• Studies were retrospective case-series.
• High heterogeneity of outcome data reported across all studies.
• This review highlights the current need for higher level studies to be performed before any conclusion can be made as to the gold standard of TFCC lesion repair.

Bibliography
AM Poster 207: Angle of Thumb Adduction: A Novel Diagnostic Tool for DeQuervain's Tenosynovitis

Hand and Wrist; Diseases and Disorders
Level 4 Evidence

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Hypothesis
De Quervain’s tenosynovitis [DQT] is a condition that presents with radial-sided wrist pain. While Finkelstein’s maneuver has been the gold standard for diagnosis, its propensity to yield false-positives in patients with other radial-sided wrist pathologies challenges its subjectivity and specificity. We aim to describe a novel physical exam finding that: (1) objectively supports a diagnosis of DQT and (2) concretely tracks outcomes of corticosteroid injections.

Methods
Forty-five patients with unilateral DQT based on positive Finkelstein’s maneuver and no evidence of CMC arthritis on grind test or radiographic imaging were enrolled in this study, excluding those with previous corticosteroid injections. Patients were instructed to use both hands and “give a thumbs up”. While in full active abduction, a fellowship trained hand surgeon employed a goniometer to measure the angle of thumb adduction with respect to the volar plane (Fig. 1). The angles of both symptomatic and asymptomatic hands were compared using paired t-test and Wilcoxon rank sum test in cases of non-normal data. A corticosteroid injection was delivered into the first dorsal compartment and patients were advised to follow-up. In the control group, the same measurement was recorded in 26 asymptomatic patients with negative Finkelstein tests.

Results
Both gross observation (Fig. 2) and comparison of goniometer measurements of paired symptomatic and asymptomatic hands were significant. The average difference between symptomatic and asymptomatic angle measurements was 11.9° (SD=6.1, p<0.001) with a median difference of 10° (Interquartile Range [IQR] 8-16). There was no correlation of angle measurement with respect to laterality, gender, nor age (p-values 0.4839, 0.5191, and 0.4118, respectively). Moreover, with a median difference of 0° (IQR 0-2), the control group showed no significant difference between paired hands. Thirteen patients presented for follow-up after corticosteroid injection where repeat measurements were obtained and all patients were
asymptomatic upon follow-up. On average, the symptomatic angle reduced by 13.5° (SD=5.2, p<0.001). At follow-up, there was no significant difference between symptomatic and asymptomatic thumb angles, with a median difference of 0° (IQR of -1-1) (p=0.72).

Summary Points

- In DQT, the difference in the angle of adduction with respect to the volar plane between symptomatic and asymptomatic thumbs can be grossly visualized and objectively measured.
- The symptomatic thumb presents with a significantly greater angle of adduction as compared to the asymptomatic thumb.
- This angle becomes negligible after corticosteroid injection.
- This finding can diagnose DQT and follow outcomes of corticosteroid injections.
- Unlike Finkelstein’s test, this test does not illicit discomfort.
AM Poster 208: Clinical Outcomes of Scaphoid Nonunion Treated with an Autologous Bone Screw Produced Using an Ultra-Small Precision CNC Lathe

Category: Wrist

Hand and Wrist
Level 4 Evidence
Grant received from: Japan Sports Medicine Foundation and Terumo Foundation for Life Sciences and Arts

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Hypothesis
Scaphoid nonunion is still a very challenging clinical problem. We developed an ultra-small precision computer-assisted numerical control (CNC) lathe for use under the sterile conditions of an operating room, and evaluated its clinical usefulness in producing autologous bone screws as an osteosynthesis material for scaphoid nonunion.

Methods
Our subjects were 3 patients with a mean age of 28 years who had pseudarthrosis following a scaphoid bone fracture of the wrist. An autologous bone piece was harvested from the middle of the tibia, roughly shaped manually, then crafted into a bone screw using a sterilized ultra-small precision CNC lathe (MTS4, Nano Inc., Tokyo, Japan). The appropriate size of each bone screw (length: 15-20 mm; diameter: 3.5-4.5 mm) was determined based on preoperative computed tomography (CT) scan findings, and each screw was augmented with a manually-produced bone peg to counteract rotation. A thumb spica cast was applied after surgery, and removed when the patient’s pain lessened. Time course clinical outcomes were investigated based on the Modified Mayo Clinical Wrist Score.

Results
Average length of time to produce a bone screw during a surgery was 67 minutes, and the average postoperative follow-up observation was 17 months. Preoperative average Modified Mayo Clinical Wrist Scores of 78 improved to 97 points at the final outpatient follow-up evaluation. In all patients, follow-up CT examination showed favorable bone union at the
repaired pseudarthrosis lesion, and the bone screw was fused with the recipient scaphoid bone. Harvesting a bone piece from the tibia caused no functional disturbance of the lower limb, with subsequent bone regeneration at the donor site, as was confirmed by X-ray and CT.

Summary Points

- Conventionally, metal screws are used for fixation of scaphoid bone fracture.
- While strong fixation may be achieved with metal screws, the presence of a metal implant may create artifacts on CT or magnetic resonance images due to sensitization to metal, hindering postoperative evaluation; additionally, bone union may be adversely affected by the insertion of a large metal screw in a pseudarthrosis lesion.
- Harvesting a bone piece from the tibia caused no adverse events.
- An autologous bone screw of appropriate shape can be precisely produced intraoperatively and is considered clinically effective as an osteosynthesis material for surgical repair of scaphoid nonunion.

Bibliography

AM Poster 209: Ulnotriquetral Split Tear Repair: Is it Myth or Fact?

Category: Wrist

Hand and Wrist; General Principles; Practice Management
Level 4 Evidence

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Hypothesis
Ulnar sided wrist pain is a common cause of upper extremity disability. While the mechanism and clinical presentation of ulnotriquetral (UT) ligament split tears has been described, there is limited data regarding the outcomes of this condition. Patients with UT ligament split tear will achieve improved functional wrist scores and decreased pain scores after arthroscopic treatment.

Methods
228 wrists (142 right and 86 left) in 221 patients (100 males and 128 females, mean age 35 ± 15.5, range 14-77 years) underwent UT ligament split tear repair between 2007 and 2016. Mayo wrist score, Visual Analogue Scale (VAS) pain scores, and objective measures including grip strength and range of motion were obtained. Patients were followed with a mean follow up of 10.3 months. The comparison between preoperative and postoperative outcomes was performed with a paired t-test. The a level was set to 0.05. All statistical analyses were conducted using JMP®, Version 13.0.0, SAS Institute Inc., Cary, NC, 1989-2007.

Results
Ulnotriquetral split tear repair resulted in substantial improvements in pain and function. Mayo Wrist Score for the cohort improved from 56 preoperatively to 82 postoperatively (p<0.0001), and 83% of patients achieved a good or excellent outcome. VAS pain scores decreased from 6.0 preoperatively to 1.4 postoperatively (p<0.0001). Grip improved from 26.1 kg preoperatively to 29.8 kg postoperatively (p=0.003). There was no significant change in range of motion of the wrist. Complications were noted in 13 patients with 8 experiencing continued pain, 4 with dysesthesia of the dorsal sensory ulnar nerve and 1 superficial infection.
Summary Points
- Largest series reporting outcomes of UT split tear repair.
- UT ligament repair results in predictable pain relief, improved function with low complications.
- UT ligament repair significantly reduced pain and improved Mayo Wrist Scores.

Bibliography
Hypothesis
Median nerve disorder is one of complication after surgery using volar locking plate (VLP) for distal radius fracture (DRF) and its development in 0.5-14.6% have been reported. In this study, elasticity of the median nerve at the proximal inlet of the carpal tunnel was quantified using ultrasound elastography (Real-Time Tissue Elastography (EG)) and compared between the operation and healthy sides in patients after surgery for DRF using VLP.

Methods
Between June 2015 and October 2016, 38 patients with DRF received surgical treatment at our hospital. The subjects were 28 of them who could be examined by EG 6 months or more after surgery (4 males and 24 females; mean age: 58.5 years). We evaluated of median nerve elasticities on the operation and healthy sides using EG on the final follow-up.

Results
No median nerve disorder was noted before or after surgery in any patient, and no soft tissue complication was observed in any patient. The median nerve strain ratios were 3.97 ± 2.99 on the operation side and 3.91 ± 1.51 on the healthy side, showing no significant difference in elasticity of the median nerve between the operation and healthy sides.
Summary Points
In this study, no median nerve disorder and no significant difference in elasticity of the median nerve between the operation and healthy sides. Based on these findings, we consider that atraumatic operation of the median nerve during surgery, accurate placement of the plate, and retention of the reduction position reduce stimulation of the median nerve and surrounding tissue, being important points to prevent development of median nerve disorder after VLP fixation.
Hypothesis
Radiocarpal fracture-dislocations were classified by Fernández as type IV with the distal radius avulsion fractures always combined with radiocarpal dislocation. However, we did not find the description of a fracture pattern without dislocation, combining fracture of radial styloid and avulsion of volar and dorsal rims of the radius, associated with a laminar fracture of the lunate and/or scaphoid fossa together with a very narrow lamina of subchondral bone, not more than 3 mm thick but without dislocation.

The goal of this study is analyze this distal radius fracture pattern, included in C3 type or Fernandez IV fractures but with some distinctive specific fragments that might be treated different from the standard distal radius articular lesions.

Methods
We retrospectively reviewed initial X rays and CT scans from all patients operated for Distal Radius Fracture in our Hospital between January 2012 and December 2017. Our inclusion criteria was:

- Radial Styloid fracture,
- Avulsion of the ventral and dorsal rims of the distal radius,

We excluded:
- patients younger than 18 years-old
- patients with radiocarpal dislocation

The resulting preoperative X rays and CT scans were compared looking for a common fracture pattern. Postoperative studies were evaluated to review the type of fixation used.

Results
Ten patients among 1019 distal radius fractures met the inclusion criteria (1%).
All patients but one were male. Mean age was 39 years old.
See Table 1 for other Demographic results.
In all the cases the 3D CT scans clearly defined the fracture fragments, seldom identified with only plain X rays. All the patients that met inclusion criteria had an associated fragment of the lunate fossa and its subchondral bone, not thicker than 3 mm. This fragment was part of the volar rim fragment in 7 wrists or appeared as an independent fragment in three. Our findings on fracture pattern are summarized in Table 2. Both Radial Styloid fractures and dorsal or volar avulsion solid fragments were fixed with cannulated headless 2.3 screws. Smaller avulsion or comminuted avulsion fragments were fixed with bone sutures or bone anchors. Dorsal comminution was butressed with 2.0 or smaller plates. None of the fractures was feasible for standard volar locking plating.

Summary Points
• We describe a pattern of Distal Radius avulsion fracture without dislocation, that is associated with subchondral distal fracture of the lunate fossa.
• This pattern of fracture affected more frequently young male with high energy injuries.

Bibliography
AM Poster 212: Extra-Articular Corrective Osteotomy to Achieve Lengthening and Regain Alignment for Distal Radius Fracture Malunion: A Straightforward Technique

Category: Wrist

Hand and Wrist
Level 5 Evidence

Hui-Kuang Huang, MD
Jung-Pan Wang, MD

Hypothesis
Surgical correction of the distal radius fracture malunion is challenging due to the 3-dimensional deformity. We propose an easy and straightforward method of corrective osteotomy to achieve bone lengthening together with good correction for radial alignment.

Methods
The osteotomy was performed at the appropriate site, and then the osteotomy gap was expanded and multiple osteotomes were placed in the gap. Next, allobone grafting was performed to maintain the corrected radial length. Kapandji intrafocal pinning was used dorsally to provide dorsal supporting force and radially to correct the radial inclination. Finally, a volar anatomical fixed-angle plate was used to buttress and push the distal fragment to fit as to regain the correct volar tilting.

Results
Good radial length and alignment can be restored and the plate application is very straightforward with no need of adjustment. There is no need of additional ulnar shortening and less complications.

Summary Points
- With this method, the plate application is easy with no need to manipulate and reduce the distal fragment by fixing the plate to it first.
- The radiographic and functional outcomes are good.

Bibliography


AM Poster 213: Effect of Midcarpal Bone Structure on the Distribution of Forces through the Radiocarpal Joint

*Hypothesis*

Assuming that distinct bony patterns will transfer forces differently through the wrist, our purpose was to associate the forces transferred to the distal radius and ulna measured in cadaver arms with the morphological assessment of their wrist radiographs. We hypothesized that we will find significant correlations between force transfer and two distinct anatomical patterns based on the midcarpal joint morphology.

*Methods*

Radiographs from a database of 49 cadaver wrists previously tested for force transfer between the radius and ulna were evaluated for lunate and capitate shape within the midcarpal joint and measurements of contact between the capitate and surrounding carpal bones. Percentage of compressive forces through the distal ulna and radius was determined by mounting load cells to the distal radius and ulna while 22.2 N tensile forces were individually applied to the extensor carpi ulnaris, the extensor carpi radialis and brevis, the flexor carpi radialis and the flexor carpi ulnaris. Each wrist was tested in neutral flexion-extension and radioulnar deviation.

*Results*

Thirty-five wrists had lunates type 1 with mean transferred ulnar force of 27.6% and 11 lunates type 2 with a mean ulnar force of 10.4% (3 unclassified). There was a significant association between lunate type and percent of force transfer through the ulna p=0.0003. Percent force transferred to the ulna was weakly correlated with other radiographic parameters. Table 1 Contacts between the capitate and the metacarpals (carpometacarpal joints) were not associated with load transfer to the ulna.

*Summary Points*

- Lunate type affected percent transfer of force through the ulna in normal cadaver wrists.
- Lunate type 1 wrists and those with a greater contact between the capitate and lunate and a smaller contact with the scapholunate ligament transferred more force to the ulna.
• In the intact wrist, ulnar variance is not a strong predictor of percent force transfer through the ulna (supports a previously published study).
• The lack of strong correlations between intracarpal structure and percent load transfer through the ulna may be explained by variations in soft tissue structures such as the TFCC and radiocarpal ligaments which participate in load transfer between the radius and ulna but may also vary with lunate type.
• Further study may improve our understanding of the relationship between wrist structure and transfer of forces.

Bibliography
AM Poster 214: A Sacrifice the Scapholunate Interosseous Ligament Does Not Always Cause a Scapholunate Dissociation

Category: Wrist

Hand and Wrist
Level 4 Evidence

Masahiro Tatebe, MD, PhD
Akimasa Morita, MD
Hitoshi Hirata, MD
Michiro Yamamoto, MD
Shigeru Kurimoto
Katsuyuki Iwatsuki, MD, PhD

Hypothesis
Kienbock disease (KD) can also lead to wrist osteoarthritis, lunate resection and vascularized pisiform transfer is one treatment option and this procedure sacrifices the scapholunate interosseous ligament, but the long-term results are good and there is no progression of scapholunate dissociation (SLD) or severe wrist osteoarthritis. We hypothesize the malalignment of SLD is different from KD.

Methods
We retrospectively reviewed 17 patients with SLD and 14 patients with KD. All arthroscopic findings of SLD were classified as Geissler 4. Carpal alignments were evaluated from pre- and postoperative radiographs. We assessed the radio-lunate angle (RLA), radio-scaphoid angle (RSA), carpal height ratio (CHR), and the scaphoid and capitate locations by plain radiographs and CT/MRI.

Results
All assessed parameters on non-affected sides were similar in both groups. The pre-operative RSA showed no significant differences between groups, but the RLA was significantly lower in SLD and the CHR was significantly lower in KD. The scaphoid and capitate were located dorsally in SLD compared to KD. Eleven of 17 (65%) SLD cases and no KD cases showed scaphoid dorsal subluxation. No case of KD showed subluxation of the scaphoid before or after surgery. Post-operative radiographs revealed a lower CHR/higher RSA in KD, but the CHR in KD showed no progression. There was no radiographic progression of OA in either group at final follow-up. Mean preoperative/postoperative wrist flexion-extension arc and grip strength were similar in both groups and these showed no significant correlation between the radiological parameters.
Summary Points

- The sacrificed the SLIL and preserved the dorsal capsule for KD, but it did not cause SLD.
- KD showed no dorsal subluxation of the scaphoid.
- The carpal malalignment of SLD is definitely different from KD.
Hypothesis
The important technical point of volar locking plate (VLP) fixation for distal radius fracture is to position the distal screws next to subchondral bone as to support it adequately, and minimize the postoperative correction loss, which adversely affect the clinical outcome. We considered a method for performing subchondral support operations by applying an original technique that uses cannulated screws at distal screw holes of VLP and assessed the utility.

Methods
We targeted 38 cases of distal radius fracture in 38 patients who underwent open reduction and internal fixation using Global Form (Nexmed, Chiba, Japan) to treat distal radius fractures. The mean patient age was 61.4 years, and the mean follow-up period was 454.9 days. The fracture types according to the AO classification were as follows: A, 12 and C, 26. At all the distal screw holes, we inserted a 0.8 mm guide wire along the subchondral bone with feeling the touch of bone and a 2.4 mm cannulated locking screw was set in the position, with the aim of achieving optimal subchondral support. We evaluated postoperative clinical results on the basis of postoperative corrective loss, minimum distance between distal screws and the radial subchondral bone (MD [mm]), the Modified Mayo Wrist Score (MWS), and the Disabilities of the Arm, Shoulder, and Hand (DASH) score. Statistical analysis was performed using the unpaired two-tailed Student’s t-test.

Results
The mean amounts of correction loss were VT-2.4°, RI-2.31°, and UV+0.87 mm, and the mean MD was 1.61 ± 1.50. Regarding MWS, 23 cases were “excellent,” 10 were “good,” 5 were “fair,” and 1 was “poor.” The mean DASH score was 7.8. The Pearson’s coefficients of correlations between the mean MD and the amounts of correction loss with respect to VT, RI, and UV were
0.10, 0.07, and -0.34, respectively, and a weak correlation was observed with the UV. No statistically significant difference was found between MD and the clinical outcome (p = 0.46).

Summary Points
- The described technique demands relatively less skill and can be useful in terms of achieving effective subchondral support with screws.
AM Poster 216: Shenton's Line of the Wrist

Category: Wrist

Hand and Wrist; Diseases and Disorders; General Principles
Level 4 Evidence

Joanthan B. Slaughter, MD
Christopher Casstevens, MD
Peter J. Stern, MD

Hypothesis
On true lateral xrays (pisiform overlies the volar capitate head and scaphoid tuberosity), there is a smooth transition or “arc” (Shenton’s line of the wrist) created by the volar surface of the radial styloid and volar surface of the waist and tuberosity of the scaphoid. We hypothesized that if this line was disrupted on true lateral X-rays, the patient likely has carpal malalignment/instability.

Methods
A retrospective review was performed by searching Centricity for wrist x-rays that were performed since January 2016 to identify uninjured (No prior fracture or prior surgery) wrist x-rays. Next, a review of proximal row carpectomy surgeries performed since April 2013 was performed to identify preoperative wrist x-rays of patients with scapholunate advanced collapse. Only true lateral x-rays (pisiform overlies the volar capitate head and scaphoid tuberosity) were included in the study. The x-rays were then evaluated for the presence or absence of “Shenton’s line” and measurements of the scapholunate angle, capitolunate angle, and scapholunate interval were recorded.

Results
A total of 106 uninjured wrist x-rays and 50 SLAC wrist x-rays were evaluated. The uninjured wrists had an average age of 52.9 years, and the SLAC wrists had an average age of 66.8 years. Shenton’s line was present in 103/106 (97.2%) in the uninjured group, and present in 10/50 (20%) in the SLAC group (p<0.001). Shenton’s line had a 93% positive predictive value and 91% negative predictive value for carpal malalignment.

Summary Points
- In normal, uninjured wrists, the scaphoid tuberosity and radial styloid form a consistent arc/line on neutral rotation, true lateral x-rays
- If this line is present, there is a high likelihood there is no carpal malalignment
- If this line is disrupted, there is a high likelihood the patient has carpal malalignment
Bibliography
AM Poster 217: Morphologic Characteristics of the Sigmoid Notch of the Distal Radius Affect the Stress Distribution Patterns in the Distal Radioulnar Joint: A Computed Tomography Osteoabsorptiometry Study

Category: Wrist
Level 4 Evidence

Yukinori Tsukuda, MD, PhD
Daisuke Kawamura, MD
Yuichiro Matsui, MD, PhD
Norimasa Iwasaki, MD, PhD

Hypothesis
Because the individual osseous anatomy of the sigmoid notch varies widely [1], the long-term loading condition would depend on the types of the sigmoid notch. We hypothesized that morphologic differences in the sigmoid notch would affect the stress distribution pattern through the distal radioulnar joint (DRUJ).

Methods
Computed tomography (CT) image data of the wrists of 14 wrists of 13 patients (1 woman; 12 men) with various diseases not affecting the DRUJ were collected. The examined wrists were allocated to the “C” type sigmoid (C) group and the ski-slope sigmoid (SS) group, by reference to a previous report with modifications [2] (Figure 1). The C and SS group included 8 wrists and 6 wrists, respectively. We utilized CT osteoabsorptiometry to evaluate the distribution of the subchondral bone density within articular surfaces of the sigmoid notch which shows the loading history. The high-density area was defined as the upper one-third of the whole threshold from the minimum to the maximum Hounsfield units in each sigmoid notch. The sigmoid notch was divided into three regions as follows: dorsal region (DR), middle region (MR), and volar region (VR). The percentage of the high-density area (%HDA) occupying the total regions and each region of the sigmoid notch were calculated, and the obtained %HDA data were compared between the C group and the SS group. These data were also compared among the DR, MR, and VR in each group. Statistical comparisons were conducted with the Kruskal-Wallis test and the Mann-Whitney U test (p < .05).
Results
In the total regions of the sigmoid notch, the %HDA in the C group and SS group were no significant difference between the two groups (Table 1). The %HDA of the DR was greater in the SS group than in the C group (15% vs 4.6%) (p = .003), and the %HDA was significantly greater in the DR than in the VR belonging to the SS group (15% vs 3.5%) (p = .03) (Table 1).

Summary Points
- Bony morphologic differences in the radial sigmoid notch affect the stress distribution pattern through the DRUJ.
- The stress distribution focuses on the dorsal side due to the tilting toward the dorsal side and the straight line of the sigmoid notch
- The results of the current study may lead to further understanding of the biomechanics of the DRUJ and the relating problems such as osteoarthritis of the DRUJ.

Bibliography
A New Screw Fixation Technique for Scaphoid Proximal Pole B3 Fractures

Category: Wrist

Hand and Wrist
Level 4 Evidence

Moroe Beppu, MD, PhD
Koichi Ohkubo
Yuuichirou Arakawa

Hypothesis
The dorsal approach for fixation of Herbert type B3 proximal pole scaphoid fractures was originally described by Joseph Slade MD, but cartilage injury, proximal pole fragmentation, and poor fixation may lead to failure, particularly when the proximal pole fragment is small and/or unstable. In these cases, improved results are attainable if the screw is placed through a cartilage-free area and directed perpendicular to the plane of the fracture.

Methods
We insert a headless compression screw at about a 5mm-wide cartilage-free area of the scaphoid, located between the dorsal ridge and dorsal scaphoid sulcus, and between the radioscpahoid and scapho-capitate surfaces. The nutrient blood supply of the distal scaphoid is delivered by the palmar branch of the radial artery, remote from the site of screw placement. The proximal pole vessels, from the dorsal branch of the radial artery, enter the scaphoid radial to screw placement and are protected during the procedure. The fracture site is marked on the dorsal wrist using fluoroscopy. After this mark is set at center of the longitudinal slow incision, the capsule is incised and fracture or pseudoarthrosis is exposed and reduced manually. The guide pin of headless compression screw (DTJ mini) to the proximal fragment from dorsal distal to proximal palmar is inserted perpendicular to the fracture line at the cartilage-free area of the scaphoid as in fig.1. The cancellous bone graft is made at the pseudoarthrosis.

Results
Five scaphoid fractures were treated with this method, including three male and two female patients. Three right and two left wrists were injured, and included two acute fractures and three pseudarthosis. Four proximal pole fractures (Herbert B3), and one case classified as both B3 and B2. All cases had greater than six months follow-up, and all healed. Healing time averaged 9 weeks (range 7-11 weeks) for acute fractures and 21.3 weeks (range 9-38) for established nonunions.
Summary Points
- Placement of a scaphoid screw in the bare area between the dorsal ridge and dorsal sulcus permits placement of a scaphoid screw perpendicular to the scaphoid fracture line in Herbert type B3 injuries without any penetration of the articular cartilage and without endangering scaphoid blood supply.
- Although it requires an open approach, it remains our procedure of choice for these fractures, whether acute or chronically ununited.

