RF: Poster 01: Suture Tape Augmentation for Scapholunate Ligament Repair: A Biomechanical Study

Category: Skin and Soft Tissue

Surgical Technique
Level of Evidence: N/A

Robert G. Thompson
Joel Dustin
D. Keith Roper
Steven M. Kane
Gary M. Lourie

HYPOTHESIS
The maximum load to failure of the scapholunate ligament repairs augmented with suture tape will be higher than the scapholunate ligament tears repaired solely with suture anchors.

METHODS
Twelve fresh frozen cadavers (6 matched pairs) underwent a dorsal approach to the wrist and the scapholunate ligament was sharply dissected off of its scaphoid attachment. Six of the cadavers underwent direct repair of the SL ligament utilizing 2 suture anchors (2.2x4mm Micro Corkscrew FT Anchors). The other six cadavers underwent repair of the SL ligament with 2-0 FiberWire augmented with Fiber Tape (InternalBrace) utilizing 3.5 mm DX SwiveLock SL anchors. All specimens then underwent load to failure testing using tensile distraction forces applied by an Instron universal testing system (Instron, Canton, MA). The maximum load to failure and mode of failure were recorded.

RESULTS
The mean maximum load to failure for the suture anchor repair only group was 68 N with a standard deviation of 14.69. The mean maximum load to failure for the internal brace augmented group was 135 N with a standard deviation of 44.94. A p-value of 0.019 was calculated denoting a significantly higher max load to failure for the Internal Brace augmentation group compared to the repair only group (p< 0.05). Additionally, the mode at which each specimen failed at its maximum load point was recorded. In the suture anchor repair group two specimens failed due to suture slippage, 1 due to knot slippage and 2 due to tissue failure. In the Internal Brace augmentation group 3 failed due to suture slippage, 2 from tissue failure and one specimen from combined suture slippage and tissue failure.

SUMMARY
• Biomechanical testing demonstrated a higher maximum load to failure in scapholunate ligament repairs augmented with suture tape compared to a repair-only technique in this cadaveric model. • Acute scapholunate ligament injuries may benefit from suture tape augmentation by increasing the stability of the primary repair. This may prove to be beneficial
in higher demand patients • Augmenting with suture tape may lead to decreased periods of post-op immobilization allowing patients to begin moving sooner and decreasing time to recovery

REFERENCES:
RF: Poster 02: Staples versus sutures in hand and wrist surgery: a prospective, blinded, randomized controlled study

Category: Skin and Soft Tissue; Other Clinical Topics

Treatment; Surgical Technique; Prognosis/Outcomes
Level of Evidence: 1

Allison M. Hunter, MD
Sierra Phillips, MD
Erin Ransom, MD
Ashish Shah, MD
Joseph M. Sherrill, MD
Nileshkumar Chaudhari, MD

HYPOTHESIS:
This study sought to evaluate the safety and cosmetic outcome of staples versus sutures for primary skin closure. We hypothesized that cosmetic outcome, wound complications, pain scores and materials cost would be similar between treatment groups, while time for incisional closure using staples would be faster, saving operative time.

METHODS
Patients were enrolled under the care of two fellowship trained hand surgeons at a single institution and randomized into staples (standard size) or sutures (4-0 or 5-0 nylon) for primary skin closure of linear incisions. Both the patient and the attending surgeons were blinded to the skin closure method. Demographic preoperative, operative, and postoperative details were collected and compared between patients. Primary outcomes included wound complications and aesthetic assessment of the skin using the Patient and Observer Scar Assessment Scale (POSAS) scores at 10-14 days, 6-weeks, and 3-months. Secondary outcomes included time to place and remove staples versus sutures, materials cost, and Visual Analog Scale (VAS) pain scores upon staple or suture removal.

RESULTS
101 extremities were randomized into two groups: Group 1 (suture group, n= 54) and Group 2 (staple group, n= 47). Cosmetic outcome was similar between both groups at all time points, however patients in both groups consistently rated cosmesis to be poorer compared to both the surgeon and an independent observer. Four wound complications were observed (2 suture, 2 staple): one required oral antibiotics, while all others were managed with local wound care and resolved by 6 weeks. Staples required less operative time than sutures (204 sec vs 87 sec). There was no difference in removal times or VAS pain scores before and after removal. Materials cost was more expensive for stapler use.
SUMMARY
Staples offer a faster closure with comparable cosmetic results, pain scores and without increased risk of wound complication. Future studies should further evaluate the difference between patient and surgeon reported outcomes of incisional cosmesis to guide post-operative expectations in hand and wrist surgery.