Bibliography
Hypothesis
Ulnar shortening osteotomy (USO) is an effective procedure for ulnar impaction syndrome. It potentially leads to degenerative changes of the distal radioulnar joint (DRUJ). Previous studies focused on the DRUJ types in coronal plane as possible factors relating to DRUJ degeneration. We hypothesized that the osseous anatomy of the sigmoid notch in the transverse section affects the occurrence of degenerative changes of the DRUJ after USO. The purpose of this study was to compare the patterns of subchondral bone mineralization within the DRUJ among different types of the sigmoid notch in axial plane before and after USO in patients with ulnar impaction syndrome.

Methods
Because it is difficult to evaluate the actual loading conditions within the DRUJ in vivo, we used computed tomography (CT) osteoabsorptiometry to evaluate the distribution of subchondral bone density which shows the loading history. We reviewed the pre- and post-operative axial CT images of 15 wrists that underwent USO for ulnar impaction syndrome. We classified patients into two groups according to the type of sigmoid notch (ie, curved and linear type sigmoid). We defined the high-density area as the upper one-third of the whole threshold, from the minimum to the maximum Hounsfield units in each wrist. We divided the sigmoid notch into four regions. The percentage of high-density area (%HDA) at each region was calculated and statistically compared among the divided regions within the same group before and after USO. Statistical analysis was performed using the Wilcoxon test (p < 0.05).

Results
In the curved sigmoid, the %HDA significantly increased in the distal-volar region of the sigmoid notch before surgery and in the proximal-volar after surgery. The %HDA in the distal-dorsal region of the linear sigmoid was higher than the other regions before surgery. There was no specific region that showed increased %HDA than other regions in the sigmoid notch after surgery.
Summary Points

- The osseous anatomy of the sigmoid notch in the transverse section affected stress distribution patterns in the articular surface of the sigmoid notch of ulnar abutment syndrome patients.
- In the curved type sigmoid group, the stress distribution shifted from the distal-volar to the proximal-volar region after USO. Alternatively, the stress on the sigmoid notch was dispersed after USO in the linear type sigmoid group.
- The osseous anatomy of the sigmoid notch could be one of the possible predictive factors for degenerative changes of the DRUJ after USO.

Bibliography

AM Poster 220: Double Trapezial Sign in Scaphoid Nonunion

Category: Wrist

Hand and Wrist
Level 4 Evidence

Joo-Dong Yeo, MD
Yoon-Min Lee, MD

Hypothesis
Diagnosis of a scaphoid fracture is often delayed because of its anatomical complexity, and this can lead to nonunion. In scaphoid nonunion, the nonunion site became sclerotic in several cases, producing a “double trapezial sign,” which appears as two trapezia in one wrist because the distal scaphoid segment looks like a trapezium with its sclerotic fracture margin. The purpose of study is to introduce clinical significance of the double trapezial sign for diagnosing scaphoid nonunion based on plain wrist radiograms.

Methods
From 2004 to 2017, plain wrist radiographs of 124 patients diagnosed as scaphoid nonunion were reviewed. For intra-observer reliability, each plain radiographs were reviewed twice with a 3-week interval, and for inter-observer reliability, two hand surgeons and one musculoskeletal radiologist reviewed by random patient order for each test. For assessment of observer reliabilities, $\kappa$ values and percentages of agreement were analyzed. Patients were divided three groups according to the interpretation of the sign (A, B and C). Presence of avascular necrosis of proximal pole in MRI and location of fracture site in plain radiographs were assessed in each groups.

Results
The prevalence of the double trapezial sign was 46.7% in all scaphoid nonunions. The mean period from trauma to the initial visit was 38.9 months in the group positive for the double trapezial sign and 9.3 months in the non-positive group ($P$ value = 0.029). Osteonecrosis of the proximal pole was displayed by 88.6% of the non-positive group and 25% of the positive group ($P$ value = 0.047). The intra and inter-observer reliabilities for positive double trapezial sign were excellent ($\kappa$ values = 0.95/0.84), and for negative were substantial ($\kappa$ values = 074/0.72).
Summary Points
Although typical radiological findings of scaphoid nonunion are well established, a clear diagnosis based on a plain X-ray can be difficult in some cases. Double trapzial sign is a new radiologic finding which can be good clue for presence of osteonecrosis of proximal pole and predictor for prognosis with good intra and inter-observer reliabilities.
AM Poster 221: Pisotriquetral Subluxation and Osteoarthritis with Carpal Collapse

Category: Wrist

Hand and Wrist; Diseases and Disorders
Level 4 Evidence

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Karl Josef Prommersberger, PhD

Hypothesis
Carpal collapse promotes pisotriquetral subluxation and osteoarthritis. The underlaying pathology (SNAC/SLAC) and its stage might influence the pathomechanism.

Methods
We identified 234 patients (83% men, mean age 50 (21-76) years) with an scaphoid nonunion or scapholunate advanced collapse (86 SNAC and 148 SLAC wrists stage 2° or 3°), who had an MRI (89) or CT scans (145) of the wrist prior to a salvage surgery. Those were retrospectively evaluated with regard to subluxation or osteoarthritis of the PT joint. The prevalence and degree of PT osteoarthritis was analyzed according to the cause and stage of the carpal collapse, age of the patients and a concomitant PT subluxation.

Results
Among all patients, PT osteoarthritis was found in 76%, 71% of all SLAC wrists, and 85% of all SNAC wrists. In SLAC wrists, the prevalence was significantly higher in stage 3° (77%) than stage 2° (52%). In SNAC wrists, both stages were similar (83 and 85%) and significantly higher than in SLAC wrists. Severe Osteoarthritis was significantly more often observed in SLAC wrist 3° (53%) than in 2° (21%), SNAC wrists had a high 58% at both stages. The highest rate of PT osteoarthritis was found in patients younger than 30 years (88% of 17 patients) and patients older than 70 years (91% of 11 patients). The lowest rate had patients between 30 and 39 years of age (58% of 31 patients). Patients in their 4th, 5th and 6th decade of age had 79, 76 and 77% PT osteoarthritis rate.

66% of all patients had a subluxation of the pisiforme, mainly a translation proximally, followed by a tilt into flexion, less patients had a widening of the joint gap. The rate was similar in SLAC- and SNAC wrists, except a higher rate of patients with palmar tilt among the SLAC wrists. With regard to the 154 patients with pisiforme subluxation, 80% of them had concomitantly a PT
osteosarthritis, 49% a severe osteoarthritis. Vice versa, 69% of the patients with a severe PT osteoarthritis had simultaneously a pisiforme subluxation.

Summary Points

- Carpal collapse comes very often along with PT osteoarthritis
- The incidence is higher in SNAC wrists than in SLAC wrists
- Severe PT osteoarthritis was found more often and earlier in SNAC wrists than in SLAC wrists
- With PT osteoarthritis, subluxation was often, but not always present

Bibliography

Hypothesis
Spontaneous extensor tendon rupture in the wrist is a common comorbidity in patients with rheumatoid arthritis (RA). Untreated extensor tendon ruptures tend to progress in a sequential manner causing rupture of adjacent radial extensor tendons. Surgical results are generally better with one or two extensor tendon ruptures than with multiple extensor tendon ruptures. We hypothesized that there was specific bone morphology at the distal radius relating to the number of ruptured extensor tendons.

Methods
Overall, 32 patients with RA (38 wrists) with wrist lesions with or without extensor tendon ruptures were enrolled. Patients’ age ranged from 36 to 84 years (mean, 60 years). Patients were divided into four groups based on the number of the ruptured extensor tendons: group A without rupture (14 wrists), group B 2 ruptured tendons (6 wrists), group C 3 ruptured tendons (10 wrists), and group D 4 or 5 ruptured tendons (8 wrists). Degree of joint deterioration of each wrist joint was graded using the Larsen grade with plain wrist X-ray film. We also reviewed axial CT images and measured the maximum and minimum width of the dorsal cortex from the tip of the Lister’s tubercle to the ulnar cortical edge. The measured maximum and minimum width was standardized by indexing it to the width of the volar cortex of the radius at the proximal end of the Lister’s tubercle (Wmax, Wmin). Non-parametric multiple comparisons were conducted among the groups. Correlation analyses were then conducted between the number of the ruptured tendons and Larsen grade, Wmax and Wmin.

Results
Average Wmax in group C was significantly lower than that in group A. Wmin in group C and D were significantly lower than that in group A. There was no correlation between the number of the ruptured tendons and Larsen grade. We found a strong negative correlation between the
number of the ruptured tendons and Wmin; there was a weak negative correlation between the number and Wmax.

Summary points

• The width of the dorsal cortex of the distal radius which forms the gliding floor of the extensor tendons was negatively correlated with the number of the ruptured tendons.
• Morphology of the dorsal cortex at the distal radius could be a useful prognostic factor for extensor tendon ruptures in patients with RA.
AM Poster 223: Accuracy and Reproducibility of Three-Dimensional Printing for Evaluation of Carpal Bones

*Category: Wrist*

Hand and Wrist; General Principles
N/A - not a clinical study

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Lili Schindelar, MD
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**Hypothesis**
Three-dimensional (3D) printed models have become increasingly prevalent in the medical field, and can be used for operative planning, as teaching aids, and to generate customized surgical implants. The use of computerized tomographic (CT) image files to generate 3D printed models of carpal bones has not been studied. We hypothesize that 3D printed structures can generate accurate anatomic representations of carpal bones generated from CT images.

**Methods**
CT scans of five wrists were identified at random and screened for grossly normal anatomy of the carpal bones. DICOM (Digital Imaging and Communications in Medicine) files from each CT file were de-identified. The DICOM files were then converted to Stereolithography (STL) files manually with segmentation, threshold editing, island isolation, and smoothing using 3D Slicer (www.slicer.org), an open source software platform for medical image informatics. The resulting STL files were then edited to isolate the scaphoid, lunate, trapezium and capitate for each scan. The modeled individual carpal bones were then printed using a commercially available additive manufacturing printer (www.ultimaker.com). The dimensions of the 3D printed carpal bones were then compared to the original CT scan dimensions in order to evaluate accuracy of the conversion and printing process.

**Results**
A total of 16 carpal bones were printed successfully. Measurement differences between the CT images and the printed models averaged 0.4 +/- 0.6 mm for the scaphoid, 0.2 +/- 0.4 mm for the lunate, 0.3 +/- 0.3 mm for the trapezium, and 0.3 +/- 0.5 mm for the capitate.
Summary Points

- Reconstruction using DICOM data from existing patient CT scans can reliably produce three dimensional prints of carpal bones, and provide accurate bone models.
- Accurately reproduced 3D models of carpal bones aid in understanding of complex anatomical relationships.
- Preoperative planning, patient specific implants, and surgical interventions may be aided by 3D modeled anatomy in hand surgery.
AM Poster 225: Development and Proof of Concept Testing of a Novel Method of Force Quantification During Reduction of Distal Radius Fractures

Category: Wrist

Hand and Wrist
N/A - not a clinical study
Grant received from: National Institutes of Health; (2P20 GM104937 (COBRE Bioengineering Core)

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Hypothesis
Three-point molding (TPM) of dorsally angulated distal radius fractures (DRFs) after splinting is common practice, though up to 31% of patients with DRFs managed with closed means experience complications; up to 10% may experience signs of acute carpal tunnel syndrome. Direct pressure on the carpal tunnel has been shown to increase pressure and precipitate median nerve dysfunciton. The force applied during TPM may result in increased carpal tunnel pressures. The purpose of this study is to develop a system that can detect force application during molding with good repeatability and validate its use in patients with DRFs.

Methods
With IRB approval, six healthy controls and two patients with dorsally angulated DRFs were enrolled. A pressure sensing film (Tekscan 5250) was calibrated while using a plaster splint, cotton, and an elastic bandage, weights of known forces, and a scale. After calibration, one provider placed a TPM on the splinted wrist of the controls, simulating a reduction scenario for dorsally angulated DRFs with the sensors under the dorsal mold points (Figure 1). The provider then applied TPMs and force values were recorded and mapped at 1 Hz for a minimum of 6 seconds (Figure 2). This was repeated three times on each control after one month to assess for repeatability. Two patients with dorsally angulated DRFs requiring closed reduction were then reduced, splinted, and a TPM was applied with the sensor on the splint. Variance (Gage R&R) was calculated within repeated measures of the controls and between controls and used to calculate the repeatability coefficient (r).
Results
Mean force values for the simulated reductions ranged from 14.3 to 21.6 lbs with an overall mean of 18.0 lbs (SD 2.2 lbs). The variance within each control was 1.4 and between controls was 16.3, giving a repeatability coefficient of r=0.78, a measure that shows differences in forces between controls are due to differences in the wrists of the controls themselves, rather than the testing setup. The two patients who underwent closed reduction had mean force values of 14.3 lbs (SD 2.8 lbs) and 15.7 lbs (SD 3.3 lbs) during molding.

Summary Points
- The Tekscan 5250 sensor can be used to measure forces applied to plaster splints during TPM with good repeatability (r=0.78)
- The sensors can be used translationally during molding of DRFs to detect applied forces
- Further testing can determine clinically relevant forces applied during molding and the subsequent impact of such forces on carpal tunnel pressures

Bibliography
AM Poster 226: Diagnostic Performance of Plain Radiographs in Detecting Central-Depression Fragments of Intra-Articular Distal Radius Fractures

Category: Wrist

Hand and Wrist
Level 3 Evidence

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Hypothesis
Assessment of 3D-CT images revealed that there were 7% of central-depression fragments (CDF) in intra-articular distal radius fractures. We hypothesized that diagnostic performance and reliability using plain radiographs is low in detecting the CDF.

Methods
In 167 consecutive intra-articular distal radius fractures, we enrolled 25 intra-articular distal radius fractures including 12 fractures with CDF and 13 randomly selected fractures without CDF. Fifteen CDFs were observed by 3D-CT in the 25 fractures, and mean gap and step displacements were 2.3mm and 1.7mm, respectively. These fragments were interpreted blindly using anterior-posterior and lateral plain radiographic views by six examiners (two board-certified hand surgeons, two board-certified orthopedic surgeons and two non-certified orthopedic surgeons). The presence or absence of these fragments and the fragment displacement (step and gap) were evaluated. Diagnostic performance of plain radiographs was evaluated by average value of agreement ratio of each examiner. Interrater reliability of radiographic finding was calculated with Fleiss' kappa.

Results
Diagnostic performance using plain radiographs in detecting CDF (Mean sensitivity: 0.36 Mean specificity: 0.8 Mean accuracy: 0.59). Fifteen CDFs included 6 fragments located in the scaphoid fossa (s-CDF) and 9 located in the lunate fossa (l-CDF). Displacement of s-CDF (step:4mm, gap:2.5mm) were significantly larger than that of l-CDF (step:1mm, gap:2.5mm). Mean sensitivity of each examiner in detecting s-CDF was significantly lower than that of l-CDF (s-CDF:0.14, l-CDF:0.58, p-value<0.05). Interrater reliability of plain radiographic findings was low (kappa statistic:0.21).
Summary Points

- Diagnostic performance and reliability of plain radiograph was low in detecting central-depression fragments, indicating that there is a need of additional CT images.
- Despite the larger depression fragment in the scaphoid facet, sensitivity of plain radiograph was poor for detecting the scaphoid facet fragment, suggesting that strong attention is required for the fragment presence.

Bibliography

AM Poster 227: Delayed Carpal Tunnel Release Following Distal Radius Fracture Management is Uncommon

Category: Wrist

Hand and Wrist; Nerve
Level 2 Evidence

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Hypothesis
Distal-radius fractures can present with new onset paresthesias presumably from trauma to the median nerve. Although this may resolve without carpal tunnel release, occasional patients suffer progressive symptoms requiring urgent release. This study evaluated the rate of carpal tunnel release (CTR) in the period surrounding distal radius fracture open reduction internal fixation (DRORIF).

Methods
A cohort of all adult patients who underwent distal radius ORIF in New York State from 1998 to 2014 was selected from the New York Department of Health Statewide Planning and Research Cooperative System (SPARCS). SPARCS allows approved users to follow each patient longitudinally using unique identifiers. Thus, patients were identified with a distal radius fracture (using standard ICD procedure based selection methods) who underwent DRORIF and amongst this cohort, those who also underwent concurrent or delayed CTR within 30 days of DRORIF were analyzed for patient and injury characteristics, and demographics. Utilizing standard statistical methods, and purpose written software (Stata, College Station, TX), formal conclusions could be drawn on the combination of DRORIF and CTS.

Results
We identified 36,102 adult patients who underwent DRORIF, within this group 1,845 patients underwent CTR on the same day as DRORIF, while only 21 underwent delayed CTR. Sixty additional patients underwent CTR in the 30 days prior to DRORIF (Figure 1). Patients who underwent delayed CTR were more likely to be male, identify as a race other than white or black, have sustained an open fracture. Overall patients who underwent CTR were more likely to
identify as white race, less likely to have acute MI, CHF, DM and renal disease (Figure 2). The majority of delayed CTR were performed in the same setting as the initial surgery (13 patients had both procedures in the inpatient setting, 3 had both as outpatients, 3 crossed from outpatient to inpatient, and 2 crossed from inpatient to outpatient).

Summary Points
- This study demonstrates that return to operating room for CTR following DRORIF is rare, with 21 of the 36,280 (0.06%) DRORIF patients in the state of New York undergoing CTR in the 30 days following DRORIF.
- Risk factors for delayed CTR include male gender, open fracture, race other than white or black.
- Several patients undergo CTR prior to DRORIF, possibly to treat acute carpal tunnel syndrome in the presence of a presumed stable fracture.

Bibliography
Hypothesis
Axial carpal injuries are rare entities where a traumatic force transmits through the intermetacarpal space, dissociating the carpometacarpal joint and disrupting the distal carpal row in an axial radial or axial ulnar pattern. Previous literature has not demonstrated differences in outcomes in regards to axial carpal injury patterns or true axial vs. compressive crush injuries. We hypothesize that axial radial type injuries will result in worse outcomes, demonstrably more severe than compressive injuries.

Methods
We conducted a retrospective review of patients treated for carpal fractures or dislocations, identified by CPT code, over a 25 year period at a single institution. We reviewed radiographs, electronic records and operative reports to identify injury pattern, subsequent surgeries, complications including compartment syndrome, type of surgery performed and length of immobilization. Mayo Wrist scores were calculated. Univariate and multivariate analysis was conducted to identify factors associated with poor outcome as identified by Mayo Wrist score.

Results
A retrospective case series identified 37 patients over 25 years who presented to a Level 1 Trauma Center with 54% experiencing an axial radial injury and 46% experiencing an axial ulnar injury. Of all the variables evaluated, only axial radial injuries were identified as predictors of poor outcome as defined by Mayo Wrist scores with univariate analysis demonstrating 6 times increased risk and multivariate analysis demonstrating 15 times increased risk of a poor outcome compared to axial ulnar injuries.

Summary Points
- Axial carpal injuries are rare, representing only 1.1% of carpal fractures over a 25 year period at a single Level I Trauma Center
- 78% of injuries were consistent with true axial patterns vs. 22% crush type injuries with similarly poor outcomes
- 27% of patients required flap coverage, 14% developed compartment syndrome
• These are devastating injuries with nearly half of patients with axial carpal injuries result in poor outcome and no patients with excellent outcome
• Soft tissue injury was not an independent predictor of poor outcome as previously shown
• Axial Radial injuries result in significantly worse long term outcomes than axial ulnar injuries

Bibliography
2: Dobyns JH, Linscheid RL, 3rd. Fractures and dislocations of the wrist and hand, then and now. J Hand Surg Am. 1983, 8: 687-90
AM Poster 229: Long-Term Outcomes after ECU Subsheathe Reconstruction with Extensor Retinaculum

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
We describe outcomes of ECU subsheath reconstruction with extensor retinaculum at a median follow-up of 8 years.

Methods
In this retrospective study, we identified patients who underwent ECU subsheath reconstruction for subluxation of the ECU tendon at two level I trauma centers and one associated community hospital between January 2003 and December 2016. Our cohort consisted of 6 male (40%) and 9 female (60%) patients. Patients underwent ECU subsheath reconstruction at a median of 5.9 weeks after diagnosis (IQR 2.4-13). Reconstruction consisted of using the extensor retinaculum as a sling reconstruction. (Figure 1).

Medical records of patients were manually reviewed and assessed for complications and unplanned reoperations. Patients were invited by letter to complete patient rated outcomes surveys and a questionnaire specific to symptoms of their ECU subluxation over the phone.

Results
No ruptures of the ECU tendon were observed. Two patients (13%) developed an ECU tendinitis. Three patients (20%) required a reoperation; one patient requested removal of a stitch, one patient underwent arthroscopic TFCC debridement because of persisting ulna-sided wrist pain, and one patient underwent neurolysis of two branches of the dorsal sensory ulnar nerve. At a median follow-up of 8.4 years, the median PROMIS UE Physical Function score among 10 patients was 56 (IQR 41-56), the median score for pain 0.5 (IQR 0-2) and the median score for satisfaction 9.5 (IQR 6-10). Four patients reported symptoms related to their ECU subluxation in rest or during forceful forearm rotation, 1 patient experienced limitations in daily activity, and 4 patients experienced limitations in their sports activity (Table 1).
Summary Points

- The extensor retinacular sling technique demonstrated favorable results at long-term follow up.
- Unlike other procedures that maintain integrity of the ECU sheath and subsheath, this technique allows the surgeon to address concomitant ulnar-sided wrist pathology of the ECU.
Hypothesis
Treatment of proximal pole scaphoid nonunion with avascular necrosis is a challenging issue. We retrospectively reviewed the results of 82 patients with proximal pole scaphoid nonunion, 53 with avascular necrosis, treated with a capsular-based vascularized distal radius graft.

Methods
Sixty-five male and seventeen female patients with symptomatic nonunion at the proximal pole of the scaphoid were included in this study. No patient had a humpback deformity. The mean patient age was 29 years (range, 19-44). In all patients, the vascularized bone graft was harvested from the distal aspect of the dorsal radius and was attached to a capsular flap of the dorsal wrist capsule. The graft was vascularized by the artery of the fourth extensor compartment. After fixation of the scaphoid with a small cannulated screw, the graft was inserted press-fit into a dorsal trough across the nonunion site. Supplementary fixation of the graft with a micro suture anchor into the scaphoid was used in 59 patients. At follow-up each patient was evaluated with physical and radiographic examination.

Results
At a mean time of 12.4 weeks (range, 6-24) after surgery, solid union was achieved in 69 of 82 patients (84%). Eleven patients had persistent non-union and two fibrous union as determined by CT scan. Sixty of the patients with solid bone union were completely pain free and nine complained of slight pain with strenuous activities. Wrist flexion and extension were improved postoperatively. Grip strength was improved significantly by a mean of 66%. The mean modified Mayo wrist score significantly improved from 43 to 86. No arthritic changes were noted at the dorsal ridge of the radius. No donor site morbidity was observed.
Summary points

- The capsular-based vascularized bone graft from the distal radius is a reliable alternative technique for scaphoid nonunions.
- It is a simple technique that eliminates the need for dissection of small-caliber pedicle or microsurgical anastomoses.
- The supplemental fixation with a micro suture anchor eliminates the risk of graft displacement.

Bibliography
Hypothesis
The objective is to study the scapho-lunar kinematics in vitro on healthy wrists, then having a complete lesion of the scapho-lunar ligament, and finally after repair by flexible anchors on the posterior then on the anterior part. The hypothesis is the modeling of a ligament repair by flexible anchors on the posterior and volar side of the scapholunate space makes it possible to bring the joint kinematics closer to a physiological behavior.

Methods
6 healthy wrist from fresh/frozen cadaver were selected from the anatomy laboratory. Steel beads of 1 and 1.5mm were inserted in the scaphoid, lunatum, third metacarpal and the radius. A CT was then performed. The radius and ulna were fixed in a PMMA cement and secured in a neutral pronosupination position by transverse screws. The fingers were secured to a plate connected to a motor allowing movements of 30° of flexion at 60° of extension and 20° of radial at 30 degrees of ulnar deviation, in steps of 10°. Low-dose bi-planar radiographs were performed on the healthy wrists, then after injury the scapholunate ligament and after repair by 1mm soft anchors at the posterior portion of the ligament (instrumentation I1) and then at the anterior part (instrumentation I2). With the help of a housemade software and specific code lines matlab, the recovery of the coordinates of the beads within the bones made it possible to study comparatively the relative mobility of the scaphoid and the lunatum according the different configurations.
Results
As part of the flexion/extension wrist movement, focusing on the 30 ° flexion-30 ° extension range, the total flexion / extension (°) amplitude of the scaphoide for healthy, injured wrists, I1 and I2 are respectively 45.5 ± 7.3, 54.6 ± 9.6, 48.9 ± 11.9, 47.2 ± 12.5. For those of the lunatum we find respectively: 37.2 ± 14.9, 40.1 ± 21.6, 40.6 ± 16.2, 43.8 ± 17.8. The anteroposterior translation between the scaphoide and the lunatum (in mm) is: 0.9 ± 0.2, 1.1 ± 0.5, 0.7 ± 0.4, 0.9 ± 0.7.

Summary Points
• Accurate understanding of the scapholunate kinematics
• Anterior repair of the ligament seems to improve the scaphoid kinematics
• But less true for the lunatum kinematics
• Interest of making custom models in finite elements of the wrist

Bibliography
AM Poster 232: Age-Related Variations in Volar Cortical Angle of the Distal Radius: Do Current Volar Locking Plate Designs Need To Be Re-examined?

Category: Wrist

Hand and Wrist
Level 3 Evidence

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Hypothesis
Volar locked plating is as an attractive option when surgery is warranted for distal radius fractures. Commonly used commercial volar distal radius plates are designed with an angle that is fixed that ranges anywhere from 18-30 degrees to fit the palmar surface of the distal radius (1, 2). We hypothesize the volar cortical angle (VCA) of uninjured distal radii do not anatomically correspond with the VCA of modern volar plate designs and patient demographics play a role in variations of the VCA.

Methods
A retrospective radiographic analysis of adult distal radius was performed. ICD-9 and CPT codes were used to identify patients presenting with wrist pain and undergoing wrist radiographs from 2005-2015. Of the 938 patients identified, we excluded 665, leaving 273 patients for this study. Patient demographics including age and sex were collected. Patients were stratified by age quintiles (< 27 years, 27 = Age < 44, 44 = Age < 52, 52 = Age < 65, 65 = Age). Patients with prior radius, ulna, or carpal bone fracture were excluded as well as those with inadequate lateral wrist radiographs. VCA was measured on standard lateral wrist radiographs. Multivariable linear regression analyses were performed to determine the relationship between VCA and demographics such as age and sex.

Results
Age ranged from 18-94, with a mean of 48.3 (SD 19.4). 86 (31.5%) were male while 187 (68.5%) were female. VCA ranged from 23.2 to 42.6 degrees, with a mean of 32.2 degrees (SD 3.79, Figure 1). Mean VCA was 32.8 (SD 4.17) in the youngest cohort (Age < 27 years) and 30.4 (SD 3.63) in the oldest cohort (65 = Age). Mean VCA decreased with age, approximately 0.04 degrees
per year after adjusting for sex (p < 0.05, 95% CI -0.063 – -0.019, Figure 2). Males have on average a 1.6 degree greater VCA than females after adjusting for age (p <0.05, 95% CI 0.68 – 2.52). The relationship between age and sex was not significant (P=0.302) suggesting that the decrease in VCA is similar in males and females.

Summary Points
- VCA in normal, uninjured distal radius is on average greater than the VCA of modern volar plates.
- VCA tends to decrease with age in both males and females, and men on average have greater a VCA then females.
- Current volar distal radius plate designs may hinder an anatomic reduction of distal radius fractures, especially in young, male patients.

Bibliography
AM Poster 233: Worse Outcome (DASH) at 12 Months in 128 Patients with Combined Radius-Ulna Metaphyseal Fracture than Radius Fracture Alone: A Register Study of 3666 Patients - Need for Evidence Based Treatment Guidelines?

Category: Wrist

Hand and Wrist; Practice Management
Level 2 Evidence
Grant received from: Local hospital funds, Region Skåne, Sweden.

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Hypothesis
Up to six percent of the distal radius fractures (DRFs) have a concomitant distal ulna metaphyseal fracture (DUF), treatment algorithms are used for DRFs, but are missing for a concomitant DUF. In the present study we used our prospective register to describe and analyze patients with combined DRF and DUF.

Methods
Since 2002, all DRFs in patients 18 years and older at our hospital are prospectively registered and patient-reported outcome (DASH) recorded at one year. Between 2003 and 2012, 3666 patients (2833 women) were included in the register (mean age 62 (18-98) years) (1). All patients with a DRF and a concomitant DUF were identified. The radiographs were evaluated and distal ulnar styloid fractures without metaphyseal extension were excluded. 128 patients (111 women) were classified according to AO:s Q Modifier for ulnar fractures, and the Biyani classification.

Patient characteristics, type of treatment and 1-year DASH were extracted from the register. Medical records were reviewed for comorbidity according to the Charlson index and use of medications. Statistical testing was made using the Mann-Whitney U test.

Results
The subjective outcome at one year was worse (DASH 23) in patients with DRF+DUF compared to the whole DRF cohort (DASH 9; p< drugs regularly).
Summary points

- The patient group with both DRF and DUF had a substantially worse subjective outcome one year after the injury compared to patients with DRF alone.
- A majority of the patients in the group with both DRF and DUF are elderly with multiple health issues.
- Additional studies are needed to determine how to best treat this subgroup in the future.

Bibliography
AM Poster 234: Four-Corner Arthrodesis of the Wrist: Outcomes of Lag Screw Fusion Device Technique

Category: Wrist

Hand and Wrist; Diseases and Disorders
Level 4 Evidence

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Hypothesis
Four-corner arthrodesis using the CarpalFix intraosseous fusion device (CarpalFix, Extremity Medical, Parsippany, NJ, USA) has comparable or better results to previously published techniques in terms of fusion rates, alleviation of pain, grip and pinch strength and range of motion.

Methods
Retrospective analysis of 30 four-corner fusions by a single surgeon using the CarpalFix implant in a cohort of 29 patients with degenerative conditions. Mean follow-up was 12 months (2–80 months). Pain was evaluated using pre and postoperative Patient-Rated Wrist Evaluation (PRWE) and Visual Analog Score (VAS) scores. Functional outcomes of the technique were assessed by grip/pinch strength and range of motion. Postoperative radiographs were used to review bone fusion. A systematic literature review of four-corner fusion procedures was performed and results were compared to our series outcomes. Statistical analysis was performed using the Mann-Whitney U test.

Results
All patients experienced significant improvement of their pain compared to preoperative status (p<0.001). 8 wrists (27%) experienced complete pain relief. The average PRWE wrist score was 31, a significant improvement over the preoperative average of 83. Pinch strength improved from preoperative 12.7 kg (± SD 6) to 13.9 (± SD 6). Grip strength improved from preoperative 50.5 kg (± SD 24) to 60.9 (± SD 26). Postoperative capacities of pinch strength and grip strength were 95% and 79% of the contralateral side. The average preoperative flexion and extension were 47° (± SD 19) and 51° (± SD 18) compared to 32° (± SD 11) and 39° (± SD 11) postoperatively. Fusion was confirmed radiographically in all of the wrists (100%). Five wrists (17%) required subsequent procedures: three removal of hardware and one radiocarpal fusion.
for persistent pain. Comparisons between our results and previous studies are provided in Tables 1 and 2.

**Summary Points**
- four-corner arthrodesis with CarpalFix implant is a safe and effective procedure that provides pain relief, improved grip/pinch strength and satisfactory range of motion in patients with degenerative conditions of the wrist
- four-corner arthrodesis with CarpalFix implant outcome results are comparable to or better than results of previously published techniques

**Bibliography**
AM Poster 235: A Prospective Intraoperative Evaluation of the Anatomy of the First Dorsal Compartment in Patients Requiring Surgery for De Quervain’s Tenosynovitis

Category: Wrist

Hand and Wrist; Diseases and Disorders; Practice Management
Level 4 Evidence

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Hypothesis
The wrist’s first dorsal compartment and its contents exhibit considerable anatomic variation, which is believed to play a role in the pathophysiology of De Quervain’s tenosynovitis (DQT). We hypothesized that the anatomic variability of the first dorsal compartment in patients requiring surgery for DQT would differ from literature data which is based primarily on cadaveric studies.

Methods
This prospective cohort study consisted of 130 DeQuervain’s tenosynovitis patients undergoing FDC release. The treating surgeons completed a questionnaire detailing the type of incision utilized, the number of abductor pollicis longus tendon slips, the number of extensor pollicis brevis tendon slips, the number of SBRN branches encountered, the number of additional subcompartments created by any septations, and active/passive tendon stability. Descriptive statistics were performed.

Results
The cohort was predominantly female (83%) and had a mean age of 57 years (Range: 24-82). A singular FDC was found in 37% of cases, while 55% of patients had two sub-compartments and 8% had three. Multiple abductor pollicis longus tendon slips (Range 1-4) were identified in 78% of patients. In contrast, a single extensor pollicis brevis tendon was found in 92% of patients (Range: 0-2). At least 1 SBRN (Range 0-2) was encountered in 61% of cases. Following FDC release, instability was evident in 9% of patients, who had tendons perch with passive wrist flexion. One of these patients (<1%) had the tendons dislocate volarly out of the FDC during active flexion.
Summary Points

• Data regarding the anatomic variability of the first dorsal compartment of the wrist is based primarily on cadaveric studies, and it is unclear whether this variability can be applied to patients with DQT.

• DQT patients had a first dorsal compartment with at least one septation in 63% of cases, a substantially larger proportion compared to normals (44% in a recent systematic review of cadavers).

• We expect to encounter the SBRN during FDC release in greater than 50% of patients but are unconcerned if it is not visualized during a careful approach.

• Tendon instability has an incidence of 9%; however, dislocation is rare (<1%).

• Our study can bolster surgeons’ knowledge of the first dorsal compartment’s anatomical variation in DQT patients, which may lead to a higher success rate of surgical release.
Hypothesis
While the radial styloid screw aids in fixation strength in volar locked plating of distal radius fractures, cortical screw penetration can occur. Defining an intra-operative radiographic view to best determine radial styloid screw position and length may improve fixation and aid in decreasing cortical penetration and resulting hardware complication. We utilized a cadaveric model to demonstrate a reproducible, oblique radiographic view to identify radial styloid screw position.

Methods
Nine fresh-frozen cadavers including elbow to fingertips were utilized for this study. A 2.4-mm variable angle volar distal radius locking plate (Synthes, West Chester, PA) was applied to the volar aspect of the radius. A kirschner wire (k-wire) was inserted into the radial styloid through the plate. Placement of the tip of the k-wire through the tip of the styloid at the cortical edge was confirmed through a separate radial incision. A second k-wire was placed through the radius shaft into the ulna to aid in angular measurements. Live fluoroscopic imaging was then utilized as the forearm was brought from 90 degrees full supination towards pronation. Once the k-wire was identified as abutting the cortical edge, rotation ceased, and a goniometer was utilized to measure the angle of forearm rotation. This was repeated two more times for a total of three repetitions on each cadaver.

Results
The average angle of supination best depicting the position and length of the radial styloid screw was 68.5 degrees (range 64.3-70.5 degrees).
Summary Points

• Radial styloid screw fixation in locked volar plating of distal radius fractures increases ultimate strength to failure, but cortical screw penetration and resulting hardware complication can occur.

• The 70 degree supinated oblique intra-operative view provides the most accurate evaluation of the position and length of the radial styloid screw.

• We recommend obtaining a 70 degree supinated oblique view as part of the final intra-operative radiographs for volar locked plating of distal radius fractures to evaluate radial styloid screw position.

Bibliography


Hypothesis
The outcomes of ten consecutive cases of bilateral DRF treated with open reduction and internal fixation (ORIF) at our institution are described. We hypothesized that patients with bilateral DRF treated surgically would have an increased incidence of complications relative to their unilateral counterparts.

Methods
We retrospectively searched our electronic medical records data for all patients 18 years of age or older treated surgically for bilateral DRF over a six-year period (2011-2016). Patients with less than one year of follow up were excluded. Patient demographics, fracture classification, fixation method, post-operative complications, QuickDASH scores, wrist range of motion (ROM), and radiographic measurements of X-rays at final follow up were collected and analyzed.

Results
Ten patients with twenty fractures were assessed. Our cohort was predominantly female (80%), with a mean age of 63 years and 2.4 years of follow-up on average. Per AO/OTA fracture classification, 80% of fractures were C1 or C2 and the remaining 20% were A3 fractures. A volar approach for ORIF was utilized in 90% of cases. Six of twenty (30%) wrists experienced post-operative complications and required hardware removal. Mean QuickDASH score was 24.8 at final follow-up. On average, ROM reached 58° extension, 52° flexion, 75° pronation, and 75° supination. Mean measurements of radial shortening, radial inclination, and volar tilt taken from final postoperative radiographs were 1.3mm, 21.2°, and 7.8°, respectively.
Summary Points

- Bilateral DRF is an uncommon injury rarely covered in the literature.
- This is the first study to analyze outcomes and complication data in bilateral DRF patients treated with concomitant ORIF.
- Functional outcomes, recovery of wrist ROM, and restoration of radiographic parameters are comparable to those seen in patients with ipsilateral DRF.
AM Poster 238: Range of Lesions of Extrinsic Wrist Ligaments in Patients with Complete Tear of the Scapholunate Interosseous Ligament: A Radiographic Study

Category: Wrist

Hand and Wrist; Diseases and Disorders; General Principles
Level 3 Evidence

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Hypothesis
The long radiolunate ligament, radiopalmar scaphotrapezial ligament, and dorsal intercarpal ligament lesions have a high prevalence in complete scapholunate interosseous ligament (SLIL) tears and are significantly associated with the presence of dorsal intercalated segmental instability (DISI).

Methods
Patients ages =18 who had wrist radiographs and MRI at our institution from 2007-2016 with an intraoperative diagnosis of complete SLIL tear or intact SLIL (control group) were included in this retrospective study. Ligament injury was evaluated as complete tear, partial tear, plastic deformity (defined as hyperintensity and thickening without partial or complete discontinuity), or intact on coronal and sagittal cartilage-sensitive fast spin MRI echo sequences by one musculoskeletal MRI radiologist. The following ligaments were evaluated: long radiolunate (LRL), short radiolunate (SRL), radioscapohapitate (RSC), dorsal radiocarpal (DRC), dorsal intercarpal (DIC) and radiopalmar scaphotrapezial (rST). Presence of DISI (RL angle > 15o) and SL instability (SL angle > 60o) were measured on lateral wrist radiographs by two independent orthopedic surgeons. Categorical data was analyzed using Fisher’s Exact test and ordinal data was analyzed using Wilcoxon rank-sum tests.

Results
Twenty-five patients with complete SLIL tear and twenty-five patients with intact SLIL met the inclusion criteria. Compared with controls, patients with complete SLIL tears had more severe tears of the LRL (p<0.005), DIC (p<0.005), and rST (p=0.006). No differences in severity of tears of
the DRC (p=1.00), RSC (p=0.90), and SRL (p=0.47) were noted. Between the 6 ligament groups, no group had significantly higher rate of SL instability (p=0.63) or DISI deformity (p=0.61). Patients having SL instability (n=19) had torn LRL (47%), rSTT (32%), and DIC (32%). Patients having DISI deformity (n=16) had torn DIC (38%), LRL (31%), and rSTT (25%). No patients with DISI deformity or SL instability had partial or complete tears of SRL, RSC, and DRC.

Summary Points

- LRL, DIC and rSTT have ligaments have significantly higher tear severity in the complete SLIL tear vs. control group (intact SLIL).
- No single ligament tear was associated with SL instability or DISI.
- Our results suggest that an individualized repair of the LRL, DIC or rSTT repair at the time of SL reconstruction may be warranted.

Bibliography


Hypothesis
Osteochondral reconstruction of proximal pole scaphoid nonunions with avascular necrosis has been demonstrated using medial femoral trochlea and rib autografts. We hypothesize that the proximal pole of the hamate is a suitable donor for proximal pole scaphoid reconstruction, with similar size and morphometric dimensions.

Methods
Ten cadaver specimens (5 male, 5 female) were dissected. Measurements of the proximal poles of the scaphoid and hamate bones were independently performed by two of the authors using electronic calipers and standard radius of curvature gauges [Figure 1]. The average values of the two observers’ measurements were used for analysis. Statistical analysis was performed on the measurements of the scaphoid and hamate using Student’s paired t-test.

Results
Measurements were compared between the proximal poles of the scaphoid and hamate for sagittal radius of curvature (ROC), coronal ROC, height, width, and maximum graft length. There were no statistically significant differences between the average height of the scaphoid proximal pole (12.3 ± 1.2 mm) compared to the proximal hamate (11.3 ± 1.2 mm) (p=0.36) or the average width of the scaphoid (7.8 ± 1.0 mm) compared to the proximal hamate (8.60 ± 1.05 mm)(p=0.09). Similarly, there was also no significant difference in the sagittal ROC between the hamate (9.1 ± 1.1 mm) and scaphoid (9.5 ± 0.8 mm) (p=0.36). There was a statistically significant difference between the coronal ROC of the hamate (23.4mm) and scaphoid (21.1mm) in our cadaveric samples (p=0.03). Additionally, we found a difference in size for male versus female cadaveric scaphoids and hamate, with females having smaller bones. However, there was no statistically significant difference in fit between the scaphoid and hamate measurements based on gender alone.
Summary Points

- The proximal poles of the scaphoid and hamate bones have similar morphology and size, with mean measurements of height, length, and sagittal ROC all within 1mm.
- Further clinical investigation with follow-up is needed to determine the effectiveness of proximal hamate osteochondral reconstruction as a procedure for proximal pole scaphoid nonunions with avascular necrosis.
AM Poster 240: Non-Inferiority of 2.4mm vs. 2.7mm Cortex Screws for Distal Radius Plate Use

Category: Wrist

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Hypothesis
Two-column volar distal radius plates are used in intra- and extra-articular fractures, nonunions, and malunions of the distal radius with or without extensions into the radial diaphysis. Limited information is available in the non-inferiority of a distal radius plate construct with 2.4mm vs. 2.7mm cortex screw. The study hypothesis was that the construct strength of the VA-LCP 2-column volar distal radius plate secured with 2.4mm cortex screws would be non-inferior to the construct strength of the plate secured with 2.7mm cortex screws, with an 11N non-inferiority margin, based on axial compressive testing.

Methods
An MTS Static Axial Test Frame with a 500 N Load Cell (MTS Systems Corporation, Eden Prairie, MN) was constructed to evaluate the construct strength of 2.4mm vs. 2.7mm cortex screws. The test specimen components (Figure 1) consisted of 2.4mm/2.7mm VA-LCP 2-Column Volar Distal Radius Plate, 3-hole shaft, Wide, Right, Stainless Steel with Test Construct A: one-2.4mm Variable Angle Stainless Screw, and two-2.4mm stainless steel cortex screws; and Test Construct B: one-2.4mm Variable Angle Stainless Screw, and two-2.7mm stainless steel cortex screws (DePuy Synthes, West Chester, PA). 14 samples were tested for each construct. The test constructs were loaded at a rate of 5mm/min until a clear ultimate load was determined. Data from both constructs were tested both for normality and equal variances to support evaluating the data with a two-sample one-sided T-test.

Results
Mean peak load was 358N for Construct A with 2.4mm cortex screws and 364N for Construct B with the 2.7mm cortex screws. The failure mode was construct yielding, no fractures were observed. Figure 2 shows the box plot summary of peak load for both Constructs. Anderson Darling Normality Test p-value for Construct A was =0.292 and p-value for Construct B
was=0.414 (p-value>0.05, assume normality). Levene’s Test for Equal Variance was 0.869 (p-value>0.05=assume equal variance). The test failed to meet the original acceptance criteria, therefore the data was analyzed to report at what margin Construct A is non-inferior to Construct B. The Construct A Peak Load was non-inferior to the Construct B Peak Load (p-value=0.049) with a non-inferiority margin of 14.8N.

Summary Points
- The 2.4mm test construct is physically non-inferior to the 2.7mm test construct with a 14.8N non-inferiority margin (4.1%).
- Surgeons now have information on test construct strength when choosing between the 2.4mm and 2.7mm cortex screw (in conjunction with clinical considerations).
AM Poster 241: Surgical Repair of Distal Radius Fractures Decreases Salvage Procedures

Category: Wrist

Hand and Wrist; General Principles
Level 2 Evidence

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Eric Angermeier, MD

Hypothesis
Distal radius fractures are one of the most common types of fractures, and are increasing in incidence. We performed a population-level analysis comparing surgical fixation to closed treatment of distal radius fractures to determine the rate of salvage procedures required depending on the treatment, with the hypothesis of surgical treatment of fractures would decrease need for salvage procedures.

Methods
Using the Truven MarketScan database from 2010 to 2014 we identified patients 18 years or older that sustained a distal radius fracture, with open treatment vs closed treatment tracked by CPT codes, and were followed for at least 1 year. Rates of patients undergoing a salvage procedure after this were tracked, and the types of salvage procedures were distinguished. Salvage procedures were grouped into repairs of malunion/nonunion, total wrist fusion, partial fusions, wrist arthroplasty and distal radioulnar joint (DRUJ) procedures by CPT codes. A chi-square test was used to compare the two groups.

Results
During this time frame, a total of 31,760 patients suffered a distal radius fracture. Of these patients, 14,981 (47%) underwent surgical fixation. Of patients that underwent surgical fixation, 236 (1.57%) underwent a salvage procedure compared to 327 (1.94%) of patients that were initially treated closed. The majority of salvage procedures performed were malunion/nonunion repairs, with a significant difference shown with 164 performed in the surgery group and 240 performed in the closed group (p<.001). There was also a significant difference in DRUJ group with 23 procedures performed in the surgery group and 43 in the closed group (p<.001). There was no significant difference in total fusions, 43 in the surgery group and 39 in the closed group, 1 in surgery group and 2 in closed group, or arthroplasty 5 in open group and 3 in closed group.
Summary Points

• The incidence of salvage procedures for distal radius fractures was statistically significantly lower in patients that underwent surgical treatment compared to closed treatment, with a 20% reduction in salvage procedures.

• The main difference in outcomes came in salvage procedures done for malalignment and DRUJ arthropathy.

• Given our results we would recommend continued operative treatment for malaligned distal radius fractures, although more work is needed for surgical indications and techniques to decrease post-traumatic intraarticular disease.
Hypothesis
There would be more complications with dorsal percutaneous scaphoid screw fixation compared to a mini-open dorsal approach.

Methods
We retrospectively assessed intra- and post-operative complications in two cohorts of consecutive scaphoid fractures, 44 undergoing dorsal percutaneous scaphoid fracture repair (age 24 +/- 10) and 36 using a small incision (approx. 2cm) mini-open dorsal repair (age 30 +/-16). All scaphoid fractures were acute or fibrous nonunions (less than 6 months from injury) treated with cannulated headless compression screws. Complications assessed: intra-operative guide wire breakage, intra-operative fracture, extensor tendon rupture/dysfunction, infection, persistent pain, radial sensory nerve irritation, CRPS, scar problems, scaphoid screw removal, and intra-articular screw prominence.

Results
There was one intra-operative guide wire that broke in each group, necessitating a small volar incision for removal. In the percutaneous group, there was one case of tingling along the RSN distribution. In the mini-open group, there was one hypertrophic scar. Additionally, one patient in the mini-open group had persistent pain for 6 months post-operatively despite 50% bridging bone on CT scan at 3 months. There were no problems with intra-operative fracture, extensor tendon dysfunction/rupture, or infection. Noteworthy events not included as complications in this analysis include one patient whose fracture could not be reduced with percutaneous joysticks and was converted to volar open approach to achieve adequate reduction.

Summary Points
Complication rates from percutaneous screw fixation of scaphoid fractures in the reported literature range from 0-30%. Techniques are often not well controlled and offer a mix of volar and dorsal instrumentation. We present two cohorts treated by the same surgeon with two
different dorsal techniques and compared their complication rates, specifically analyzing intra-operative complications. There were 2 complications in the percutaneous group (4.5%) and 3 in the mini-open group (8.3%), not statistically significant. All complications except for the hypertrophic scar occurred in patients being treated for delayed union or nonunion fractures. When contrasting these results to a prior published report (ref 1.) with 29% complications (5 major, 2 minor) in 24 patients using a dorsal percutaneous technique, our group had a considerably low complication rate. The rate of minor complications in both groups was low compared to previously reported accounts (ref 2-4.). In conclusion, we were unable to present statistically significant data suggesting fewer complications with mini-open technique. While one report (ref 5) challenges the idea that percutaneous techniques produce better outcomes, we have not identified a difference in complication rates between the two approaches.