REFERENCES:

![Figure 1: Flow diagram of included patients.](image-url)
Figure 2: POSAS Results for 2 weeks, 6 weeks, and 3-months
RF: Poster 04: Rodeo Thumb: to Replant or Not
Category: Bone and Joint

Prognosis/Outcomes
Level of Evidence: 4

Justin Davis
Anna Meade
Lindsey Cochran
Douglas Sammer
Andrew Y. Zhang

HYPOTHESIS
Rodeo thumb is a complex injury, involving both avulsion and crush components, that occurs in team roping events. Because the thumb can be considered a hindrance in team rope dallying, ropers who forgo replantation after injury may report better hand function — by not considering thumb loss as a deficit. Our goal is to add information that will support surgeons in the process of decision making when faced with a rodeo thumb injury.

METHODS
A retrospective review was performed for all rodeo thumb amputations from 2009-2019. Any patient who experienced traumatic rodeo thumb amputation was contacted and an over-the-phone questionnaire survey was administered. Outcomes measured included daily functionality determined by QuickDASH scores, roping ability, and overall satisfaction. These were then compared between different levels of injury (Metacarpal (MCP) versus Interphalangeal (IP)) and definitive treatment (amputation vs replantation). Outcomes between older and younger patients were also compared. Two-sided t-tests were used for QuickDASH scores and Pearson’s Chi square test for categorical data.

RESULTS
Those who had IP injury treated with replantation had an average QuickDASH less than those treated with amputation (1.36 vs. 8.11; p=0.07), but fewer were roping at the same level or better (40% vs 78.6%; p=0.262). Most patients were happy with their treatment decision between replant and amputation (80% vs. 71.4%; p=1.00). Those who had MCP injury and replantation also had an average QuickDASH less than those treated with amputation (7.32 vs 10.4; p=0.52) and more claimed to be roping at same level or better (66.6% vs 55.6%; p=1.00). Patients who underwent replantation were also happier with their decision than those who underwent amputation (77.8% vs 44.4%; p=0.335). Younger patients had lower QuickDASH scores than older patients (5.53 vs. 8.19; p=0.42), more who were roping at the same level or better (100% vs. 53%; p=0.02), and more who were satisfied with their treatment decision (88.9% vs. 60.7%; p=0.22). There were also more MCP replants in younger patients than in adults (44% vs 17.9%; p=0.08).
SUMMARY
For IP level injury, amputation seems to result in the same or better roping abilities as replantation. Because it has a greater effect on daily living, patients tend to be more satisfied with replantation at the MCP level. Younger patients tend to have better outcomes, possibly due to increased adaptation to injury. MCP replantation is more common in younger patients because of the emphasis on saving the thumb in younger patients.

REFERENCES:

<table>
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<th>IP Replant (n=5)</th>
<th>IP Amp (n=14)</th>
<th>P value</th>
<th>MCP replant (n=9)</th>
<th>MCP Amp (n=9)</th>
<th>P value</th>
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<td>Quick Dash score</td>
<td>1.36 ± 2.03</td>
<td>7.60 ± 8.11</td>
<td>0.07</td>
<td>7.32 ± 8.93</td>
<td>10.35 ± 10.55</td>
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<td>Roping at same level or better</td>
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<td>11 (78.6%)</td>
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<td>6 (66.6%)</td>
<td>5 (55.6%)</td>
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<td>Satisfied with decision</td>
<td>4 (80.0%)</td>
<td>10 (71.4%)</td>
<td>1.00</td>
<td>7 (77.8%)</td>
<td>4 (44.4%)</td>
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<table>
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<th>Age ≥24 (n=28)</th>
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<td>QuickDASH score</td>
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<td>Satisfied with initial decision</td>
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RF: Poster 07: Processed 3D Printed Plastic Casting Material Shows Decreased Bacterial Adherence

Category: Other Clinical Topics

Basic Science
Level of Evidence: N/A

Joseph Massaglia, DO
Cory Lebowitz, DO
Keith Fitzgerald, BS
Noreen Hickok, PhD
Pedro Beredjiklian, MD
Michael Rivlin, MD

HYPOTHESIS
This study evaluates the bacterial adherence to different casting materials. We hypothesize that significantly fewer bacteria will adhere to silicone coated plastic during inoculation and that there will be significantly fewer bacteria remaining on silicone after washed with a soap solution compared to a sterile water control.