**Bibliography**

2. Fixation of nondisplaced scaphoid fractures: making treatment cost effective. Arora, R. 1; Gschwentner, M. 1; Krappinger, D. 1; Lutz, M. 1; Blauth, M. 1; Gabl, M. Archives of Orthopaedic & Trauma Surgery. 127(1):39-46. 2007.
AM Poster 243: The Feasibility and Usability of a Point of Care Conjoint Analysis to Elicit Preferences for Distal Radius Fractures in the Elderly

Category: Wrist
Hand and Wrist
Level 4 Evidence

Lauren M. Shapiro, MD
Sara Lynn Eppler, MPH
Robin Kamal, MD

Hypothesis
A point of care conjoint analysis tool for preference elicitation is feasible and usable for elderly patients with distal radius fractures demonstrating clinical equipoise.

Methods
A conjoint analysis tool was created for operative and non-operative treatment of distal radius fractures using evidence from literature review and clinical practice patterns. Patients fifty-five years or older with a fracture pattern meeting criteria for clinical equipoise were enrolled. A fellowship-trained hand surgeon presented the tool, explained the options, and participants rated attributes and levels and distributed points accordingly. Usability was assessed using the validated System Usability Scale (SUS), a questionnaire scored from 0-100 in which a score of 68 or greater indicates above average. Feasibility was assessed by recording the time to complete the conjoint analysis.

Results
Twenty-one patients completed the conjoint analysis [76.2% female, 57.1% treated non-operatively, mean age 67.5 (SD±8.6)]. The average SUS score was 91.6 (SD±12.0). Average completion time was 4.6 minutes (SD±1.2). Attribute importance scores demonstrated that grip strength at one year, use of anesthesia, and time immobilized were the most important to patients.

Summary Points
- A conjoint analysis tool is feasible and usable for preference elicitation in elderly patients with distal radius fractures
- Conjoint analysis can be used as a reproducible process to facilitate shared decision-making
- Implementation of this tool may improve patient-centered care
Bibliography


Hypothesis
The incidence of operative treatment of distal radius fractures has steadily increased over the past 20 years likely as a result of improved fixation options and a better understanding of the deleterious effects of residual deformity at union. Furthermore, early fixation of extraarticular distal radius fractures has been shown to improve short term functional outcomes.1–3 We hypothesized that an increase in time to fixation of intraarticular distal radius fractures would increase the likelihood of postoperative complications. Secondarily, we predicted that patients who suffered complications would have had longer tourniquet times, worse range of motion (ROM), and longer time to fracture union.

Methods
A retrospective chart review of adult patients (aged 18-90) who underwent open reduction and internal fixation (ORIF) of an intraarticular distal radius fracture by a fellowship-trained hand surgeon at our institution over a 10.5-year period (3/2007 – 8/2017) was performed. Patients undergoing concomitant fixation of ipsilateral upper extremity fractures, revision fixation, or concomitant nerve or soft-tissue procedures were excluded. Those cases which met inclusion criteria were reviewed for time to surgery (TTS) from injury, age at surgery, gender, smoking status, fixation construct, tourniquet time, complications (inclusive of infection and secondary surgeries), final postoperative ROM, and time to union. Logistic regression analysis was used to compare TTS, total wrist ROM and time to union between patients with and without postoperative complications with p < 0.05 indicating statistical significance.
Results
In total, 212 fractures in 207 patients which met inclusion criteria were identified and reviewed. Forty (18.9%) patients were identified to have postoperative complications. The mean TTS for all patients was 9.2 days. The mean TTS was slightly higher if postoperative complications occurred; though, not significant (10.8 vs 8.9 days; p=0.19). The mean tourniquet time for all patients was 70.8 minutes. Tourniquet time was significantly higher in patients who experienced complications than in those who did not (78.9 min vs. 69.3 min; p=0.03). No statistically significant correlations with respect to time to union (p=0.7) or final wrist ROM (p=0.7) were observed between those patients who did and did not experience complications. Based on our regression model, patients who undergo surgery on the date of injury have an 11% risk of postoperative complications. This increased by 50% at 14.9 days post-injury, and doubles by 25.9 days post-injury. Tourniquet time is significantly longer in operative distal radius fracture patients who experience complications. TTS does not significantly impact the incidence of postoperative complications.

Bibliography
AM Poster 245: The Effect of Operation Time on Rates of Postoperative Complications After Operative Treatment of Distal Radius Fractures

*Category: Wrist*  

Hand and Wrist; General Principles; Practice Management  
Level 4 Evidence

Shane Sobrio, BS  
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**Hypothesis**  
Longer surgical times may correlate to higher postoperative complications, while higher re-operation rates may be associated with more rapidly performed procedures.

**Methods**  
Data was collected from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) for surgeries for distal radius fractures from 2005 through 2014. Data collected include demographic information, comorbidities, and postoperative complications occurring within 30 days of surgery.

Subjects were identified using Current Procedural Terminology (CPT) codes. Primary CPT codes 25607, 25608, 25609 were used to identify patients receiving distal radius fractures repairs. Diagnosis codes were used to filter all fractures of distal radius only. 4572 patients were identified, with the shortest surgery lasting 5 minutes and the longest surgery lasting 294 minutes. The mean length of surgery was 73.03 minutes and the median was 66 minutes. The standard deviation was 34.14 minutes.

Data on patients’ demographics, and postoperative complications were analyzed with SPSS software. Univariate analysis was performed using Chi-square and one-way ANOVA when appropriate. Linear regression analyses were performed with operation time as a continuous variable and all comorbidities being controlled for. This was to determine the presence of independent predictors of surgical complications.

**Results**  
Out of 4572 patients, 47 total complications were discovered for a complication rate of 1.03% overall. Logistic regression analysis determined that operation length independently predicted
increases in 2 postoperative complications after distal radius fracture repair: superficial SSI (OR 1.02, p=0.028), and urinary tract infection (OR: 1.02, p=0.003). Operation length was not found to be an independent predictor of any other surgical complication. Only complications that occurred at least 1 time in the study were included in Table 1.

Summary Points

- Complications from distal radius fracture repair surgeries are low.
- The average length of surgical repair of a distal radius fracture is near 73 minutes with a large amount of variability, with some surgeries finishing in as quickly as 5 minutes and some finishing in as long as near 5 hours.
- Operation length was shown to be a significant predictor of superficial SSI and urinary tract infection.
- Surgeons should be aware of the increased risk of longer operations while taking the appropriate time for the procedure.
AM Poster 246: A Prospective Randomized Comparison of Variable-Angle and Fixed-Angle Volar Locking Plating for Dorsally Displaced Unstable Intra-articular Distal Radial Fractures

*Category: Wrist*

Hand and Wrist
Level 2 Evidence

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**Hypothesis**
We hypothesized that variable-angle volar locking plates (VAVLPs) would provide better functional and radiographic outcomes than fixed-angle volar locking plates (FAVLPs) for the treatment of dorsally displaced unstable intra-articular fractures of the distal radius.

**Methods**
Fifty-eight consecutive patients with dorsally displaced unstable intra-articular fractures of the distal radius were randomized to open reduction and internal fixation with a VAVLP (APTUS Radius 2.5, Medartis, Basel, Switzerland) (n=29) or a FAVLP (Stellar 2, HOYA Technosurgical, Tokyo, Japan) (n=29). The patients were evaluated at 6 weeks, 3 months, 6 months, and 1 year after surgery. Outcome was measured on the basis of active wrist range of motion; grip strength; the Patient-Rated Wrist Evaluation (PRWE) score; Disability of the Arm, Shoulder, and Hand (DASH) score; and standard radiographic parameters.

**Results**
There were no significant differences in the demographic characteristics or fracture severity between the groups (p > 0.05). Two patients in both groups required supplementary Kirschner-wire fixation to hold small intra-articular fragments. At 1 year, there were no significant differences between the groups in terms of the range of motion, grip strength, PRWE and DASH scores (p > 0.05). The average PRWE score at 1 year was 6 in VAVLP group and 7 in FAVLP group. Volar tilt was significantly greater in FAVLP group in the immediate postoperative period and at the time of the latest follow-up (p = 0.02). Two patients with VAVLP and 1 patient with FAVLP had an intra-articular gap or step-off greater than 2mm at the latest follow-up. Two patients with VAVLP lost volar tilt greater than 10 degrees due to locking screw loosening. One patient with
VAVLP had deep infection. There were no patients with complex regional pain syndrome or tendon rupture.

**Summary Points**

- The fixation with VAVLP and FAVLP restored and maintained acceptable reduction and provided equal functional outcomes for the treatment of dorsally displaced unstable intra-articular fractures of the distal radius.
- However, use of VAVLP risks loss of volar tilt due to locking screw loosening.
Hypothesis
Patients with diabetes mellitus will have increased complications following operative treatment of distal radius fractures than their non-diabetic counterparts.

Methods
Data was collected from the ACS National Surgical Quality Improvement Program (ACS-NSQIP) for all operative treatments for distal radius fractures from 2005 through 2014. Data collected include demographic information, comorbidities, and complications occurring within 30 days of initial surgical intervention.

Subjects were identified using Current Procedural Terminology (CPT) codes. Primary CPT codes 25607, 25608, 25609 were used to identify patients receiving distal radius repair. Two patient cohorts were defined in this study: (1) patients without diabetes mellitus, and patients with diabetes mellitus. Differentiation was not made between type I and type II diabetics. 4897 patients were included in the analysis, including 4478 patients identified as non-diabetics, and 419 patients identified with diabetes.

Data was analyzed with both univariate and multivariate analyses on SPSS software. Univariate analysis was performed using Chi-square or one-way ANOVA when appropriate. Variables with $p<0.200$ were selected for multivariate analyses. For the multivariate analyses, logistic regression analyses were performed to determine independent predictors of extended hospital stay and post-operative complications.

Results
Demographics showed diabetics VS non-diabetics had significant differences in age ($p<0.001$), race ($p<0.001$), and body mass index ($p<0.001$). Preoperative comorbidity analysis showed the
diabetic group had significantly higher rates of smoking (p=0.015), hypertension on medication (p<0.001), renal failure (p=0.001), steroid use (p<0.001), preoperative transfusion (p=0.036), bleeding disorder (p<0.001), dyspnea (p<0.001), and functional status (p<0.001).

Out of the 4897 total patients analyzed in the data, 63 total complications were discovered for a complication rate of 1.29% overall, not including reoperation or readmission data. Upon univariate analysis, the diabetic group was shown to have a significantly higher rate of deep SSI (p=0.001), wound dehiscence (p=0.001), acute renal failure (p=0.001), cardiac arrest (p=0.001), sepsis (p=0.012), septic shock (p=0.001), and DVT (p=0.001). After controlling for comorbidities in the multivariate analysis, diabetes was not found to be an independent predictor of any postsurgical complications.

Summary Points

- Complications after surgical repair of distal radius fractures are low.
- Though diabetes has been shown to be a significant predictor of postsurgical complications, it is not a significant predictor of complications in our analysis of the NSQIP data regarding distal radius fracture repairs, likely as a result of the minimally invasive nature of the surgery compared to many other procedures.
- Surgeons should remain vigilant regarding postoperative complications in diabetic patients, regardless of our study’s results.
AM Poster 248: Long-term Outcomes of Scaphoid-Hemi-Resection and Arthrodesis of the Radiocarpal Joint

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
Clinical Review of patients who have undergone the SHARC procedure with greater than 8 years follow-up will demonstrate persistent relief of pain, functional mobility, strength and endurance.

Methods
This procedure has demonstrated in early and midterm follow-up to provide stable resolution of the painful radiocarpal articulation through arthrodesis and enhancement of mid carpal motion by eliminating the "bridging strut "provided by the distal one half of the scaphoid. In order to assess long-term outcomes, all patients (N=32) who have undergone the SHARC procedure in our institution, where it was originally developed and described greater than 8 years following surgery were clinically evaluated and their charts and radiographs were reviewed regarding pain, range of motion, functional ability, radiographic appearance and level of satisfaction using the Quick Dash and PRWE Upper limb evaluation tools.

Results
All patients demonstrated a complete and successful radiocarpal arthrodesis. 4 demonstrated some degree of mid carpal arthritis. 2 required revision, performed successfully, to total wrist arthroplasty. 1 patient required hardware removal due to tendon irritation. There were no infections, no tendon ruptures and pain was rated as 1.8 on the VAS scale. Overall motion measured 40-50% of normal with a functional arc of circumduction allowing a wide array of functional activities. Radiographs revealed maintenance of functional mid carpal joint articulations in 88% and overall patient reported satisfaction was high (including in those patients who required revision surgery to TWA).
Summary Points

- Advanced radiocarpal arthritis precludes some motion sparing procedures, such as proximal row carpectomy or 4 corner fusion. Previous alternatives have been either total wrist arthrodesis or total wrist replacement arthroplasty.
- Scaphoid hemiresection and arthrodesis of the radiocarpal joint is an enduring, successful procedure in alleviating arthritic radiocarpal pain while preserving/enhancing functional mobility through the mid carpal joint at long-term follow-up. In the few patients in whom the arthritic process has progressed within the mid carpal joint conversion to successful total wrist replacement arthroplasty has been possible.
- Successful functional outcomes and high patient satisfaction rates comparable to other motion sparing wrist surgical procedures has been maintained through long-term follow-up evaluation.

Bibliography

1: Sraj, SA. Seitz, WH. Scaphoid Hemiresection and Arthrodesis of the Radiocarpal Joint Techniques in Hand & Upper Extremity Surgery. Volume 14, Number 3
AM Poster 249: Distal Radius Fractures with Methaphyseal-Diaphyseal Comminution – Results from Fixation with Long Volar Locking Plates

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Pedro X. Fernandes
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Hypothesis
Distal radius fractures with methaphyseal-diaphyseal comminution result from high energy trauma and are challenging to treat. Long volar locking plates are a valid option and obtain good results and a limited range of complications.

Methods
From 2011 to 2017 we treated all consecutive comminuted methaphyseal-diaphyseal distal radius fractures with open reduction and fixation with long volar locking plates. We used the AO classification. We measured the reduction obtained and recorded time to consolidation. At latest follow up the wrist’s range of motion and Quick DASH score were obtained. The statistical analysis was based on IBM® SPSS® Statistics 21 program and applied T-test, Pearson Correlation and ANOVA.

Results
We have treated 15 consecutive wrists (14 patients), average 62.78 years of age (38 to 85), 8 females and 6 males. The fractures were AO 23-C3 (7 cases), AO 23-A3 (5 cases) and AO 23-C1 (3 cases). There were 5 open fractures, Gustillo-Anderson type II (3 cases), type I (1 case) and III (1 case), 3 of these treated initially with external fixator. There was a distal ulnar fracture in 9 cases, of which 5 had locking ulnar plate osteosynthesis, 1 had trans-osseous suture of the ulnar styloid and 2 had nothing done. The average follow up time was 29.2 months. Fractures healed at 16.1 weeks (5 to 22). Post operative radial shortening was 1.5mm, distal radial ulnar inclination was 27.4º and the volar tilt was 5º. The final range of motion was within functional range. There were complications in 8 cases, 3 early ones, all in open fractures, that required reoperation (infection, wound dehiscence and loss of reduction). There were 5 late complications of which 3 required surgery (EPL rupture, FPL rupture and stiffness). The QuikDASH was 29.1 (0 – 72.7). There was no significant correlation between the functional result and age, fracture classification or being an open fracture.
Summary Points

• Distal radius methaphyseal-diaphyseal fractures have good clinical results when treated with volar locking plates
• Open fractures don’t have worse final clinical results
• Open fractures have more early complications

Bibliography

2: Rampoldi M et al, Distal radius fractures with diaphyseal involvement: fixation with fixed angle volar plate, J Orthopaed Traumatol (2011) 12:137-143
AM Poster 250: Inter- and Intra-Rater Reliability of the Assessment of Scapholunate Instability Utilizing Four-Dimensional Computed Tomography (4DCT)

**Category:** Wrist

Hand and Wrist
Level 4 Evidence

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John Hopkins
Daniel Squire, MD
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**Hypothesis**
Four-dimensional CT (or 4D CT) scans are a novel approach to diagnosing scapholunate instability. The objective of this pilot study is to evaluate the inter- and intra-rater reliability of the assessment of scapholunate stability utilizing 4D CT wrist scans.

**Methods**
4D CT scans of thirteen healthy volunteers and four patients with scapholunate instability were prepared. Seven orthopaedic and plastic surgeons were recruited to qualitatively assess the stability of the scapholunate joint in the 4D CT scans. Statistical analysis included percent agreement, Fleiss’ kappa, and Gwet’s AC1 coefficient.

**Results**
The percent agreement amongst all raters was 0.80392 (95% CI: 0.675 - 0.932). Fleiss’ Kappa was 0.54895 (95% CI: 0.252 - 0.846) and Gwet’s AC1 was 0.54895 (95% CI: 0.391 - 0.915). The intraclass correlation coefficient (ICC) for intra-rater reliability was 0.71631 (95% CI: 0.5567 - 0.8423).

**Summary Points**
- This pilot study suggests good inter- and intra-rater reliability for the qualitative assessment of scapholunate instability in 4D CT scans
- Further studies are required to validate the accuracy of scapholunate 4D CT scans
- There is a potential future role for 4D CT as a non-invasive diagnostic modality for scapholunate instability
AM Poster 251: The Effect of Carpal Alignment on Post-Operative Range of Motion After Four Corner Fusion in Wrists with Type 1 Lunates

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Ruby Grewal, MD, MSc, FRCSC
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Hypothesis
Restoring carpal alignment during four-corner fusion (4CF) has been reported in the literature to affect post-operative motion and functional recovery. However, these studies did not investigate whether underlying bone morphology affected post-operative outcomes. The purpose of this study was to understand the true effect of sagittal and coronal plane alignment in 4CF by standardizing the pre-operative population to specifically examine patients with type 1 lunates.

Methods
A retrospective chart review of a single-surgeon's practice over a six-year period was conducted to identify 37 patients with 38 wrists that underwent 4CF with headless compression screw fixation. The final cohort consisted of 15 patients with 15 lunate type 1 wrists. Our primary functional outcomes of interest included percentages of maintained pre-operative flexion-extension arc (FEA) and grip strength. Pre- and post-operative radiographs were analyzed to obtain the lunocapitate and radiolunate angles in the sagittal plane and the capitolunate relationship in the coronal plane. Scatterplots of primary functional outcomes were created to confirm that a linear relationship existed. Pearson correlation coefficients of carpal alignment parameters and primary outcome data were also analyzed and compared.

Results
Pre-operative lunocapitate angle (LCA) (mean 13.08, SD 8.99) was most highly correlated with the percentage FEA maintained post-operatively (mean 112.93, SD 129.76), with many patients having actually improved their range. In fact, the greater the LCA pre-operatively, the greater the patient had maintained their range post-operatively ($r = 0.77$). Furthermore, LCA correction (mean 1.19, SD 9.44) was positively correlated with percentage maintained FEA ($r = 0.52$). With regards to the capitolunate relationship on coronal plane (mean 3.85mm, SD 2.27), correcting the radially translated capitate to a position directly in line with the lunate correlated with a greater loss of final FEA ($r = -0.54$). The relationship between radiolunate angle and functional
outcomes was negligible. Grip strength was not strongly correlated with any alignment parameters.

Summary Points
- Pre-operative LCA is strongly correlated with post-operative range of motion outcomes
- LCA correction to neutral and avoiding translation of capitate to a 'lunate covered' position improves the percentage maintained pre-operative FEA
- Radiolunate angle did not correlate with final FEA of motion
- We were unable to identify any carpal alignment parameters which correlated with grip strength.

Bibliography
Hypothesis
The purpose of this study was a retrospective evaluation of a number of cases, which were prospectively treated, by cartilage evaluation and decompression of the scaphoid, under arthroscopic assistance, adding, as an associate surgical procedure, the metaphyseal core decompression of distal radius, for the purpose of revascularization

Methods
Six cases of PD were treated, 4 patients were retrospectively evaluated with a minimum follow up of 1 year. All female, two dominant hand. Average age was 31.5 years (range 23-41). Mean follow-up time was 46 months (range 14-96). Preoperative evaluation was made by clinical examination of the wrist, scaphoid ‘s X-Rays projections, and MRI. According to the classification of Herbert & Lanzetta modified by Kalainov, we recorded Stage I: one case, Stage II: 2 cases and only one patient as stage III. We have adapted, the arthroscopic classification of Kiënbock to PD disease, to decide if was possible to make arthroscopic treatment. All cases have received arthroscopic treatment with this sequence: -evaluation the status of the cartilage,- synovectomy,-decompression of the scaphoid with biopsy, and metaphyseal core decompression of distal radius. Postoperative evaluation included VAS score, range of motion, grip strength and X-ray exam to determinate the progression or not of the osteoarthritis of radio-scaphoid joint.

Results
According to arthroscopic classification, of cartilage changes of the scaphoid, we have observed and classified, two cases in stage 0, one as stage I, and another as stage II. Among the arthroscopic findings, we registered synovitis, attenuation/partial rupture of the scapholunate ligament and fragmentation of the proximal pole; all were treated simultaneously, by debridement. Histopathology confirmed osteonecrosis is all cases. In the final functional evaluation a marked improvement was assessed, from the average 8.2 VAS in the preoperative, to a 0.3 in the postoperative, a motion range of 150 ° and grip strength 90 % compared to the healthy side respectively, and a high patients satisfaction rate, with remission of mechanical symptoms. Further Rx studies showed no progression of collapse of the scaphoid or acceleration of degenerative changes in the wrist.
Summary Points
The debridement and drilling of the scaphoid, by arthroscopy assistance, adding metaphyseal core decompression of distal radius, constitutes a minimally invasive technique that seems to provide functional encouraging results in early stages, especially when the necrosis is located in the proximal pole (Kailanov 2). The core decompression, as in the initials stages of the Kienböck disease, would have the same beneficial effects in this condi

Bibliography
Hypothesis
The clinical importance of prominent hardware volar to the watershed line was established in a landmark study by Soong et al.(1) demonstrating that prominent plates increased the risk of tendon injury.

Our hypothesis is that there is a difference in volar prominence as defined by the Soong Grading between DVR Crosslock plates and Variable Angle LCP plates as a result of different positioning due to plate design.

Methods
A total of 400 patients that underwent open reduction and internal fixation between November 2013 and January 2018 were included in this study. Cohort 1 was defined as 200 consecutive patients treated with DVR plates (ZimmerBiomet, Belrose, Australia) in this period. Cohort 2 were 200 consecutive patients who had volar plate fixation with Variable Angle LCP plates (DePuy Synthes, North Ryde, Australia) in this period. There were no differences in baseline demographics between both cohorts. Surgery was carried out by 67 different respective primary surgeons. Two independent reviewers categorized post-operative standardized lateral wrist radiographs into Soong Grade 0, 1 or 2. Chi-Square test was applied to determine if the differences in Soong categorical ratings between the two cohorts were significant.

Results
In cohort 1, 87 plates (43,5%) were not prominent volar to the watershed line -Grade 0-, 95 plates (47,5%) demonstrated Grade 1 prominence and 18 plates (9,0%) demonstrated Grade 2 prominence. In cohort 2, 63 plates (31,5%) were Grade 0, 103 plates (51,5%) were Grade 1 and
34 plates (17%) had Grade 2 prominence on- and volar to the watershed line. These radiographic results show a greater incidence of volar plate prominence with respect to the watershed line, as defined as Soong Grades 1 and 2 in cohort 2 (Chi-Square test, p=0.003).

Summary Points
- The Variable Angle LCP plate results in more prominent volar positioning with respect to the watershed line in clinical practice in a large cohort of patients in the hands of a generalizable group of respective Orthopaedic Trauma surgeons, as compared to the DVR Crosslock plate.
- In previous studies, it has been well established that patients with a more prominent plate are exposed to a higher chance of iatrogenic flexor tendon rupture.
- Plate design may direct plate positioning in clinical practice, and thus increase the chance of tendon rupture based on design factors rather than surgeon factors.
- A subsequent follow-up study will define the clinical significance of these cohorts

Bibliography
AM Poster 254: Diagnostic Performance of Distal Radioulnar Joint (DRUJ) Ballottement Test for Detecting Triangular Fibrocartilage Complex (TFCC) Foveal Tears and Ulnocarpal Impingement Syndrome (UIS)

Category: Wrist

Hand and Wrist
Level 4 Evidence

Akio Iida, MD
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Hypothesis
Patients with TFCC foveal tears and UIS may have DRUJ instability. Assessment of DRUJ instability using manual stress test may provide reasonable diagnostic accuracy to distinguish patients with these pathologies from patients with the other ulnar wrist problems.

Methods
From 2006 to 2017, 65 patients with ulnar wrist pain were enrolled in this study. Diagnosis of these patients were confirmed by open or arthroscopic surgery. There were 30 patients with foveal tear of the TFCC, 15 with UIS, 9 with disc tear of the TFCC, 4 with osteoarthritis of the DRUJ, 5 with extensor carpi ulnaris tendinitis, 2 with lunotoriquetral ligament injury. DRUJ ballottement test were performed by a hand surgeon to evaluate DRUJ instability at the initial visit to our hospital. DRUJ instability was classified into four grades (grade 0: stable joint, grade 1: DRUJ less stable than intact contralateral side, grade 2: lack of endpoint in either the dorsal or palmar direction, grade 3: no endpoint in either direction) according to Nakamura’s criteria. We compared the DRUJ instability grades between three groups; patients with TFCC foveal tear, patients with UIS and patients with the other pathologies, using analysis of variance and post hoc test of Bonferroni correction. Then, we analysed diagnostic accuracy for detecting two groups; patients with TFCC foveal tear or UIS, and patients with the other pathologies.

Results
The instability grade averaged 1.7±0.7 in patients with TFCC foveal tear, 1.5±0.8 in patients with UIS, 0.8±0.9 in patients with the other pathologies. The grade in former two groups were significantly larger than that in the third group. When a positive test was defined as grade 1 or higher, the sensitivity, specificity, and accuracy of the DRUJ ballottement test in distinguishing the patients with TFCC foveal tears or UIS from the patients with other pathologies were 89%, 45%,
and 75%, respectively. When a positive test was defined as grade 2 or higher, and accuracy were 67%, 75%, and 69%, respectively.

Summary Points

- Assessment of DRUJ instability using manual stress test provided reasonable diagnostic accuracy to detect patients with TFCC foveal and degenerative tears by UIS.
- When the DRUJ in the affected wrist is less stable than the contralateral side and has an endpoint, these findings are sensitive but not specific for diagnosing TFCC foveal tears and UIS.
- When there is no endpoint in the manual stress test, 75% of the subjects have a possibility of other pathologies.

Bibliography

Hypothesis
Although common practice in South-Australia, the efficacy of DTVs (coined as the Lleyton Hewitt View in SA) has not been evaluated in a large prospective cohort to date. We hypothesize that in one-third of patients, dorsally protruding screws are changed per-operatively when obtaining additional DTVs.

Methods
At one level I trauma center, we prospectively included 100 patients (70 females and 30 males) with an average age of 57 years (range, 18 to 89 years) undergoing volar plating for 39 extra-articular (AO Type A), 39 simple articular (AO Type B), and 22 complex articular fractures (AO type C) between September 2016 and May 2017. All fractures were surgically treated by senior registrars under supervision of attending consultants. Variable angle locking compression plates (VA-LCP, Synthes, North Ryde, NSW, Australia) with 4 distal holes in 68 cases, and 5 distal holes in 32 cases were used, including 7 Volar Rim plates. Surgeons were instructed to save all DTV views (the forearm placed in 75 degrees inclination on the horizontal arm table, and the wrist held in maximum flexion) – including fluoroscopy views that included protruding screws – to our Digital Archiving Systems, and document change of screws (Figure 1). The lengths of screws changed were documented prospectively.

Results
Efficacy (defined as change of screws) of DTVs after volar plating of distal radius fractures is 31%. DTVs revealed dorsal cortex protrusion in 26 of 100 included fractures (26%) with an average screw length of 20.8 mm (range, 26 to 12 mm) changed to 18.1 mm (range, 22 to 10 mm): 16
radial styloid screws, nine 2nd from radial-, five 2nd from ulnar- and five ulnar sided screws were changed. Treating surgeons decided to change to longer screws in 5 cases with lengths from 16.4 mm (range, 20 to 14 mm) to 20.0 mm (range 24 to 16 mm). One patient had an extensor pollicis longus (EPL) rupture, which may have been caused by either a protruding screw that was not identified on DTV, or fracture fragment spica obscuring the obtained view as identified on computed tomography.

**Summary Points**

- Obtaining additional DTVs (aka Lleyton Hewitt View in South Australia) is efficient
- Obtaining additional DTVs leads to change of screws in almost one-third of cases in order to avoid potential iatrogenic extensor tendon rupture after volar plating for distal radius fractures
- Accuracy of the DTV is unknown and subject of a future large prospective cohort study
Hypothesis
Both dorsal cortex and intra articular screw penetration may cause iatrogenic complications after volar plating for distal radius fractures.
Our hypothesis is that other (additional) imaging strategies have higher efficacy, reliability and/or accuracy of detecting screw penetration after volar plating for distal radius fractures compared to the conventional used anteroposterior and lateral fluoroscopic views.

Methods
In this systematic review, we included all retrospective- and prospective in vitro- and in vivo studies analysing imaging strategies to detect protruding screws in distal radius fractures in models, cadavers and/or adult patients that reported diagnostic performance characteristics (i.e. intra- and inter-observer-reliability, efficacy and/or sensitivity, specificity, and accuracy) of respective fluoroscopic views, additional imaging modalities or a combination of these.

Results
35 studies were included. 19 studies reported on conventional fluoroscopic views. 29 studies reported on additional fluoroscopic views including oblique views, 1 study reported on 3D fluoroscopy, 1 study reported on rotational fluoroscopy, 7 reported on ultrasound and 1 study reported at a new strategy using a camera on the drill. 22 studies made direct comparisons, mostly comparing a new fluoroscopic view or ultrasound to conventional anteroposterior (AP) and lateral views.

PA and lateral views have low reliability, efficacy and accuracy compared to additional fluoroscopic views and imaging techniques. Additional view such as Dorsal Tangential View,
Carpal Shoot Through view and the Radial Groove View show good reliability, high efficacy and higher accuracy compared to PA and lateral. Based on mainly in vivo studies, ultrasound shows to be reliable, efficient and in some studies more accurate than additional fluoroscopic views. Especially for intra articular screw placement, 3D or 360 degrees fluoroscopy has shown better result than PA and lateral views.

Summary Points
- The authors recommend the use of additional imaging techniques to prevent protruding screws.
- The Dorsal Tangential View - also known as Dorsal Horizon View, Tangential View, Skyline or Hoya view - is most studied and proves to be practical and time efficient, with higher efficacy, accuracy and reliability compared to conventional views.
- In vitro studies and case series show promising results for ultrasound. However, it is questionable whether ultrasound is as useful during surgery.
- Well-designed accuracy studies of new modalities including the Carpal Shoot Through view and the Radial Groove and ultrasound and new techniques could give valuable additional information.
AM Poster 257: The Stability of Intra-articular Distal Radius Fractures
Using Volar Locking Plates with Unicortical and Bicortical Screws

Category: Wrist
Hand and Wrist
N/A - not a clinical study

Antonio T. Neder Filho, MD, PhD

Hypothesis
The mechanical behavior of the model using unicortical screws in the fixation of volar plates in intra-articular fractures of the distal end of the radius is equivalent to the model using bicortical screws.

Methods
The material consisted of forty-two fourth-generation left-hand radius models (Sawbones™; Pacific Laboratories Inc., Vashon, WA; model # 3407). Each model received a Stryker™ Matrix plate and seven screws. They were divided into 6 groups with 7 models in each. Each group underwent a type of mechanical test: axial compression, dorsal flexion, and volar flexion, respectively.

Results
Comparative results between the assembling types in the first static test, in the second static test, and in failure generally showed a very similar behavior. Cyclic loading, performed between the first and second static tests caused the models to behave similarly in the second static test, and this led us to realize that stiffness differed during dorsal flexion only in the first static test. Comparative results between the first and second static tests on bicortical and unicortical assembling showed significant differences in all parameters analyzed, except for deflection during the axial compression test and deflection during the flexion test. Comparisons between the assembling types and the features in the quantitative form were performed using Student's t-test, since the model's usual assumptions (normality and homoscedasticity) were met. The Student's t-test assumptions were checked using the Shapiro-Wilk test for normality and Levene's test for homoscedasticity (homogeneity between variances). This analysis aims to evaluate whether deflection, stiffness, and maximum force (this only in failure) differ between uni- and bicortical assemblies. Comparisons between features of the first and second static tests were performed through the paired t-test, since the usual assumptions (normality and homoscedasticity) were met. The paired t-test assumptions were checked using the Shapiro-Wilk test for normality and Levene's
test for homoscedasticity. This analysis aimed to evaluate whether changes in deflection and rigidity occurred after cycle in the various test types.

**Summary Points**

- We conclude that a unicortical screw having at least a length of 75% shows mechanical properties similar to those of a bicortical screw in assembling locked volar plates in intra-articular fractures of the distal radius.
- We recommend using unicortical screws in intra-articular fractures of the distal end of the radius, in order to avoid extensor tendon injuries.

**Bibliography**


AM Poster 258: Effect of Radial Lengthening on Distal Forearm Loading Following Simulated Radial Shortening

*Category: Wrist*

Hand and Wrist  
N/A - not a clinical study

Ahaoiza D. Isa, MD, MSc, FRCSC  
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Nina Suh, MD  
James A. Johnson, PhD  
Graham J. W. King, MD, FRCSC

**Hypothesis**  
The purpose of this study was to evaluate the amount of radial lengthening necessary to restore wrist biomechanics following distal radius malunion under simulated dynamic wrist motion.

**Methods**  
A custom built adjustable radial implant was used to simulate up to 4mm of distal radius shortening (-4mm) and 3mm of lengthening (+3mm). One degree of freedom load cells were placed in the distal radius and ulna in 8 cadavers to measure their respective axial loads. The specimens were mounted on a wrist motion simulator capable of producing active wrist motion. To simulate radial lengthening osteotomy following radial shortening from malunion, the radius was sequentially lengthened by 1 mm intervals from -4mm to +3mm. Radial and ulnar loads were measured during simulated dynamic wrist flexion, ulnar deviation (UD) and flexion dart throw (DT) at each 1mm interval of radial lengthening up to +3mm.

**Results**  
For each millimeter of radial lengthening from -4mm to the native length during wrist flexion and UD, there was a significant increase in distal radial loads (p<0.001). No significant change in radial load was observed beyond restoring the native length during flexion (p=0.316) and UD (p=0.172). There was no change in distal radial loads during DT for each interval of radial lengthening from -4mm to +3mm (p=0.243). A sequential decrease in ulnar loads was observed as the radius was lengthened from -4mm to +3mm (p<0.001) for all wrist motions evaluated.
Summary Points

- Excessive radial lengthening beyond the native length was not detrimental to radial loading and further reduced distal ulnar loading; achieving at least native ulnar variance seems to be appropriate based on this in-vitro study.
- Overlengthening of the radius did not result in detrimental loading of the distal radius and may be appropriate in the setting of ulnar impaction syndrome or distal radioulnar instability.
AM Poster 259: Distal Radius Fracture Reduction Simulator as a Teaching Adjuvant for Junior Orthopedic Residents – A Pilot study

_Hypothesis_
The study sought to construct a short course, involving both didactics and a physical reduction simulator, for incoming residents in managing distal radius fracture consults. The aim of the investigation was to analyze the effectiveness of the course and to establish a proof of concept for future studies. The hypothesis was that the simulator would lead to improved comfort with reduction techniques prior to attempts in the emergency department.

_Methods_
A 3-D printed bony model of an adult forearm wrist and hand with an extra articular distal radius fracture was used as a simulator with tensile pulleys to adjust the degree of fracture displacement and angulation. A silicone mold functioned as a soft tissue envelope upper extremity. Each participant underwent didactic session covering distal radius fracture reduction and then was given instruction on reduction maneuvers splinting and molding. The resident then attempted the reduction simulator. Residual displacement and angulation along with splint quality was visualized. Feedback on technique was given immediately. The resident was then completed a short survey after the experience. Unpaired t-tests were used for analysis with P values of 0.05 or less were considered significant.

_Results_
To date, 6 residents have completed the survey, and had encountered between 0-5 distal radius injuries prior. Subjective level of comfort with closed management of distal radius on a sliding numeric scale was 3.2, and 7.4 (p = 0.0033) with an average 4-point increase (95% 1.76-6.64 pre- and post-course. In a text response, many felt that learning markers for obtaining adequate radiographs and molding was the most useful. Overall, 100% of the participants felt that the reduction simulator was informative and worthwhile.
Summary Points

- The decision for non-operative or operative management is largely based on the stability of the fragments post reduction.
- As such, effective closed management of distal radius fractures in the emergency department may be a daunting task to junior residents.
- Mastery of the technique early on may lead to a reduced number of reduction attempts in the Emergency department.
- The study has highlighted the efficacy of physical fracture reduction simulators to educate junior residents on common injuries.
- Future studies will endeavor to add radiographic analysis, and developing simulators for additional injuries as teaching tools for junior residents.

Bibliography

Hypothesis
The ulnar foveal sign is not a specific test for foveal detachment of the triangular fibrocartilage complex (TFCC). Our new test the ulnocarpal impaction plus test will have improved specificity to the ulnocarpal impaction maneuver for the diagnosis of ulnocarpal impaction.

Methods
This study looks at prospectively collected data from an ulnar sided wrist pain database collected at St Paul’s Hospital. We looked at 52 consecutively enrolled patients who had wrist arthroscopy between 2014 to 2017. The ulnar foveal test was completed as described by Berger (2007). Ulnocarpal impaction maneuver was performed as described by Nakamura (1997). The ulnocarpal impaction plus test is performed by doing the ulnocarpal impaction maneuver with the addition of foveal pressure as in the ulnar foveal sign, a positive test being tenderness with reproduction of patient’s pain. Foveal detachment of the TFCC was defined as Palmer 1b classification. Ulnocarpal impaction was defined as Palmer type two degeneration or findings of chondromalacia of the lunate or ulnar head at the time of wrist arthroscopy.

Results
The average age of patients enrolled was 43, with 77% being male. There was a total of four foveal detachments and 47 patients with a positive foveal test. The sensitivity and specificity for a foveal detachment with use of the foveal test was 100% and 15% respectively. The sensitivity and specificity for ulnocarpal impaction with use of the foveal test was 90% and 25%, respectively.

The sensitivity and specificity for foveal detachment with use of the ulnocarpal impaction maneuver was 100% and 21%, respectively. Whereas the sensitivity and specificity for ulnocarpal impaction with use of the ulnocarpal impaction maneuver was 88% and 42%, respectively.
The sensitivity and specificity for foveal detachment with the ulnocarpal impaction plus maneuver was 100% and 15%, respectively. Whereas the sensitivity and specificity for ulnocarpal impaction with the ulnocarpal impaction plus test was 93% and 33%, respectively.

**Summary Points**

- Our results confirm our hypothesis that the ulnar foveal test is not specific for detection of foveal detachment of the TFCC.
- The ulnocarpal impaction plus test has comparable sensitivity and specificity to the ulnocarpal impaction maneuver for the diagnosis of ulnocarpal impaction.
- The diagnostic accuracy of the tests investigated highlight the difficulty with evaluation of ulnar sided wrist pain as one test alone is not particularly specific, however the diagnosis is based rather on the history, findings of multiple exam maneuvers, selective injections and imaging obtained.

**Bibliography**

Hypothesis
Scaphoid fractures (SF) are the most commonly injured carpal bone, but rarely reported in older adults and the elderly. (1–3) Furthermore, the correlation between bone density and outcomes following SF in this patient population has not been explored. The 2nd metacarpal index (2MCI) is a ratio of 2nd metacarpal cortical width to the entire bone width at the isthmus. (4) 2MCI values ≥50; confirmed radiographic evidence of an acute, closed SF; diagnosis within 1 month of reported injury; and >1 clinical visits. Variables included patient demographics, radiographic characteristics, time to union, and type of treatment. Patients were grouped into middle-aged (50-64 years) and elderly (>65 years) cohorts. Subset analysis also stratified patients by operative status and radiographic evidence of pre-existing arthritis. 2MCI was measured at the isthmus on digital radiographs by two authors.

Results
121 patients were included in the final analysis with 76 in the middle-aged and 45 in the elderly cohorts. 30 patients had no radiographs and were excluded. There was a female predominance (59%). 87% of injuries occurred via a low-energy mechanism. 79% of fractures were non-displaced. A vast majority of patients were treated non-operatively (80%). Overall mean (SD) 2MCI was 60%. Median 2MCI was 0.59 for non-displaced and 0.62 for displaced (p=0.72). 2MCI showed a moderate correlation with age (r = -0.52). 16% of patients had 2MCP <0.5, and 50% <0.6. There were no statistical differences in radiographic characteristics, treatment, or time to union based on age. Results stratified by operative status and displacement are summarized below (Table 1 and Table 2).
Summary Points

- The majority of SFs in the middle-aged and elderly affect female patients via low-energy mechanism, are non-displaced, and treated non-operatively.
- This population may represent a fragility cohort with an osteopenic 2MCI

Bibliography

Hypothesis
We hypothesized that PRC combined with capitate implant resurfacing would result in improved motion, strength and patient-rated outcome scores, for patients with wrist arthritis including proximal capitate disease.

Methods
We performed a retrospective review of patients with wrist arthritis who underwent capitate resurfacing using the HemiCAPITATE arthroplasty system (Arthrosurface, Franklin, MA, USA) from September 2015 through August 2016. All surgeries were performed by one senior hand surgeon (RWC). Data queried included preoperative Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) scores, grip-strength, and wrist flexion-extension arc. Secondary outcomes included postoperative complications and additional surgeries performed following the index surgery.

Results
Patient demographics:
Ten patients with median age 62 years (range, 32 to 85 years) satisfied inclusion. Eight patients were male, and 6 surgeries were performed on the non-dominant extremity. All patients were treated for sequelae of peri-scaphoid arthritis; 7 patients with SLAC wrist, 2 patient with SNAC wrist, and 1 patient with history of psoriatic arthritis who developed radiocarpal arthrosis secondary to a distal radius fracture malunion. Two SLAC patients had not previously undergone surgery while the remaining 5 patients had undergone at least one prior surgery at the wrist: 2 PRC’s with capsular interposition, 1 distal radius hemiarthroplasty + PRC, 1 PRC after two failed attempts to repair a scaphoid nonunion, and 1 RSL fusion with distal scaphoid excision.

Objective Outcomes
Average follow-up duration was 16.1 ± 8.5 months. Mean QuickDASH scores improved from 56.9 +/- 22.5 preoperatively to 29.9 +/- 17.0 postoperatively (paired t-test; P = 0.009). Significant improvements in grip strength (33 ± 12 pounds preoperatively vs. 49 ± 21 pounds postoperatively; P = 0.021) and wrist flexion-extension-arc (57 ± 15 degrees preoperatively vs. 75 ± 6 degrees postoperatively; P = 0.008) were also noted. One patient underwent implant removal and conversion to total wrist fusion for progression of radiocarpal arthritis. Two patients with painless wrist flexion and extension postoperatively had additional surgery for painful forearm rotation due to preexisting DRUJ arthritis (1 ulnar head arthroplasty, 1 Schecker prosthesis). No infections or wound complications occurred.

Summary Points

- PRC with capitate resurfacing was safe and effective in treating longstanding posttraumatic and degenerative wrist arthritis this small series of patients.
- This is a promising treatment option for a wide patient demographic who wish to preserve motion and functionality, while alleviating pain.
- Further study is warranted to evaluate outcomes in comparison to other techniques for treating wrist arthropathy.
Hypothesis
The objectives of this study were to (1) compare the radiographic outcomes of early (0 to 2 weeks) and delayed (3-6 weeks) surgical fixation of distal radius fractures and (2) to compare complication rates in the two surgical groups. Our null hypothesis was that the two groups would be equivalent.

Methods
We performed a retrospective case-control study at two level I trauma centers between 2003 and 2015. Patients ages 18+ treated with a volar locked plate for a distal radius fracture were included in the study. The study arm included those treated from 3-6 weeks following injury, and those treated <2 weeks were controls. Cases were matched for age, sex, and AO fracture type. Radiographs were assessed by a blinded reviewer for reduction and hardware complications (radial height, radial inclination, volar tilt) at 3 time points: injury, immediate post-op, and union. Medical records were evaluated for post-operative complications and need for soft tissue releases and/or osteotomy. Clinical and radiographic metrics were compared via conditional logistic regression.

Results
The 2:1 case control included 25 cases and 50 controls. The case cohort had surgery at a mean of 24.8 days (range 22-31, SD 2.4) from injury and the control cohort at 5.64 days (range 0-12, SD 3.5). There was no statistically-significant difference in the radiographic parameters on injury x-rays (p = 0.188, 0.257, 0.516), in improvement in radiographic parameters on post-reduction x-rays (p = 0.366, 0.354, 0.510) or in the maintenance of radiographic parameters at final follow-up (p = 0.665, 0.904, 0.793) at a median follow-up of 13 weeks. Review of operative notes
revealed 6 (24%) delayed cases with use of the extended FCR approach and 9 (36%) delayed cases with use of an osteotome. There were 2 (8%) complications in the delayed group consisting of superficial infection and neuropraxia, compared with 3 (6%) complications in the early group consisting of hardware removal for extensor tenosynovitis and malunion ($p = 0.743$) at a median follow-up of 19 weeks.

**Summary Points**

- Delayed surgical treatment of distal radius fractures produces equivalent radiographic outcomes and complication rates.
- Patients with delayed initial presentation or late displacement of distal radius fractures may be treated with surgical fixation rather than further immobilization and/or late osteotomy.
- Acceptably aligned but potentially unstable distal radius fractures may be continued to be treated non-operatively with close radiographic follow-up.
AM Poster 264: Outcomes and Complications in the Management of Distal Radius Fractures in the Elderly

Category: Wrist
Hand and Wrist; Diseases and Disorders; General Principles
Level 2 Evidence

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Hypothesis
We hypothesized that patients with distal radius fractures over the age of 65 years treated with operative management, including: external fixation (EF), closed reduction and percutaneous pinning (CRPP), and open reduction and internal fixation (ORIF) would demonstrate increased complication rates, but decreased rates of subsequent procedures when compared with non-operative management.

Methods
We performed a retrospective observational study using the Optum Labs Data Warehouse (OLDW), which includes claims data for over 100 million privately insured and Medicare Advantage enrollees throughout the US. To identify the analytic DRF cohort, we retrieved all claims from 2009-2014 using ICD-9-CM diagnosis codes of distal radius fracture and separated the fractures by treatment modalities. Ninety day and 1-year complication rates per 1000 fractures were analyzed overall and by treatment modality.

Results
Data analysis was performed on 14,616 DRF in patients age 65 years and over from 2009 - 2014. Short-term complications within 90 days of fracture identified an overall complication rate of 36.2 per 1000 fractures and the 1-year upper extremity-specific complication rate was 254.9 per 1000 fractures. Overall, post-injury stiffness was the most common 1-year complication with an 11.4% incidence. There was no difference in operative versus non-operative management when comparing 90-day complication rate (39.5 vs 34.9, p=0.1875). However, operative management had a significantly higher 1-year complication rate than non-operative management (304.6 vs 236.3, p<0.0001). Overall the five most common complications following DRF were stiffness (11.4%), chronic regional pain syndrome (9.5%), carpal tunnel syndrome (7.6%), tendon-related complications (2.7%), and osteoarthritis (2.1%). Stiffness was greater following operative management (15.8% vs 9.8%). The rates of fracture malunion were greater following non-
operative management. The overall rate of secondary procedures, including but not limited to carpal tunnel release, corrective osteotomy, distal radioulnar joint procedures, and hardware removal, were higher following non-operative management (19.6%), versus operative management (6.7%).

Summary Points
- Stiffness is the most common complication in patients greater than 65 years of age regardless of mode of management.
- Operative management of DRF results in significantly lower fracture malunion rates and secondary surgical procedures at the expense of increased overall 1 year complication rates.
- Therefore, operative management of DRF should be carefully considered when discussing treatment options with patients over age 65.