METHODS
The minimal inhibitory concentration of a phosphate-free soap that achieved total bacterial kill off was determined. 3D printed plastic samples were coated with silicone. Plaster, fiberglass, non-coated plastic, and silicone samples were inoculated with Staphylococcus aureus. Using either sterile water or a soap solution, the samples were subjected to a washing cycle. Each material was run in 30 replicates: 6 without treatment, 6 with sterile water for 1 minute, 6 with soap for 1 minute, 6 with sterile water for 3 minutes, and 6 with soap for 3 minutes. Samples were then rinsed and sonicated in polysorbate to remove the remaining adherent bacteria on the materials’ surface. The sonicated solutions were plated, incubated, and counted for quantification of colony forming units (CFU). This protocol was repeated for a total of 4 trials. Single factor ANOVA was used to compare the mean CFU on each material after bacterial inoculation and the mean remaining CFU on each material after washings. Student t-test was used to compare the mean remaining CFU on silicone after washings with a soap solution versus sterile water for either amount of time. Statistical significance was set at a p-value of 0.05.

RESULTS
During inoculation, there was significantly fewer bacteria that adhered to the silicone compared to all other materials (p=0.002). The remaining bacteria on silicone’s surface was significantly fewer than that remaining on all the other materials’ surface when washed with sterile water for 1 minute (p=0.009) or 3 minutes (p=0.015) or a soap solution for 1 minute (p<0.001) or 3 minute (p<0.001). Silicone was successfully decontaminated as demonstrated by significantly
fewer remaining bacteria on its surface after washed with a soap solution compared to a sterile water control (p=0.020).

SUMMARY
• Silicone harbors significantly fewer bacteria than other casting materials. • Patients can easily remove, wash, and decontaminate a silicone coated plastic cast helping to prevent underlying skin compromise, breakdown, and infection. • 3D printed, silicone coated plastic casts are a more hygienic and comfortable alternative to traditional plaster and fiberglass casts.

REFERENCES:

![Graph](image)

Figure 1. Remaining CFU on the casting materials’ surface (y-axis) after washing trials with or without a soap solution (x-axis).
HYPOTHESIS
We present a unique and thought-provoking case along with a review of the literature of compartment syndrome of the hand in the presence of unexplained bullous edema. The purpose of sharing this case is to highlight potential clues to aid in prompt diagnosis and improve patient outcomes.

METHODS
60-year-old male admitted for routine sigmoidectomy secondary to multiple unresectable colonic polyps. Surgery was complicated by significant blood loss, conversion to open hemicolectomy and eventual transfer to the intensive care unit on mechanical ventilation. Dermatology and Orthopedic Surgery were consulted on post-operative day 2 and 3, respectively, for bullous edema of the left hand. Dermatology performed punch biopsies of the bullous lesions and orthopedic surgery performed compartment pressure measurements using a Stryker needle device. The thenar and hypothenar compartments were found to have a pressure of 75 mmHg and the remaining compartments of the hand had pressures <20 mmHg. At this time, the decision to proceed with 10-compartment fasciotomy was made. Interestingly, the fourth dorsal interossei compartment musculature appeared non-viable and the hypothenar and thenar compartments had intra-compartmental hematoma, but viable musculature.

RESULTS
There is currently an absence of universally accepted diagnostic signs and compartment pressures for the diagnosis of compartment syndrome of the hand. Table 1 summarizes the disparity of absolute compartment pressures in the literature. Due to ambiguity in the current literature, it is crucial to take other objective and subjective findings into account. We suggest acute bullous eruption as a presenting symptom of compartment syndrome of the hand, as it is indicative of severe injury to the underlying soft tissue and may herald the development of increasing compartment pressures.

SUMMARY
• It is imperative to have a high level of clinical suspicion for compartment syndrome of the hand in patients with unexplained edema and hemorrhagic bullae • While an innovative set of
diagnostic criteria and a consensus threshold of compartment pressures remains to be published, the available clinical history and clinical gestalt must allow the orthopedic surgeon to make a quick decision regarding treatment. Without prompt intervention, poor outcomes should be expected and are not limited to just necrosis and contractures, but possibly loss of limb or life.