Bibliography
AM Poster 265: Nonunion of Radiocarpal Fusion With and Without Proximal Row Carpectomy: A Meta-Analysis

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
Wrist fusion provides a solution to the painful, arthritic wrist, and can be concomitantly performed with or without a proximal row carpectomy (PRC); the benefits of which include a large amount of local bone graft for fusion and a lower number of joints needed to fuse. We therefore hypothesize that wrist fusion combined with proximal row carpectomy will have a higher fusion rate than wrist fusion performed without proximal row carpectomy.

Methods
A systematic review was performed to identify all papers in the literature involving wrist arthrodesis using the following databases: Pubmed, Ovid, Scopus, Web of Science, and COCHRANE. A literature search was performed using the phrase (wrist OR radiocarpal) and (fusion OR arthrodesis). Articles were screened by title and abstract, and then the full text was evaluated. Inclusion criteria are the following: 1. complete radiocarpal fusion performed for rheumatoid, post-traumatic, or primary arthritis, 2. union rates available, and 3. english language study. Studies were excluded if: 1. case reports, 2. diagnoses other than the ones listed above, and 3. inability to abstract the data. Data collected included wrist fusions with PRC or without PRC, union rate, patient age, underlying diagnosis, method of fixation, and type of bone graft used. Categorical data was analyzed using Chi-Squared test in CMA (Comprehensive Meta-Analysis) with p<0.05 as significant.

Results
A total of 51 studies were included in the analysis. There were 44 studies with no PRC, 6 studies with PRC, and 1 study with both PRC and without PRC. There were 220 patients with a PRC (average age-47.6). 127 had rheumatoid arthritis, 79 had post-traumatic arthritis, 3 had osteoarthritis, and 11 had no documented condition. 214 patients had a fused wrist (97.3%).
1425 patients had a wrist fusion with no PRC (average age-50.2). 794 had rheumatoid arthritis, 307 had post-traumatic arthritis, 24 had osteoarthritis, and 300 did not have a documented condition. 1373 patients had fusion of the wrist (96.4%). Fusion rate between the two groups, 97.3% vs. 96.4%, was not statistically significant (p=0.48).

Summary Points
- Wrist fusion with PRC had a higher fusion rate than wrist fusion with no PRC, however the result was not statistically significant.
- Overall, the fusion rate after wrist arthrodesis is high no matter the technique used.
- More work needs to be done to determine other factors leading to nonunion. For example, the influence of the different underlying diagnoses, or the method of fixation of the arthrodesis.

Bibliography
AM Poster 266: Retrospective Comparison of Capitolunate Fusion Using Headless Compression Screws vs Nitinol Memory Staples for SLAC and SNAC Wrist: Radiographic, Functional, and Patient-Reported Outcomes

Category: Wrist

Hand and Wrist; Diseases and Disorders
Level 4 Evidence

Richard Randall McKnight, Jr., MD
Mark Tait, MD
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Hypothesis
There is a renewed interest in capitolunate arthrodesis (CLA) for scaphoid nonunion advanced collapse (SNAC) and scapholunate advanced collapse (SLAC) wrist. (1-3) While headless compression screws are the main method of fixation, nitinol memory compression staples show promise as an effective alternative. (4,5) The purpose of this study was to compare the clinical outcomes and complications of CLA for SNAC or SLAC wrist treatment using either compression screws or nitinol staples. We hypothesized that nitinol staples would have similar clinical outcomes and complications to headless compression screws.

Methods
47 patients with SNAC or SLAC deformities who had CLA by a single surgeon over the last 10 years were identified retrospectively from our institution’s database. Patients were grouped by fixation type. We included all patients with CLA or capitolunohamate arthrodesis for SLAC or SNAC wrist, with screws or nitinol staples for their internal fixation construct. Primary outcome was fusion on radiographs and/or CT. Secondary outcomes were hardware-related complications (HWC) and other complications. Functional outcomes included range of motion (ROM) and grip strength. Patient-reported outcomes (PROM) included visual analogue scale (VAS); Disabilities of the Arm, Shoulder, and Hand (DASH) score; and patient-rated wrist evaluation (PRWE). Information was also collected on demographics, concomitant procedures, and need for additional surgery.

Results
40 of 47 (85%) eligible patients were included. 31 patients in the staple group and 9 patients in the screw group. 3 patients declined to participate. Average age was 49 years old (17-80). 2
patients in the staple group received capitolunohamate arthrodesis, while all other patients were CLA. There was a 100% union rate overall. 2 patients in the screw group had the HWC of screw backout. One had delayed union and the other reoperation for hardware removal. There were 2 (6.5%) HWCs in the staple group. One patient had staple loosening requiring revision fusion, and the other dorsal impingement and stiffness requiring staple removal and capsulotomy. The patient with dorsal impingement was the primary surgeon’s first case with nitinol staples. In all subsequent cases the staples were countersunk. There were no significant differences in any functional or PROMs (Table 1).

**Summary Points**
- We believe that nitinol staples represent a safe and effective alternative to compression screws for CLA.
- We found no differences between nitinol staples and screws for CLA in regards to HWC, functional outcomes, or PROMs.

**Bibliography**
Hypothesis
The scaphotrapezial (ST) joint is oriented out-of-plane relative to the articular surface of the distal radius, and thus standard radiographic views of the wrist may not readily detect pathology including fracture, arthritis, or screw prominence during antegrade fixation of scaphoid fractures. Novel radiographic views specifically designed to look into the plane of the ST joint may detect pathology better than standard views of the wrist.

Methods
Three-dimensional models of the bony architecture of the wrist were created from 50 normal wrist CT scans. For each model, a plane was fit to the proximal articular surface of the trapezium, and this was referenced to a standard distal radius coordinate system (Figure 1). Based off these calculations, we describe novel ST posteroanterior (PA) and ST lateral views (Figure 2). Using a cadaveric model, the ST PA and ST lateral views were compared to standard views of the wrist as well as the Bette and supinated oblique views to determine the best view for detecting prominent hardware in the ST joint. A threaded Steinmann pin was advanced antegrade along the axis of the scaphoid until it was flush with the articular surface of the distal pole by direct visualization. Radiographic views were acquired and repeated sequentially as the pin was advanced by 0.5mm increments until it was 2.0mm prominent. This process was repeated in 10 specimens. Two blinded, independent readers graded all images for hardware prominence. All views were compared against the top-performing view for minimum pin advancement until visibility via Cox proportional hazards modeling.
Results
Hardware prominence in the ST joint was detected earlier in the ST lateral view compared to the standard lateral view. The hazard ratio [95% CI] for the ST lateral versus the standard lateral view was 0.28 [0.09, 0.83] for reader 1 and 0.33 [0.12, 0.95] for reader 2 (P = 0.022 and 0.039, respectively). There was no significant difference in detection of pin prominence for the ST PA, supinated oblique, PA, or Bette views versus the ST lateral view.

Summary Points
- Using a CT-based approach with 3D modeling, we describe novel ST radiographic views.
- In a cadaveric model, the novel ST lateral view detected hardware prominence earlier than the standard lateral view.
- Novel views may be utilized intra-operatively to reduce hardware complications and reoperation rates for prominent hardware in antegrade scaphoid fixation and may improve radiographic detection of other ST joint pathologies including arthritis.

This research was supported by a Residents & Fellows Fast Track Grant from the American Foundation for Surgery of the Hand.
AM Poster 268: Long-term Follow-up: Reduction and Association of the Scaphoid and Lunate (RASL) for Chronic Scapholunate Dissociation

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Hypothesis
Many of the current treatment options for chronic state scapholunate instability thwart obligatory scapholunate intercarpal motion altering wrist kinematics. We hypothesize that the reduction and association of the scaphoid and lunate (RASL) is a safe and effective procedure that improves function and alleviates pain in the injured wrist.

Methods
In a 23-year time period, the senior author performed 39 RASL procedures. This reconstruction involves reduction of the scaphoid and lunate followed by re-association stabilized by a cannulated, headless, smooth-shafted screw directed along the axis of rotation between the two bones. We performed a retrospective case review, evaluating both subjective and objective patient-based outcomes. Treatment failures were included in all data analysis except range-of-motion measurements.

Results
Of the 39 patients, 4 were lost to follow-up after 6 months. 35 were available for subjective assessment and 25 were available for physical examination, with a final follow-up of 9.72±6.6 (1.14-24.23) years post-operatively. Of the 35 patients captured during the study period, 2 were considered failures. One patient progressed to SLAC wrist arthritis and underwent proximal row carpectomy (DASH of 4.2). The second patient developed pain and progressed to SLAC wrist, receiving 4-bone fusion (DASH 36.7). The mean Disability of the Arm, Shoulder, and Hand (DASH) score at follow-up was 17.47±17.5 (0-69.2). Average visual analog pain scale (VAS) scores at rest were 0.45±.81 out of 10 (0-3) and with activity were 2.67±2.74 (0-7.3). The average flexion/extension arc was 102±28.9 (55.0-160.0) degrees, compared to 118±31.9 (60.0-170.0) on
the contralateral side, which was not significantly different (p=0.138). Average grip strength was 66.02±9.6 (17.64-68.01) lb, compared to 79.18±23.2 (44.1-123) on the contralateral side, which was significantly different (p<0.005). X-rays showed significant decreases in scapholunate gap (4.5 mm pre-operatively, 2.1 mm post-operatively, p < 0.001) and scapholunate angle (p < 0.001) as compared to preoperative films.

Summary Points

- The RASL procedure is a safe and effective treatment for chronic scapholunate dissociation. Reduction is maintained over time with excellent function and has long-term clinical success.
- The ideal candidate has preserved articular cartilage, though the RASL has been used successfully in patients with SLAC 1 wrist arthritis.
- Capitolunate arthritis is an absolute contraindication to the RASL procedure.

Bibliography

AM Poster 269: FasT-Fix All-Arthroscopic Repair of Peripheral TFCC Tears: Safe and Effective in Long-Term

Category: Wrist

Hand and Wrist; Diseases and Disorders; General Principles
Level 4 Evidence

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Hypothesis
The FasT-Fix device (Smith and Nephew Endoscopy, Andover, MA) has been utilized for all-arthroscopic peripheral triangular fibrocartilage complex (TFCC) repairs with promising early clinical results. We hypothesized that these repairs would remain effective in the long-term and result in satisfactory functional outcomes.

Methods
A retrospective review of patients undergoing arthroscopic TFCC repair or debridement at our institution between 2005 and 2015 was performed. Inclusion criteria were Palmer Type 1B TFCC tears diagnosed on arthroscopy and repaired using all-arthroscopic FasT-Fix suture technology. Patients with evidence of other injuries to the wrist at the time of surgery, history of prior wrist surgery, or non-peripheral TFCC tears were excluded. Minimum follow-up was four years. Postoperative complications, range of motion, and grip strength were recorded. Additionally, each patient completed Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH), Modified Mayo Wrist, and Patient-Rated Wrist Evaluation (PRWE) questionnaires. Means, standard deviations, and ranges were recorded.

Results
Eleven patients (mean age 36 years, range 20-64) who underwent all-arthroscopic FasT-Fix suture device repair for isolated Palmer Type 1B TFCC tears comprised the study cohort. The mean follow-up period was 7.0 years (range, 4.3-10.9). Mean range of motion of the wrist revealed flexion of 76°±11°, extension of 73°±12°, radial deviation of 17°±8°, and ulnar deviation of 42°±11°. Mean pronation and supination were 81°±7° and 86°±4°, respectively. Mean grip strength was 98%±15% of the nonsurgical extremity. The mean QuickDASH, Modified Mayo, and PRWE scores were 9±8, 80±6, and 12±12, respectively. No surgical complications were observed and no patient required any further surgical intervention. Ninety-one percent of the patients were satisfied with their outcome and indicated that if needed, they would have the procedure performed again.
Summary Points

• Our cohort of patients demonstrated excellent objective clinical parameters and subjective outcome scores following all-arthroscopic FasT-Fix suture repair of isolated Palmer Type 1B TFCC tears at a mean follow-up of 7.0 years.
• These findings indicate that the FasT-Fix device is a reliable, safe, effective, and most importantly, durable treatment option for repair of peripheral TFCC tears.

Bibliography
Hypothesis
The purpose of this study is to retrospectively evaluate an active duty military cohort return to duty and push-up activity rate following wrist arthroscopic electrothermal shrinkage for treatment of scapholunate predynamic instability.

Methods
We undertook a retrospective review of wrist arthroscopic electrothermal shrinkage surgery for treatment of scapholunate predynamic instability done in an active duty military patient cohort at one military academic medical center. At a two year minimum follow up, cohort data was analyzed with the two primary outcomes of the rate of return to full duty and the rate of return to push-up activities. The study was completed through retrospective chart review and through query of the military physical profile database.

Results
This study identified 14 active duty patients who met inclusion criteria. The study cohort had a mean age of 29 years, 43 percent were male, and 64 percent had a concomitant arthroscopic occult dorsal ganglion cyst removal at time of the index surgery. The severity of the scapholunate instability was staged using the Geissler classification; the cohort distribution for stage I, II and III was three patients, ten patients and one patient respectively. At two year follow up, the return to duty rate was found to be 86 percent and the return to push-ups activity rate was found to be 79 percent. Pain reduction with activities by Visual Analog Scale went from 7.1 to 1.4 (p <0.001). No statically significant correlation was found with regards to gender, smoking status, psychiatry comorbidities or concomitant procedures.

Summary Points
• While prior studies have demonstrated scapholunate ligament electrothermal shrinkage as a modality for pain relief, this study suggests that this treatment may also aid in return to specific physical activity.
• The exact benefit of scapholunate ligament electrothermal shrinkage is still unclear. Some studies have hypothesized that pain relief from thermal shrinkage is not just
secondary to stiffening of the scapholunate interval, but may result in pain relief via a denervation effect.

- This study demonstrates that wrist arthroscopic thermal shrinkage for pre-dynamic scapholunate instability may be a reliable treatment modality for return to duty and push-up activities for active duty military patients.
AM Poster 271: Incidence of Complications Following Volar Locking Plate Fixation of Distal Radius Fractures: An Analysis of 647 Cases

Category: Wrist

Hand and Wrist; Diseases and Disorders; General Principles

Level 4 Evidence

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Hypothesis
We hypothesized an analysis of the major and minor complications after volar locking plate fixation of distal radius fractures would permit the identification of patient factors and fracture characteristics associated with hardware removal, tendon irritation or rupture, nerve injury or compression neuropathy, and malunion or delayed union, which could be used to provide anticipatory guidance to patients.

Methods
A retrospective review of patients undergoing volar locking plate fixation of distal radius fractures between May 2000 – May 2015 with clinical and radiological follow-up greater than six months was undertaken. Data reviewed included: demographic variables, major complications (hardware malposition, hardware removal, tendon rupture, nerve injuries or compression neuropathy, vascular injuries, carpal or DRUJ instability or arthritis requiring additional surgery, malunion, non-union or major medical complications), minor complications (tendon irritation, chronic regional pain syndrome, wound healing problems, or transient paresthesias) and radiographic parameters (ulnar variance, radial inclination, volar tilt, and intra-articular step-off at final follow-up).

Results
647 distal radius fractures managed with volar plate fixation in 636 patients were reviewed. Mean follow-up was 9.1 months. Mean age was 56.5 years. Female to male ratio was 3.22. Mean BMI was 28.0 and 14.6% of patients had a BMI greater than 35. The majority of fractures were intra-articular with AO class 23-C (67.2%) followed by 23-A (26.6%) and 23-B (6.2%). The incidence of major and minor complications was 13.8% and 17.5%, respectively. The most common complication was transient paresthesia (9.7%). The incidence of tendon rupture or irritation was 0.5% or 2.5%, respectively. Hardware removal for painful or symptomatic hardware was performed in 40 patients (6.2%) with a mean time to hardware removal of 427.8
days. Major complications and minor complications were increased 2.2 fold and 1.9 fold in patients with a BMI > 35. Major complications were also increased 3.19 fold in patients with residual intra-articular step off following fixation. Hardware removal was 3.3 fold more likely in patients with Soong Grade 2 plate prominence and 2.9 fold more likely in patients with a history of diabetes.

Summary Points
- Volar plate fixation of distal radius fractures is associated with an overall low-complication rate.
- Multi-fragmentary, intra-articular distal radius fractures may be successfully managed with a volar plate.
- Patient factors including diabetes and obesity as well as intra-operative factors including intra-articular fracture alignment and plate prominence were associated with a higher rate of complications or revision surgery.

Bibliography
AM Poster 272: Co-Incident Translation of Scaphoid and Radius Using an Immobilization Device

Category: Wrist

Hand and Wrist
N/A - not a clinical study
Grant received from: Paul B. Helliwell Chair in Orthopaedic Research

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Hypothesis
Minimizing translation of the scaphoid relative to the radius will allow significant improvements when navigating scaphoid pinning using ultrasound to register the scaphoid intra-operatively[1,2]. We hypothesize that scaphoid location can be sufficiently fixed relative to the radius and a wrist holding device to permit accurate and precise percutaneous fixation and performed this feasibility study to test our methodology.

Methods
Five soft-embalmed cadaver forearms were fixed to an immobilization device using a combination of straps and elastic bandages. A Board-certified orthopedic surgeon instrumented each scaphoid, radius and the immobilization device with 0.8mm tantalum beads. Baseline AP and lateral fluoroscopic images were obtained prior to performing load tests using a floor-mounted flat-panel fluoroscope (Innova 4100, GE Healthcare, Buc, France). Three load tests were performed on each specimen. The first two loads were simulated, volar directed, standard low and high manual pressure required during ultrasound acquisition of the scaphoid. The third load test was application of a guide pin with drilling pressure to the distal end of the scaphoid. For each loading scenario, AP and lateral images were acquired. Finally, post-load AP and lateral ‘check’ images were acquired for each specimen to measure non-elastic motion. All load tests were performed by the same orthopedic surgeon. The simulated ultrasound pressures were accomplished with a custom applicator that incorporated a force-sensing resistor. Custom software was used to determine the bead locations in the immobilization device, scaphoid and radius in the images. The translations of the scaphoid relative to the
immobilization device (TS->I) and the radius (TS->R) were calculated [Figure 1]. The difference of the two translations represents the translation shared between the scaphoid and radius. It was expected that the radioscaphoid motion would always be less (single direction) than scaphoid-immobilizer motion; a 1-sided paired t-test was used to compare the motions [Table 1].

Results
All test scenarios demonstrated a statistically significant relationship between translation of the scaphoid and radius (P < 0.05). Maximum radioscaphoid motion was seen in lateral imaging during the High load ultrasound simulation (0.6mm SD 0.19) and is well within the clinical safe zone of 1.8±0.8mm[3].

Summary Points
- Methods used are feasible for determining the amount of scaphoid translation that is independent of the radius.
- Methods to limit motion of the radius may significantly improve localization of the scaphoid, particularly during registration.
- Measured motion of the scaphoid in this model appears to be within the limits needed for percutaneous scaphoid surgery.

Bibliography
Hypothesis
Ipsilateral combined fractures of the distal radius and scaphoid are rare injuries, with little literature to guide optimal treatment and predict long term outcome. We predict that these will be high energy injuries in young patients and that stiffness poses the largest challenge to patients in the rehabilitation period.

Methods
We retrospectively reviewed all operative cases of ipsilateral combined injuries of the distal radius and scaphoid within a 10 year period (2003-2013) at two major tertiary care centers and one affiliated community hospital. Demographic and clinical information were recorded from the patients’ charts.

Results
There are 24 total cases performed by 7 different surgeons. There were 17 males and 7 females, with an average age of 39.9 ± 15.4 years (range 22-79 years) and average follow up of 13.6 ± 19.4 months (range 1-82 months). Twenty-two were high energy injuries with the most common mechanisms being motorcycle and motor vehicle collisions, falls from height and athletic injuries. Seven of the patients were polytrauma patients who presented with other orthopaedic injuries. All of the scaphoids were fixed using headless compression screws and 22 of the distal radius fractures required internal fixation. Of those, two were fixed using lag screws and 3 required a volar locking plate and additional fixation from either a radial plate or external fixator. The remaining 17 were fixed using a volar locking plate alone. Five of the patients presented with acute carpal tunnel syndrome. One additional patient presented with delayed carpal tunnel syndrome one month after injury. Four patients had subsequent surgery, three for hardware removal and two for unreduced intra-articular depressed fragment of the distal radius fracture. At last follow up, 7 of the patients were described as having excellent or full-motion, 11 with flexion-extension arc greater than 90 degrees, and 4 with arc less than 90 degrees.
Summary Points

- Combined distal radius and scaphoid injuries are usually high energy injuries in young patients requiring operative fixation of both fractures.
- Most patients regain functional range of motion at their wrist.
- Surgeons should have high index of suspicion for acute median neuropathy, which occurred in 25% of the patients in this series.

Bibliography

Hypothesis
We hypothesized that distal fixation to the third metacarpal would achieve more anatomic alignment in a cadaveric radiocarpal dislocation model.

Methods
Ten matched transhumeral cadaveric arms were obtained. None had a history of previous injury or surgery. Each was examined grossly and radiographically to confirm the absence of anatomic deformity.

Cadaveric models were prepared through a standard dorsal approach to the radiocarpal joint. Under traction, the dorsal and volar radiocarpal ligaments were transected. Complete radiocarpal instability was confirmed with fluoroscopy. An Acu-Loc Wrist Spanning Plate (Acumed) was used for fixation; this plate is characterized by a widened center with a cluster of screw holes to permit fixation near the articular surface. Lunate overhang was measured for each specimen before and after plate placement according to Gilula’s Method using ImageJ software.

Each specimen was matched to itself to minimize confounding variables such as subtle differences in morphology. Each specimen had the plate fixed first to the radial shaft through the fourth dorsal compartment according to the suggested technique for this plate. All of the “rights” (Group 1) had the bridge plate fixed first to the second metacarpal then to third metacarpal with measurements made before and after each intervention. Group 2 included all of the “lefts” and underwent similar treatment except that distal fixation was made to the third metacarpal before the second.
**Results**
Lunate overhang was 0.29 ± 0.12 preoperatively, 0.78 ± 0.20 when fixed distally to the second metacarpal, and 0.44 ± 0.19 when fixed distally to the third metacarpal. Paired samples t-test analysis demonstrated a significant difference (p=0.001) for lunate overhang, with more anatomic alignment associated with the third.

**Summary Points**
In a cadaveric radiocarpal dislocation model, bridge plating with distal fixation to the third metacarpal may facilitate more anatomic alignment. However, a plate design that requires placement through the fourth dorsal compartment may dictate radiocarpal alignment more than choice of distal fixation. If planning distal fixation to the second metacarpal, a narrow plate design that allows for more radial placement through the second dorsal compartment may similarly facilitate anatomic reduction of the radiocarpal joint and is currently being studied.

**Bibliography**
AM Poster 275: Rates of Nonunion, Arthritis, and Fusion after Scaphoid Fractures Treated Nonoperatively and Operatively

Category: Wrist

Hand and Wrist; Diseases and Disorders; Practice Management

Level 3 Evidence
Grant received from: NIH Grant T35-DK007386

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Hypothesis
Sequelae following scaphoid fractures are common, particularly nonunion. These can lead to degenerative changes requiring a subsequent surgical procedure, causing additional morbidity. The aim of this study was to better characterize the natural history of scaphoid fractures after being treated operatively versus nonoperatively. We hypothesized that scaphoid fractures treated nonoperatively would have higher rates of development of arthritis and of nonunion requiring an additional surgical (i.e., fusion) procedure.

Methods
Using the PearlDiver patient record database, we used ICD-9 as well as CPT coding to identify 1,538 patients within the Humana database from 2007-2012 over the age of 9 years who sustained a scaphoid fracture. The rates of fusion, of development of arthritis, and of nonunion after both nonoperative and operative treatment of scaphoid fractures were evaluated. Rates were compared between groups using the chi-square test of significance.

Results
Evaluation revealed that the rate of fusion after closed versus open treatment of scaphoid fractures was significantly different (3.1% vs. 13.3%; p < 0.001). The rate of development of arthritis after closed versus open treatment of scaphoid fractures was not significantly different (9.63% vs. 7.13%; p = 0.08). The rate of development of nonunion after scaphoid fractures after closed versus open treatment was significantly different (7.7% vs. 25.7%; p < 0.001).
Summary Points

• Patients with scaphoid fractures showed a significantly higher rate of nonunion (approximately 1 in every 4 fractures) and subsequent fusion after operative treatment than those who were treated nonoperatively.
• Patients with scaphoid fractures showed no difference in rate of arthritis after operative versus nonoperative treatment.
• While the decision to treat is individualized based on the patient and the fracture pattern, this information can be used to counsel patients regarding the natural history of scaphoid fractures as well as the outcomes and the possibility of necessary additional procedures after surgical treatment.

Bibliography
AM Poster 276: Scaphoid Dorsal Subluxation in Scapholunate Deficient Wrists: A Cadaveric Study

Category: Wrist

Hand and Wrist
N/A - not a clinical study

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Hypothesis
Prior literature evaluating sagittal plane kinematics of scapholunate deficient wrists has focused on characterization of the centroid of the scaphoid, however the centroid position of the scaphoid does not necessarily correlate with the radiocarpal articulation. More recent literature has described the presence of dorsal subluxation of the scaphoid on the radius and symptomatic scapholunate deficient wrist (1). The purpose of the study was to test the hypothesis that sectioning of the scapholunate (SL) ligament would lead to dorsal subluxation of the scaphoid on the radius in a cadaveric model both in neutral and with the wrist in a mid-flexion position.

Methods
A dorsal approach to the scapholunate interval was performed in fresh-frozen cadavers. Cadaveric specimens were mounted on a jig and CT scans were performed with the wrist in neutral and a mid-flexion position (measured at 30° clinically by a goniometer). The entire SL ligament complex was then sectioned followed by 100x flexion/extension/ulnar/radial deviation manual cycling, and the CT scans were repeated. Finally, the volar radioscapoid, radioscaphocapitate and long radiolunate ligaments were sectioned, the wrist cycled, and CT scans were repeated. Percentage of dorsal subluxation (Figure 1) was compared between the SL intact, SL deficient, and SL/RS/RSC/LRL deficient wrists in both positions.

Results
Sagittal CT images are presented in Figure 2. In specimen 1, dorsal subluxation was seen in neutral after sectioning of the SL/RS/RSC/LRL ligaments, and in mid-flexion after sectioning of the SL ligament alone. In specimen 2, dorsal subluxation was noted after sectioning of the SL/RS/RSC/LRL ligaments in neutral and mid-flexion. In specimen 3, dorsal subluxation was noted in neutral after sectioning of the SL ligament alone.
Summary Points

• In this pilot study, sequential ligamentous sectioning led to a change in radioscaphoid articulation, however the extent of dorsal subluxation, as well as the ligaments sectioned, varied. Further research is required to determine which ligaments are required to prevent dorsal subluxation.

• Further research is indicated to determine whether or not radiographic imaging in mid-flexion is more likely to detect dorsal subluxation than radiographic imaging in neutral.

• Further research is indicated to delineate the mechanisms by which some patients with scapholunate deficient wrist develop dorsal subluxation of the scaphoid on the radius, the extent to which this is associated with clinical symptoms, and the extent to which surgical correction of this subluxation in repair/reconstructive surgery restores carpal kinematics and/or alleviates clinical symptoms.

Bibliography

AM Poster 277: Natural History of Kienböck’s Disease: Functional and Radiographic Disease Progression

Category: Wrist

Hand and Wrist; Diseases and Disorders; General Principles
Level 4 Evidence

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Hypothesis
The time course of clinical and radiographic progression of Kienböck’s disease is not established due to the relatively uncommon nature of the disease process and lack of long-term prospective cohort studies. We hypothesized that serial analysis of radiographic and functional parameters could identify the temporal progression of non-operatively managed Kienböck’s disease and develop a model of disease progression to provide anticipatory guidance to patients.

Methods
We performed a retrospective study of all patients treated non-operatively for Kienböck’s disease within our institution from January 1, 1999 through December 31, 2014 using International Statistical Classification of Diseases and Related Health Problems (ICD-9) code 732.3 for Kienböck’s disease. Inclusion criteria included: length of follow-up greater than 1 year, serial PA and lateral wrist radiographs, and serial functional evaluation. PA and lateral radiographs were independently reviewed at initial presentation and at final follow-up, including: Lichtman stage, carpal index, Stahl index, ulnar variance, and intercarpal angles.

Results
25 patients with 25 wrists were included. The mean age of patients was 50.2 years, average length of clinical follow-up was 3.9 years and the mean length of radiographic follow-up was 5.2 years. 48% of patients had undergone a period of splint or cast immobilization during the study period. There was no significant difference in range of motion or grip strength, however patient reported pain was significantly decreased. Lichtman stage, scapholunate angle, and radioscaphoid angle were significantly increased; and Carpal index, PA lunate ratio, and Stahl index were significantly decreased across the study period. The mean progression in Lichtman stage was 0.5 stages/year with a range of 0 to 1.6 stages/year throughout the study period. There was no significant difference in Lichtman stage progression based on stage at
presentation. A history of smoking was associated with significantly increased radiographic disease progression.

Summary Points
- The present study demonstrates that Kienböck's disease is progressive radiologically.
- However, Kienböck's disease does not necessarily appear to be progressive from a standpoint of function or pain.
- The progression of radiographic parameters presented in the study can be utilized as a guideline for predicting further progression of disease.

Bibliography
AM Poster 278: Temporary Limited Wrist Arthrodesis Using a Dorsal Spanning Plate in Perilunate Dislocations

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Background
Perilunate dislocations are severe carpal injuries that are often associated with high energy mechanisms resulting in polytrauma and various concomitant injuries. The current mainstay of operative intervention for these injuries consists of open reduction and internal fixation followed by immobilization in a cast to protect the fixation and allow healing. Patients return postoperatively for cast and hardware removal. Application of a dorsal spanning plate during the index surgical intervention permits the patient to perform loadbearing activities with the upper extremity which facilitates early rehabilitation while also serving as a rigid construct to protect and immobilize the fixation. As such, the dorsal spanning plate is especially helpful in polytrauma and elderly patients where early mobilization is paramount in preventing complications. The dorsal spanning plate is removed during the staged removal of hardware 10-12 weeks postoperatively.

Hypothesis
The application of dorsal spanning plates to augment the repair of perilunate dislocations maintains carpal stability while also allowing early loadbearing of the carpus.

Methods
This is a retrospective radiographic review of surgical interventions in patients sustaining a perilunate dislocation for which the repair is protected with casting or a dorsal spanning plate between 2012-2018. Scapholunate and lunotriquetral intervals were measured immediately after the index surgery and after scheduled hardware removal. 19 patients met inclusion criteria including 11 cases with traditional treatment and 8 cases with temporary wrist arthrodesis.

Results
Comparison of the change in scapholunate interval and lunotriquetral interval between the 11 patients in the traditional treatment group and the 8 patients in the dorsal spanning plate group did not yield any clinically significant variation after statistical analysis with unequal variances t-
test. Both groups demonstrated minimal change in the radiographic markers of carpal stability from postoperative radiographs obtained immediately after the index repair and after the removal of hardware.

**Summary Points**

- Temporary limited wrist arthrodesis using a dorsal spanning after fixation of perilunate dislocations provides a rigid construct that allows early loadbearing through the wrist while maintaining equivalent levels of carpal stability as the traditional method of fixation and cast immobilization.
- The ability to start early rehabilitation is especially important in polytrauma patients where prolonged immobility can extend hospital stay and increase rates of complications.

**Bibliography**

AM Poster 279: Return to Emergency Department after Closed Reduction of Distal Radius Fractures in Adults

Category: Wrist

Hand and Wrist; Nerve
Level 4 Evidence

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Hypothesis
Distal radius fractures are often initially managed with closed reduction and immobilization with either a cast or a splint. Some argue that circumferential casting immediately post-reduction may lead to neurovascular complications. We hypothesize that the rate and reason for return to the emergency department (ED) after closed reduction and immobilization of distal radius fractures are similar between those immobilized with a splint or a cast.

Methods
A retrospective chart review was performed at a Level I urban trauma center from 2015-2017. Patients with closed and displaced distal radius fractures that required a manipulative reduction and immobilization and were subsequently discharged home were identified via radiographic and chart review. Depending on the preferences of the orthopaedic attending on call at our institution, patients were either immobilized using a circumferential fiberglass cast or plaster sugartong splint. For all patients, the method of immobilization, medical comorbidities, pre-reduction neurovascular exam, and rate and reason for return to the ED were recorded for those patients who returned.

Results
Of the total of 474 patients included in this study, 158 were male (33.3%). Fiberglass cast was used in 329 patients (69.4%) while plaster-splinting was used in 145 patients (30.6%). 38 patients (8.0%) returned to the ED secondary to complaints related to their method of immobilization within a 2-week period after their initial injury (Figure 1). Pearson and Fisher’s exact two-sided chi-square analyses revealed that method of immobilization (i.e. casting or splinting) was not associated with an increased rate of return to the ED (p = 0.545 and 0.588, respectively). Of the 38 patients who returned to the ED, 34 were treated conservatively (e.g. bivalving casts, replacing splints, elevation) while only 4 patients required emergent surgical intervention (acute
carpal tunnel syndrome in 3 patients and skin breakdown in 1 patient). The method of immobilization was not associated with necessity of surgical intervention.

Summary Points

- We noted a return rate of 8.0% for patients who returned to the ED for a cast or splint related complaint.
- The method of immobilization (i.e. fiberglass cast or plaster splint) was not associated with an increased rate of return to ED.
- Most of the patients (89.5%) who returned to the ED were managed conservatively with bivalving of casts, application of a new splint with increased padding, and elevation.

Bibliography

Hypothesis
Distal radius osteomy for malunion is a procedure that is prone to complications requiring reoperation. Using a large population for analysis, we predict that the reoperation rate will exceed 15% and will most often be due to nonunion and tendon rupture.

Methods
A retrospective cohort study was performed utilizing the New York State Department of Health Statewide Planning and Research Cooperative System (SPARCS) database. Patients age 18 who underwent an osteotomy at the distal third of the radius between 2000 and 2016 were identified using Current Procedural Terminology (CPT) code 25350. The associated diagnoses were ascertained for each patient's primary surgery using International Classification of Diseases (ICD) codes. Patients were then followed longitudinally utilizing a unique encrypted patient identification codes for subsequent surgery and diagnostic indications at the ipsilateral upper extremity to characterize postoperative revision indications and rates. We performed descriptive analyses employing SAS version 9.4 (SAS Institute, Cary, NC, USA).

Results
During the study period, there were 273 primary osteotomy procedures at the distal radius in 273 patients with a mean age of 47.7 ± 15.6. Of the primary surgical cases, 153 (56.0%) had an associated diagnosis of distal radius malunion. There were 61 subsequent procedures at the ipsilateral distal radius among 56 (20.5%) patients. Reoperation procedure types and counts are demonstrated in table 1. The most common subsequent procedures involved hardware removal in 22 procedures (36.1%), neuroplasty and/or transposition in 15 procedures (24.6%), and repair of nonunion/malunion and/or osteotomy in 13 procedures (21.3%). Moreover, 7 procedures (11.5%) involved some level of wrist fusion or wrist arthroplasty, which are salvage procedures. Five procedures (8.2%) involved either tendon repair or tendon transfers. The three most
documented associated diagnoses for these subsequent procedures were pain in forearm joint, carpal tunnel syndrome, and fracture malunion.

Summary Points
- The rate of revision surgery for distal radius corrective osteotomy was found to be 20.5%. This is consistent with the limited previous and small retrospective studies.
- The most common subsequent surgeries were removal of hardware, nerve decompression, and correction of nonunion/malunion.
- In patients undergoing reoperation after a distal radius osteotomy, 11.5% require a salvage procedure, including an arthrodesis or wrist arthroplasty.
- While the nature of the database does not allow for determining pre-operative revision surgery symptoms, it is still helpful in counseling patients on the expected rate and possible causes for revision surgery.
AM Poster 281: Do the Tensile and Torsional Properties of the Native Scapholunate Ligament Effect Carpal Motion?

Category: Wrist

Hand and Wrist
N/A - not a clinical study
Grant support received from: 2015 AFSH Basic Science Grant.

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Hypothesis
We tested the null hypothesis that scaphoid and lunate kinematics during radial-ulnar deviation have no correlation with SLIL tensile and torsional structural properties.

Methods
Eight fresh-frozen cadaveric arms (mean age: 54 yrs; age range: 24-69; 5 male, 3 female) were transected at the elbow joint and loaded into custom jig. Kinematic data of the scaphoid and lunate were acquired in a simulated resting condition for three wrist positions: neutral, 10° radial deviation, and 30° ulnar deviation. Simulated resting tendon tension was applied to the carpus by hanging 1.5 N weights from strings secured to the ECRL, ECRB, APL, ECU, FCU, and FCR tendons. The SLIL bone-ligament-bone complex was then resected and evaluated in cyclic tension and torsion on a materials testing machine undergoing cyclic torsional testing (±0.45Nm flexion/extension at 0.5Hz) and tensile testing (1-50N at 1Hz) for 500 cycles. SLIL tensile and torsional properties were evaluated. The peak to peak (PtoP) rotation was defined as the net rotation between flexion and extension loading limits. Correlations between scaphoid and lunate rotations and SLIL tensile and torsional properties were determined using Pearson correlation coefficients.

Results
During wrist motion from radial to ulnar deviation, radial-ulnar deviation of both the scaphoid (r=-0.78, p=0.023) and lunate (r=-0.72, p=0.046) were found to be negatively correlated to SLIL PtoP rotation in torsion (Figure 1). The ratio of lunate flexion/extension to radial/ulnar deviation was found to be positively correlated with SLIL PtoP rotation in torsion (r=0.73, p=0.039), while
the ratio of scaphoid flexion/extension to radial/ulnar deviation trended towards as significant correlation with SLIL PtoP rotation in torsion (r=0.67 , p=0.070). No statistically significant correlations were found relating scaphoid or lunate rotation in the sagittal plane with SLIL tensile or torsional properties.

Summary Points

- Increased radial-ulnar deviation of the lunate and scaphoid during motion in the frontal plane is correlated with lower PtoP rotation in torsion. This suggests that stiffer SLIL’s may contribute to increased radial-ulnar motion of the lunate and scaphoid during motion in the frontal plane.

- Previous work correlated increased radial-ulnar motion of the scaphoid with decreased clinical laxity. Our work supports these previous findings.

- Our findings demonstrate a relationship between carpal motion and the mechanical properties of the SLIL.

Bibliography


This research was supported by a Basic Science Grant from the American Foundation for Surgery of the Hand.
Hypothesis
We hypothesized that distal radioulnar joint interposition arthroplasty using an Achilles tendon allograft for the treatment of persistent pain and instability following distal ulnar resection would result in improved functional outcomes and the prevention of symptomatic radioulnar convergence.

Methods
After institutional review, a retrospective review was performed on all patients who underwent Achilles tendon allograft interposition arthroplasty following failed distal ulna resection arthroplasty for persistent joint pain or instability between October 2009 and June 2013. Medical records were reviewed for demographics, co-morbidities, previous operative history, operative factors, pre- and post-operative functional evaluation with pain rating, wrist and forearm motion, and grip strength, and post-operative complications. PA and lateral forearm radiographs and wrist and forearm computerized tomograms (CTs) were evaluated for preoperative distal radioulnar instability and postoperative distal ulnar absorption, ulnar scalloping, radioulnar convergence and allograft subluxation. Reconstructive failure was defined two-fold: the presence of moderate to severe persistent distal radioulnar pain or instability with radiographic evidence of radioulnar convergence or allograft subluxation on radiographs or CT, and the need for revision arthroplasty procedure.

Results
Nine patients were identified. Mean age was 50.4 ± 4.9 years and male:female ratio was 1:2. Number of previous operations was 3.9 ± 1.4. Interposition arthroplasty was performed on average 77 months (range, 12-130 months) following the most recent distal radioulnar joint procedure. Duration of follow-up after interposition arthroplasty or until re-operation was 15 months (range, 5-49 months). Six out of 9 patients had continued symptoms of pain and instability. Mean total arc of pronation-supination improved by 39.9 degrees (p=0.06) and wrist flexion-extension arc without arthrodesis improved 15.1 degrees (p=0.91). Post-operative grip
strength decreased by 2.2 kg (p=0.9). Four patients failed the Achilles allograft interposition arthroplasty and underwent revision surgery. Reconstructive failure due to symptomatic radioulnar convergence and/or allograft subluxation occurred in 5 of the 9 patients.

**Summary Points**

- Following allograft interposition arthroplasty, minimal functional improvement in postoperative range of motion arc, grip strength or pain rating was observed.
- Revision surgical rates were unacceptably high with nearly half of all patients requiring revision surgeries within 14 months of allograft interposition.
- Given the unacceptably high failure rate of allograft interposition arthroplasty, alternative procedures should be considered for management of chronic pain and instability of the distal radial ulnar joint following distal ulna resection.

**Bibliography**

AM Poster 283: The Role of Vascularized Bone Graft in Adolescent Scaphoid Nonunion

Category: Wrist
Hand and Wrist; Congenital and Pediatric Problems; General Principles
Level 4 Evidence

Joseph S. Khouri, MD

Hypothesis
Though the vast majority of scaphoid fractures in the adolescent population will heal with immobilization, scaphoid nonunions can develop even in properly managed acute fractures. There is a paucity of literature evaluating the role of vascularized bone grafts (VBG) in the adolescent age group. The purpose of this study was to review our experience with VBG in the treatment of adolescent scaphoid nonunions. Our hypothesis is that there is a defined role for VBG in the treatment of adolescent scaphoid nonunions.

Methods
A retrospective review was performed of patients under 18 years of age who underwent VBG for scaphoid nonunion at a single institution over a 10 year period. Data were collected included age at injury, handedness, injured side, initial imaging findings, location of scaphoid fracture, time to nonunion, previous surgical treatment, pre-operative pin/ch/grip/range of motion, age at VBG procedure, type of VBG procedure, post-operative complications, and post-operative functional assessments (pinch/grip/range of motion, post-operative radiographic findings). Comparative statistical analyses were performed with significance set at p<0.05.

Results
Forty VBG were performed: 31 free medial femoral condyle (MFC) and nine 1,2-intracompartmental supraretinacular artery (1,2 ICSRA) grafts. Pre- and post-operative radioscaphoid and radiolunate angles showed significant change in both, indicating successful treatment of humpback and DISI deformities. Indication for MFC included avascular necrosis (AVN) with humpback deformity, and for 1,2 ICSRA was non-displaced proximal pole fracture. All fractures were either waist (65%) or proximal pole (35%) fractures, 55% had radiographic signs of AVN and 52.5% had previous surgery. The presence of an open physis at nonunion was significantly associated only with higher post-operative grip strength. There were 5 failures (12.5%). Failure rate for MFC was 12.9% (n=4) and for 1,2 ICSRA was 11% (n=1). No difference in recorded outcomes or graft failure rate was noted between MFC and 1,2 ICSRA. The only statistically significant predictor of graft failure was previous VBG to the area.
Summary Points
Careful patient and fracture selection is mandatory when offering VBG to adolescent patients with scaphoid nonunion. VBG are indicated in the adolescent patient with scaphoid nonunion when patients present with AVN, humpback deformity, and previous surgery. VBG as an attempt to salvage a prior failed VBG portend a worse outcome. VBG should be considered in unique situations in the adolescent age group, and overall has a high rate of union in specific difficult scaphoid nonunions.

Bibliography
5: Tsai TT, Chao EK, Tu YK, Chen AC, Lee MS, Ueng SW. Management of Scaphoid nonunion with avascular necrosis using 1, 2 intercompartmental supraretinacular arterial bone grafts. Chang Gung Med J. 2002;25:321–8
Hypothesis
Using a 3D-printer it is possible to synthesize a multiphasic bone-ligament-bone (BLB) scaffold morphologically similar to the dorsal scapholunate interosseous ligament (SLIL). We hypothesized that it would be possible to demonstrate cell growth and incorporation of the scaffold in vivo in an animal model.

Methods
The rabbit medial collateral ligament (MCL) has similar anatomical properties as the dorsal SLIL and was used as the model for testing this novel scaffold in vivo. Multiphasic bone-ligament-bone scaffolds modeled from the dorsal component of the SLIL were 3D-printed with medical grade polycaprolactone (PCL). These simulated a BLB construct with two bone compartments bridged by aligned PCL fibres mimicking the architecture of the native ligament studied from cadaveric specimens. Bone morphogenetic protein (BMP) was incorporated into the bone compartment to stimulate osteogenesis. For surgical implantation, the native MCL of the rabbit was removed with holes drilled into insertion and origin points of the ligament on the femur and tibia using a 5mm trephine. The bone compartments of the scaffold were press-fitted into the cavities and stapled in place. The rabbit knee joint was fixed in flexion using 1.4mm K-wires for 4 weeks (n=18) prior to mobilization for an additional 4 weeks (n=18). In total, 36 samples were implanted into 36 rabbits and harvested at four and eight weeks. Mechanical tensile testing (n=5 per group) and in vivo characterization of the constructs were conducted.

Results
After 4 and 8 weeks in vivo, the scaffold remained intact. Mechanical testing of the BLB scaffolds showed that they were capable of withstanding normal SLIL physiological forces. After 4 weeks of mobilization of the knee joint, tensile tests to failure demonstrated that the scaffolds improved in strength. In vivo study in the rabbits showed that the scaffold was biocompatible
and displayed good tissue integration and vascularization. At 4 and 8 weeks, bone formation and ligament remodeling was observed in the corresponding compartments.

**Summary Points**

- The rabbit MCL can be used as an animal model to test incorporation of SLIL scaffolds.
- It is possible to synthesize a 3-D printed BLB graft with structural and mechanical properties similar to the dorsal SLIL.
- Implantation of the scaffold into an in vivo animal model has demonstrated bone formation and ligament remodeling in the relevant compartments.
- The artificial scaffold may provide an alternative to current techniques for reconstruction of scapholunate instability.
Hypothesis
In 1984, Watson and Ballet coined the phrase scapholunate advanced collapse (SLAC) to describe the most common, typical sequence and progression of degenerative arthritis of the wrist in patients with articular alignment problems of the radius, scaphoid, and lunate(1). Since this description, this SLAC staging classification description has been used in numerous studies(2-11) to quantify the degree of wrist arthritis in patients undergoing wrist surgery. We hypothesize that the radiographic aspects of the SLAC wrist arthritis classification system coined by Watson et al.(1), show a good inter- and intra-rater agreement.

Methods
Forty-nine digital wrist radiographs were obtained, randomized and reviewed by five assessors following chart review of patients, 18 years or older. One week after the initial assessment the radiographs were re-randomized and re-reviewed by the same five assessors. The radiographs were assessed for signs of SLAC Stage 1, 2, 3 or 4 arthritic changes and the absence of arthritic changes. Scapholunate angle, lunocapitate angle, radiolunate angle, lunate translocation and scapholunate gap were also assessed. Intra- and inter-rater reliability were assessed using kappa, Fleiss’s kappa and intraclass correlation (ICC).

Results
Intra-rater reliability on arthritic pattern was found to be good with a kappa value of 0.618 (range 0.512 to 0.693), while the inter-rater reliability was found to be moderate with a kappa value of 0.416 (range 0.118 to 0.357). The intra-rater agreement on scapholunate and lunocapitate angles was found to be good with ICC values of 0.768 (range 0.589 to 0.898) and 0.782 (range 0.659 to 0.833) respectively. Similarly, the intra-rater agreement on ulnar translocation percentage and scapholunate gap was found to be good with ICC values of 0.891 (range 0.835 to 0.925) and 0.839 (range 0.744 to 0.930). Only the radiolunate angle was found to
have moderate intra-rater agreement with an ICC value of 0.766 (range 0.699 to 0.855). Interrater agreement was found to be moderate on scapholunate, radiolunate and lunocapitate angles with ICC values of 0.560 (range 0.454 to 0.665), 0.6410 (range 0.699 to 0.855) and 0.657 (range 0.581 to 0.732). Ulnar translocation percentage and scapholunate gap had a good inter-rater agreement with ICC values of 0.832 (range 0.808 to 0.856) and 0.760 (range 0.723 to 0.794) respectively.

Summary Points
- Radiographic classification of SLAC wrist has moderate reliability and reproducibility.
- Ulnar translocation percentage and scapholunate gap assessment has good inter- and intra-rater reliability and reproducibility.
- Scapholunate, lunocapitate and radiolunate angles assessment has moderate inter-rater and good intra-rater reliability and reproducibility.