REFERENCES:
RF: Poster 12: Force Exerted on the Hook of the Hamate in Collegiate Baseball Players

Category: Bone and Joint

Evaluation/Diagnosis; Treatment; Patient Education
Level of Evidence: N/A

Mikhail Alexeev
Steven M. Kane
Gary M. Lourie

BACKGROUND
Hook of the hamate fractures represent less than 2% of carpal fractures, but are common in the non-dominant hand of baseball players. The diagnosis is often delayed due to difficulty of fracture visualization on standard radiographic views, resulting in a prolonged treatment course which can be especially detrimental for competitive athletes. Excision of the fracture fragment has shown excellent results, allowing the athlete a reliable and expeditious return to play within 5-8 weeks postoperatively. In baseball, batting technique varies, but from the experience of the senior author, we believe that players who prefer to hold the base of the bat in the palm of their hand (palmar hamate grip) tend to have an increased incidence of fractures of the hook of the hamate. This batting technique may risk increased injury rates, and come at a high cost to both players and their respective professional organizations.

HYPOTHESIS
When compared to players batting with the conventional batting style, players utilizing the palmar hamate grip will have higher forces exerted on the hamate.

METHODS
1. IRB approval and consent obtained 2. 15 mm SingleTact calibrated miniature force sensor (Pressure Profile Systems, Inc) utilized for force measurement. 3. Force sensor system applied to each participating athlete, with central portion of the sensing mechanism placed directly over the hook of the hamate. 4. In a preliminary cohort of six athletes, a repeated measures ANOVA utilized to compare the average PSI measurements between the two groups of batters that accounts for the correlation between the observations for a single batter. The same analytical technique was utilized to determine the sample size. Preliminary data collected from individuals from the two grip types resulted in an effect size (Cohen’s f) of 4. The study is designed to detect an effect size of 2 with 90% power and a type I error rate of 5%.

RESULTS
The palmar hamate grip demonstrated a 300-400% increase in force exerted on the sensor overlying the hook of the hamate when compared to the conventional batting grip in preliminary testing.
SUMMARY
• The palmar hamate grip demonstrates a 300-400% increase in the force exerted on the hook of the hamate when compared to the conventional grip. • The palmar hamate grip may increase the risk of hook of the hamate fracture. • Educating athletes on the risks associated with the palmar hamate grip may prevent injury and minimize time out of competition, benefiting players and their respective athletic organizations.

REFERENCES:
Athlete demonstrating palmar hamate grip with sensor positioned over hook of the hamate

Category: Tendon; Other Clinical Topics

Prognosis/Outcomes
Level of Evidence: 4

Nicholas R. Pagani, MD
Matthew I. Leibman, MD
Michael S. Guss, MD

HYPOTHESIS
We hypothesized that National Football League players who underwent surgical repair of distal biceps ruptures would have a significantly shorter post-injury career length and fewer games played per season compared with matched controls. Furthermore, we hypothesized that surgical repair of the distal biceps would lead to a decrease in performance when compared to the player’s pre-injury performance and control-matched peers.

METHODS
NFL players who underwent surgical repair of distal biceps tears during a 20-year time period were identified using a publicly available online injury database. This methodology has been validated in multiple studies across multiple sports. (1-5) Demographic, performance, and return to sport data were collected for all players included in the analysis. A one-to-one matched control group was selected. Performance scores for cases and controls were calculated using a standardized scoring system specific to player position. (2-5) Comparisons between case and control groups at pre-injury and post-injury time points were made using paired-samples Student t tests.

RESULTS
Twenty-five surgeries were included in the study. Twenty-one cases (84%) were able to return to sport in the NFL at a mean of 321.4 +/- 45 days post-injury. The overall 1-year survival rate of return to play in players undergoing surgical repair of distal biceps tears was 76% and overall 2-year survival was 56%. Players who underwent surgical repair of distal biceps ruptures had significantly shorter post-injury career lengths and played fewer games per season post-injury than matched controls. There was no significant difference by position in post-injury performance scores when compared to matched controls.

SUMMARY
• Return to play at any performance level is not guaranteed following distal biceps repair, as only 84% of NFL players returned for at least one game. Many players who were able to return to sport ultimately retired within the next few seasons following surgery. • NFL players who undergo surgical repair of distal biceps tears have shorter post-injury career lengths and play fewer games per season following injury compared to peers. • In athletes that were able to
return to play, surgical repair of the distal biceps did not lead to a decrease in performance when compared to the player’s pre-injury performance and control-matched peers.