Bibliography
3: Mulford JS, Ceulemans LJ, Nam D, Axelrod TS. Proximal row carpectomy vs four corner fusion for scapholunate (Slac) or scaphoid nonunion advanced collapse (Snac) wrists: a systematic review of outcomes. J Hand Surg Eur Vol 2009 Apr;34(2):256-63
Hypothesis
The purpose of this study was to assess the effect of restoring volar tilt in distal radius fractures on flexor pollicis longus (FPL) tendon rupture. We hypothesize that restoring the anatomic volar tilt (10.8 degrees) of the distal radial fragment, will result in less contact force between the volar plate and FPL than in fragments fixed without volar tilt restoration.

Methods
We used six (n=6) cadaveric upper extremities with no history of hand, wrist, or forearm trauma. The radius and ulna were fixed in a custom jig. Using Kirschner wires, the wrist was fixed at 30 degrees of extension, and the interphalangeal and metacarpophalangeal joints were each fixed at 15 degrees of flexion while the Carpometacarpal joint was fixed in opposition simulating a “pinch configuration”. Loads of 1kg and 3 kg were fastened to the FPL tendon to simulate anatomic forces across the tendon during use. Contact force between the FPL and volar lip of the radius/plate was measured using a small force transducer. Contact force was assessed at 4 surgical conditions: Control (intact control wrist with no plate), Anatomic plate (after creating a distal radius fracture, a volar locking plate was utilized to achieve fixation with 10.8 degrees of volar tilt), Neutral Plate (distal fragment was fixed neutral), Dorsal Plate (distal fragment was fixed with an additional 5 degrees of dorsal angulation).

Results
A two-way ANOVA was used to assess for statistical significance (p<0.05). No significant difference in contact force was observed between Control and Anatomic Plate conditions at both 1kg and 3kg with mean differences of 0.26N (p=0.7179) and1.36N (p=0.0608) respectively. A significant increase was observed between the Control and Neutral plate conditions at both 1kg
and 3kg with mean differences of 1.41N (p<0.0001) and 4.6N (p<0.0001) respectively. Similar trends were seen between Control and Dorsal Plate with mean differences of 1.62N (p<0.0001) and 4.85N (p<0.0001) for 1kg and 3kg respectively.

Summary Points

- Restoration of volar tilt with a volar locking plate shows no increase in FPL contact force compared to an intact Control wrist.
- FPL contact force increases without adequate restoration of volar tilt (as demonstrated by a neutral and exaggerated dorsal angulation)
- Failure to restore anatomic volar tilt in distal radius fracture fixation may increase the risk of FPL tendon rupture

This research was supported by a Residents & Fellows Fast Track Grant from the American Foundation for Surgery of the Hand.
AM Poster 287: Early Experience with a Novel Synthetic Scapholunate Ligament Construct

Category: Wrist

Hand and Wrist
Level 4 Evidence

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Benjamin Hope, MD
Greg B. Couzens

Hypothesis
It is hypothesised that use of a woven polyurethane “artificial ligament” is suitable for reconstructing the scapholunate ligament, and with a tensile strength of 600N, it is adequate to allow immediate postoperative mobilisation.

Methods
The mini Lockdown “artificial ligament” is anchored in the distal scaphoid, routed through drill holes in the proximal row and passed across the triquetro-hamate joint to be secured into the dorsal capitate. The proximal row tunnels are the same as employed in the “SLT” reconstruction that we have previously published (1). We have performed 16 mini Lockdown reconstructions since 15/07/2016. Fifteen patients were independently examined preoperatively (including x-ray, MRI, and quality-of-life measures); 12 have been reviewed postoperatively at an average of 28.4 weeks. The scapho-lunate (SL) gap and angle were measured from x-ray imaging taken preoperatively, immediately post-op and at most recent follow up. Due to the small series of patients, only descriptive data of pain, function and range of motion outcomes were analysed for reporting.

Results
The patient-reported visual analogue scale (VAS) pain scores decreased from 40.9 to 23.4 and satisfaction increased from 23.4 to 75.9. PRWHE and QuickDASH scores improved from 54.9 to 29.2 and 43.1 to 23.1 respectively. Average grip strength increased from 25.8kg at pre-op assessment to 28.2kg at most recent follow up. Average SL gap decreased from 4mm pre-op, to 1.2mm immediately post-op and then increased to 1.9mm at the time of most recent post-op x-ray (average 22.5 weeks). Similarly, average SL angle was measured at 75.5 degrees pre-op, 57.25 degrees immediately post-op and 61.25 degrees on most recent x-ray (22.5 weeks). One revision procedure has been performed due to re-injury of the affected wrist.
Summary Points

- Many techniques have been proposed for reconstructing the scapholunate ligament. We have previously described a technique for entirely transosseous passage of a tendon graft through the proximal row (1).
- The mini Lockdown “artificial ligament” has a tensile strength of 600N, with bench and cadaver testing indicating the construct remained intact until a load of approximately 400-500N.
- The mini Lockdown is used in three SL ligament reconstruction situations:
  - In place of temporary K-wire fixation following acute repair or late reconstruction,
  - In conjunction with a strip of FCR via the same transosseous proximal row tunnels (an augmented SLT), or
  - In isolation via the SLT tunnels (a mini Lockdown "RASL").

Bibliography
Hypothesis
Magnetic Resonance Imaging (MRI) in patients with clinically suspected scaphoid fractures and negative radiographs results in the detection of 1) occult scaphoid fractures and 2) patterns of scaphoid intraosseous pathology: i.e. incidence and distribution of scaphoid fractures and contusions.

Methods
In this retrospective diagnostic study, 244 patients with clinically suspected scaphoid fractures who underwent MRI following a negative radiograph were included. MRIs were assessed for the presence of 1) fractures 2) contusions of the scaphoid. Fractures and contusions were differentiated by the presence of a cortical breach on MRI. The location of injury was classified to be present in the proximal pole, waist or distal pole of the scaphoid. Chi-square tests were applied to determine whether the type and distribution of scaphoid pathology differed significantly. Occult fractures of other structures were also reported.

Results
Scaphoid oedema -with or without visible fracture line- was detected in 27.0%(n=66) of the patients. An occult scaphoid fracture was diagnosed on MRI in 12.7%(n=31) of the patients, versus a scaphoid contusion in 14.3% (n=35). The incidence and distribution of acute scaphoid pathology was as follows: 2.5% (n=6), 7.8%(n=19) and 16.8%(n=41) of the patients had oedema of the proximal pole, waist and distal pole, respectively. A fracture of the proximal pole, waist and distal pole was identified on MRI in 1.6%(n=4), 3.7% (n=9) and 7.4%(n=18) of the patients, versus contusions in 0.8% (n=2) 4.1%(n=10) and 9.4%(n=23), respectively. Chi-square showed no significant association between location and type of bony pathology. (p=0.58). Occult fractures of other carpal bones, metacarpals or distal radius were identified in 9.4%(n=23), 1.2%(n=3) and 7.3%(n=18) of the patients, respectively.
Summary Points

• An occult scaphoid fracture was detected on MRI in 12.7% of the patients with a clinically suspected fracture, versus a contusion in 14.3% of the patients.
• Identification of occult scaphoid fractures allows for adequate treatment of true fractures, while eliminating unnecessary immobilization in patients without evidence of a fracture.
• Differentiation between true fractures and contusions on MRI remains challenging, as 1) cortical involvement proves hard to identify in the presence of oedema 2) radiological definitions vary in literature.
• This study highlights the prevalence of both occult scaphoid fractures and contusions in patients with clinically suspected scaphoid fractures. This emphasizes the need for clear distinctions to be made in the (radiological) definitions of scaphoid fractures versus contusions and more importantly, their respective clinical relevance, to further address the overtreatment of suspected scaphoid fractures.

Bibliography
AM Poster 289: The Role of MR Arthrography in the Assessment of Triangular Fibrocartilage Complex Injuries: A Comparison with CT Arthrography

Category: Wrist

Hand and Wrist
Level 3 Evidence

Takeshi Koba
Atsushi Tasaki
Taiki Nozaki
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Hypothesis
This study sought to evaluate the clinical utility of MR arthrography (MRA) in diagnosing and grading the triangular fibrocartilage complex (TFCC) injuries in comparison with CT arthrography (CTA). We hypothesized that MRA is superior to CTA with regards to identifying the partial damages of TFCC. Since MRA has higher CNR (contrast noise ratio) between water (contrast agent) and bone than MRA, MRA is easy to diagnose leakage of contrast agent.

Methods
Eighteen consecutive patients (18 wrists) who had ulnar-sided wrist pain were evaluated by both the MRA and CTA. Contrast reagents consisted of Urografin and Gadovist were injected into the joint under X-ray fluoroscopy, and then 3T three-dimensional MRI and three-dimensional CT were taken at the wrist neutral position. After the identified TFCC abnormalities were described using Palmer’s classification, the diagnostic abilities of both tests were compared. Further, contrast-to-noise ratio (CNR), which is a common measure used to determine image quality, is calculated by setting a circular region of interest (ROI) with a diameter of 0.8mm for the analysis of contrast enhancement at the same coronal plane of each CTA and MRA. Each CNR was independently measured by one orthopedic surgeon and one radiologist. The mean value of CNR was statistically compared between the CTA and MRA using the t test. The significance level was set at p=0.05.
Results
TFCC injury was observed in 14 cases. In addition to the presence or absence of damage, MRA was able to evaluate damage extent and extent of damage around fracture. The mean CNR value was -9.0 (range; -27.3 to 9.6) for CTA and 46.4 (range; 23.7 to 74.1) for MRI. The CNR value was significantly higher in MRA than CTA (P <0.001 ).

Summary
- Both the CTA and MRA were useful in diagnosing the TFCC injuries when there was a complete disruption in the TFCC. However, the partial TFCC injuries were determined only by MRA.
- The CNR value was higher in MRA than CTA, which indicates MRA has a high ability in diagnosing soft tissue injuries including the TFCC injuries.
AM Poster 290: The Validity and Responsiveness of PRWHE and QuickDASH as Outcome Measures Following Surgery to Treat Scapholunate Ligament Dissociation

Category: Wrist

Hand and Wrist
N/A - not a clinical study

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Libby Anderson
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Susan Peters, MAHTA MAHTA
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Hypothesis
We propose that the PRWHE (patient rating of wrist pain and disability) and the QuickDASH will demonstrate low construct validity and responsiveness to change in patients diagnosed with carpal instability following scapholunate ligament complex injuries.

Methods
Fifty patients were retrospectively identified from a prospective cohort of patients who had undergone surgical treatment for a carpal (wrist) instability condition (injury to the scapholunate ligament) with data collected at baseline and at least one complete set of outcome measures at a follow-up time point (3, 6, or 12 months). PRWHE and QuickDASH responsiveness was evaluated using Patients Global Rating of Change Scores for Function and Symptoms (PGRCf; PGRCs). Construct validity was evaluated by assessing the correlation between the PRWHE, QuickDASH and the PGRC.

Results
Of the fifty patients included, PRWHE and QuickDASH had generally only fair-moderate responsiveness to improvement following treatment for a wrist instability condition. There was generally a fair-moderate relationship (ranging from 0.2 to 0.77) between the PRWHE/QuickDASH and the PGRCs/PGRCf.
Summary Points

- Injury to the scapholunate ligament is a common cause of wrist instability. There are a variety of treatment options to manage these injuries, though there are no established standards of reporting the outcomes of these procedures.
- Generic upper limb patient-reported outcome measures including PRWHE and QuickDASH are being used to report clinical efficacy. Currently no patient-rated outcome measures have been validated for use in patients with wrist instability.
- The measures, PRWHE and the QuickDASH, only appear to have fair to moderate responsiveness to improvement for patients with wrist instability.
- This has implications for clinicians attempting to select appropriate and sensitive outcome measures for reporting results following treatment for wrist instability conditions.
Hypothesis
We hypothesized that branches of anterior interosseous artery (AIA) consistently nourishes the distal radius and that the relationship with the posterior interosseous nerve (PIN) allows reliable vascularized bone graft (VBG) from this area to treat patients with ulnar diaphyseal nonunion.

Methods
We dissected 16 dorsal wrists and dorsal aspect of the forearm from fresh cadavers after injecting silicone compounds through the brachial artery. We investigated vascular patterns and the location of the AIA branches to the dorsal radius. Then, we examined the anatomical relationship between the AIA and the motor branches of the PIN.

Results
Of all 16 specimens, the AIA gave off 2,3 intercompartmental supraretinacular artery (ICSRA), 4th extensor compartment artery (ECA), and branches of the posterior interosseous artery (PIA), 6.8 ± 2.8 cm, 3.0 ± 1.0 cm, and 3.6 ± 1.2 cm, respectively proximal to the distal end of the ulnar head. Vascular patterns of the dorsal radius were divided into 2 groups according to the number of branches penetrating the interosseous membrane. Type A: (one penetrating branch) The 2,3 ICSRA gave off at 5.4 ± 2.1 cm (11 cases); and Type B: (two penetrating branches) The 2,3 ICSRA gave off at 9.8 ± 1.0 cm (5 cases). The PIN ran adjacent to the 4th ECA and was consistently identified at the radial side of the 4th ECA and the AIA. The PIN gave off a motor branch to EIP and EPL at 5.9 ± 1.3 cm and 6.7 ± 1.5 cm, respectively.
Summary Points

- In type A (69%), it was possible to elevate the distal radius VBG pedicled on both the 2, 3 ICSRA and the 4th ECA. The maximum proximal border of the ulna, where can be transferred without a risk of extensor muscle paralysis, was 12 cm proximal to the distal end of the ulnar head.
- In type B (31%), it was possible to elevate the VBG pedicled on either the 2, 3 ICSRA or the 4th ECA. The maximum proximal border, where was reached by the VBG pedicled on the 2, 3 ICSRA only, was 20 cm proximal to the ulnar head.

Bibliography

AM Poster 292: Extensor Tendon Repair and Prophylactic Extensor Retinaculum Release for Extensor Tendon Ruptures in Rheumatoid Wrists

Category: Wrist

Hand and Wrist; Diseases and Disorders; General Principles
Level 4 Evidence

Seung-Han Shin, MD, PhD
Yong-Suk Lee, MD
Yang-Guk Chung, MD, PhD

Hypothesis
Extensor tendon rupture is common in advanced rheumatoid arthritis patients. Currently tendon transfer is the most common procedure for rheumatoid extensor tendon rupture, because of late detection and poor tendon quality. However, we repaired ruptured tendons to their original stumps, even in cases with a long history of extension loss. We hypothesized that the repair would produce good outcomes and prophylactic extensor retinaculum release would prevent further rupture of extensor tendons.

Methods
A total of 12 rheumatoid arthritis patients who were treated surgically for extensor tendon rupture were reviewed. The patients had a history of finger extension loss for up to 1 year. Ruptured tendons were: extensor digiti minimi (EDM) in 12, extensor digitorum communis (EDC) (little finger) in 12, EDC (ring finger) in 8, EDC (middle finger) in 5, and EDC (index finger) in 1. All tendons were repaired to their original stumps, while distal stumps of EDM and EDC (little finger) were repaired together to proximal stump of EDM muscle. Palmaris longus tendon interposition graft was used in 8 patients. Direct repair was performed for 5 out of 12 EDM-EDC (little finger) repair. In all patients, extensor retinaculum was released and repaired under extensor tendons, to prevent further extensor tendon rupture.

Results
All patients recovered active finger extension, including independent extension of the little finger. No further extensor tendon rupture occurred after the surgery. Although repaired tendons were prominent under the skin due to bowstring phenomenon, no patient reported pain in the prominent tendon and substantial functional impairment was minimal.
Summary Points

- Extensor tendon repair and prophylactic extensor retinaculum release is a good option for extensor tendon ruptures in rheumatoid wrists.
- A muscle with a tendon rupture may work again even after 1 year history of extension loss in rheumatoid arthritis patients.
- Extensor retinaculum release appears to be helpful for the prevention of further extensor tendon ruptures.

Bibliography

1: Chung 2010 - Tendon transfer or tendon graft for ruptured finger extensor tendons in rheumatoid hands
2: O'Sullivan 2016 - Tendon Transfers in the Rheumatoid Hand for Reconstruction
3: Sakuma 2014 - Number of Ruptured Tendons and Surgical Delay as Prognostic Factors for the Surgical Repair of Extensor Tendon Ruptures in the Rheumatoid Wrist
AM Poster 293: Epidemiological and Treatment Trends of Distal Radius Fractures Across Multiple Age Groups

*Category:* Wrist

Hand and Wrist; Elbow and Forearm

Level 2 Evidence

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**Hypothesis**
Distal radius fractures are one of the most common types of injuries, accounting for approximately 1.5% of all emergency department visits. The purpose of this study was to provide a current understanding of distal radius fracture epidemiology in the United States, as well as to evaluate the population specific treatment trends and associated complications.

**Methods**
The PearlDiver database (Humana (2007 to 2014), Medicare (2005 to 2014)) was used to search by ICD-9 and CPT codes for all patients who had undergone operative and non-operative treatment for a distal radius fracture in the United States. Epidemiologic analysis was performed followed by stratification based on age (pediatric, young adult, middle-aged, elderly) with analysis characterizing prevalence, treatment trends, and associated complications.

**Results**
A total of 1,124,060 distal radius treatment claims were captured. The incidence of distal radius fractures follows a bimodal distribution with distinct peaks in the pediatric and elderly population. Fractures in the pediatric population occurred predominately in males, whereas fractures in the elderly population occurred more frequently in females. The most frequently used modality of treatment was closed treatment, however, there was a significant increase in the use of internal fixation during the study period, 8.75% (2005) to 20.02% (2014), with a corresponding decrease in percutaneous fixation. There was an overall complication rate of 6% [operative (9.6%), non-operative (5.4%)] with mechanical symptoms most frequently reported.
Summary Points

- The last decade has seen a significant increase in the use of internal fixation as treatment modality for distal radius fractures.
- The impetus for this change is likely multifactorial and in part related to recent innovations like the volar locking plate and an increasingly active elderly population.
- The implicated financial cost must be weighed against the productivity cost of maintaining independent living to determine the true burden to the healthcare system.

Bibliography

AM Poster 294: The Effect of Serial Sectioning of the Volar and Dorsal Capsules on Carpal Stability

Category: Wrist

Hand and Wrist; Elbow and Forearm; General Principles

N/A - not a clinical study

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Hypothesis
The extent of the volar and dorsal capsules that can be released without causing carpal instability is unknown. We hypothesized that the lunate will translate ulnarly with serial sectioning of the volar ligaments in a cadaver model simulating grip.

Methods
The stabilizing roles of the RSC, SRL, LRL, and DRC were determined by evaluating the effect of sequential isolated sectioning on the motion of the scaphoid and lunate during simulated neutral grip, radial deviation, and ulnar deviation. The matched pairs were split into two groups of five specimens each with right and left sides arbitrarily assigned to each. The first group of specimens underwent isolated sectioning of the volar radiolunate ligaments with repeated testing (Group 1). In this group, the DRC was sectioned first, followed by the LRL & RSC, and finally the SRL. The second group of specimens underwent isolated sectioning of the volar radiolunate ligaments with the order reversed (Group 2). A mixed-effects regression with a random effect for specimen and Tukey post hoc tests was used to evaluate the effects of sectioning on lunate ulnar translation. Significance was set at P < .05.

Results
In Group 1, with the wrist in 20 deg ulnar deviation, lunate ulnar translation was significant after sectioning the DRC (-0.8±0.5 mm, P = 0.030), LRL+RSC+DRC (-0.4±0.6 mm, P < 0.001) and SRL+LRL+RSC+DRC (0.4±0.8 mm, P < 0.001) compared to the intact state (-1.2±0.4 mm) (Figure 1). Similarly, during simulated grip, lunate ulnar translation was significant after sectioning the DRC (1.1±0.8 mm, P = 0.040), LRL+RSC+DRC (1.5±0.8 mm, P < 0.001) and SRL+LRL+RSC+DRC (2.7±0.9 mm, P < 0.001) compared to the intact state (0.6±0.2 mm,) (Figure 1).

In Group 2, lunate ulnar translation was significant after sectioning the LRL+RSC+SRL (0.0±0.7 mm, P = 0.001) and SRL+LRL+RSC+DRC (0.8±0.7 mm, P < 0.001) compared to the intact state (-
1.0±0.8 mm). Likewise, lunate ulnar translation was significant after sectioning the LRL+RSC+SRL (1.5±0.7 mm, P < 0.001) and SRL+LRL+RSC+DRC (2.1±0.8 mm, P < 0.001) compared to the intact state (0.2±0.5 mm) (Figure 2).

Summary Points
- Ulnar translations of at least 1 mm relative to the intact state did not occur until after sectioning at least three ligaments.
- The data suggests that carpal instability occurs after sectioning the LRL+RSC along with either the DRC or the SRL.
AM Poster 295: Biomechanical Stability of Volar Plate Only Versus Addition of Dorsal-Ulnar Pin Plate: A Dorsal-Ulnar Fragment C-3 Type Distal Radius Cadaver Fracture Model

Category: Wrist

Hand and Wrist
Level 4 Evidence
Grant received from: Orthopaedic Research Initiation Grants

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Greg Lewis, PhD
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Hypothesis
Fragment specific fixation is superior to fixed-angle volar plate fixation in terms of its effect on stabilizing an intra-articular distal radius fracture with an associated dorsal-ulnar fragment.

Methods
AO/ASIF type C3 fractures, with a dorsal-ulnar fragment of 1/3 or ½ the width of the distal radius, were simulated in 9 matched pairs of fresh-frozen cadaveric arms randomized between fixed-angle volar plate and fragment-specific fixation systems. Prepared specimens were mounted in a custom servohydraulic load frame and were loaded in extension. Cyclic, compressive loads were applied to the carpus for 25 cycles at 10 N, then 25 cycles at 15 N, continuing in 5 N increments until failure of the specimen or reaching displacement limits of the mechanical test machine150 N. Compressive force, actuator displacement, and fracture fragment displacement values were recorded. Specimens were loaded in extension cyclically for 2,000 repetitions followed by a single cycle to failure. Initial, intermediate, and final stiffness values. Interfragmentary displacements and failure load values at 50 N, 100 N, and 150 N load were obtained and compared.

Results
Both systems were able to sustain physiologic cyclic loading. The addition of the dorsal-ulnar pin plate was significantly provided a stiffer construct for the ulnar segment at 50 N load application, resulting in mean interfragmentary displacements of -0.068 ± 0.163 mm and -0.342 ± 0.203 mm,
respectively in both the pre-cycle and post-cycle values. No other comparisons were significant with respect to interfragmentary displacements with respect to stiffness. No significant difference in load to failure was found between the systems with respect to ulnar, radial, or overall fragment displacement. Also, no significant statistical differences were found comparing the 1/3 to 1/2 size fragments.

Summary Points
- The addition of a dorsal-ulnar pin plate improved fragment stability characteristics with respect to the smaller ulnar-sided fragment at lower loads, which could suggest improved stability with an early rehabilitation protocol.
- Smaller dorsal-ulnar fragments were not shown to demonstrate increased displacement with either the volar plate alone or with the addition of the dorsal-ulnar pin plate in this model.

Bibliography
Abstract

Hypothesis
There is a correlation between the presence of a distal oblique bundle (DOB) and the anatomical type of distal radioulnar joint (RUJ) according to the classification of Tolat (from most stable to least stable: S-shape, C-shape, Ski-slope, and Flat face).

Methods
Twelve specimens (1 fresh frozen, 11 conserved) were dissected. The presence of a DOB was evaluated according to the description of Moritomo: the interosseous membrane was exposed in its distal portion to search for stretched fibers between the ulna and the radius below and on the outside. The group of specimens was then evaluated by tomodensitometry to determine the type of RUJ incisure according to Tolat's description on frontal cuts at one centimeter from the radiocarpian articulation. The statistical analysis was performed using odds ratio.

Results
The distal interosseous membrane was found in 7 specimens, (58%). The presence of a DOB was more frequent in less stable incisures (4 flat face, 3 ski slope). They were never found in the other more stable configurations according to Tolat's classification.

Summary Points
- This cadaverous observations confirm the importance of analyzing the shape of the incisure, in case of chronic instability of the RUJ.
- The flat-face or ski-slope conformation associated with a chronic instability of the RUJ deserve a reconstruction creating a strong connection between the radius and ulna at the site of the distal oblique bundle (DOB) best reconstruct the native anatomy.

Bibliography
1: A.R. TOLAT, From the Wrightington Hospital for Joint Diseases, Appley Bridge, UK
2: Hisao Moritomo, The Distal Interosseous Membrane: Current Concepts in Wrist Anatomy and Biomechanics
3: Peter R. G. Brink, Distal Oblique Bundle Reinforcement for Treatment of DRUJ Instability