REFERENCES:
RF: Poster 14: Evaluating the Ability of Preoperative Patient-Reported Outcome Scores to Prognosticate Mid-Term Functional Improvement Following LRTI

Category: Bone and Joint; Other Clinical Topics

Treatment; Prognosis/Outcomes
Level of Evidence: 4

Christopher L. Stockburger, MD
Zhining Ou, PhD
Angela P. Presson, PhD
Jordan Clawson, BS
Andrew R Tyser, MD
Nikolas H. Kazmers, MD MSE

HYPOTHESIS
The prognostic value of preoperative patient-reported outcomes (PROs) as predictors of functional improvement following elective hand surgeries is unclear. We hypothesized that high levels of preoperative patient-reported pain interference, depression, anxiety, and upper extremity disability are associated with lower magnitudes of functional improvement at ≥ 1 year following LRTI.

METHODS
Adult patients who underwent LRTI by fellowship-trained orthopaedic hand surgeons between February 2014 and April 2018 at an academic tertiary institution were considered for inclusion in this longitudinal cohort study. Simultaneous carpal tunnel release (CTR), proximal trapezoid excision, and metacarpophalangeal procedures were not grounds for exclusion; however patients undergoing other procedures were excluded. PROs were prospectively collected for clinic patients by tablet computer. REDCap was used to obtain PROs for the latest follow-up. Preoperative PROs (≤1 year preoperatively) and follow-up PROs (≥1 year postoperatively) were required for inclusion. Univariate and multivariable linear regression analyses were performed to identify factors associated with the magnitude of improvement on the QuickDASH.

RESULTS
Of 94 included participants, mean age was 61.4 ± 7.1 years and 75 (81%) were female. Preoperative PROMIS Pain Interference (PI) Computer Adaptive Test (CAT), PROMIS Anxiety CAT, and PROMIS Depression CAT scores were 57.0 ± 6.1, 46.2 ± 9.3 and 45.3 ± 9.1, respectively. QuickDASH improved by a mean of 24.5 ± 20.9 points at the final follow-up of 2.5 ± 1.0 years postoperatively. In the multivariable model, greater preoperative QuickDASH (coefficient 0.8; 95% CI 0.6 to 0.9; p < 0.001) and lower preoperative PROMIS PI CAT (coefficient -0.7; 95% CI -1.2 to -0.2; p = 0.012) were associated with greater postoperative QuickDASH improvement – this was independent of additional procedures (CTR, proximal trapezoid excision, metacarpophalangeal procedures), Eaton stage, follow-up duration, and presence of
additional preoperative upper extremity comorbidities. Preoperative PROMIS Depression and Anxiety CAT scores were not associated with QuickDASH improvement (p = 0.39 and p > 0.99, respectively), though preoperative QuickDASH was significant in both multivariable models (both p < 0.001).

**SUMMARY**

As a surrogate for resilience and coping skills,1 greater preoperative pain interference (a measure of the extent to which pain interferes with one’s life) was associated with significantly less improvement in upper extremity function at a mean of 2.5 years following LRTI. High levels of preoperative upper extremity disability were associated with greater postoperative improvement, whereas Anxiety and Depression scores were not predictive. Preoperative PROs may be useful in selecting patients that may derive the most benefit from LRTI.

**REFERENCES:**

Crijns TJ, Bernstein DN, Ring D, Gonzalez RM, Wilbur D, Hammert WC. Depression and pain interference correlate with physical function in patients recovering from hand surgery. Hand (N Y). 2018;1558944718777814.
RF: Poster 15: Autologous Fat Transfer decreases the expression of multiple inflammatory mediators in an in vitro model of Basal Joint Osteoarthritis

Category: Bone and Joint

Basic Science
Level of Evidence: N/A

Christopher G. Larsen, MD
Benjamin C. Schaffler, BS; Eric Neufeld, BS; Brandon Alba, MD; Travis Doering, MD; Yen Chen, MD
Armen Kasabian, MD
Kate W. Nellans, MD, MPH
Lewis B. Lane, MD
Daniel A. Grande, PhD

INTRODUCTION
Thumb carpometacarpal, or basal joint, osteoarthritis (OA) is a debilitating condition, affecting 36% of postmenopausal women. Many patients fail conservative treatment and benefit from surgical intervention. However, there is a group of patients who fail conservative management but are not ready to commit to surgery. Recent clinical evidence suggests that autologous fat transfer (AFT) may be a promising treatment for this condition and may be a good alternative for patients not ready for surgery. The mechanism of action is not known, but two leading theories are that AFT either reduces inflammation in the joint through the function of adipose derived stem cells (ADSC) or it acts as a mechanical buffer in the joint. The purpose of this study is to better understand the underlying mechanism of AFT using in vitro cell culture.

HYPOTHESIS
We hypothesize that in an in vitro model of OA, addition of adipose-tissue rich in adipose derived stem cells will cause a reduction in markers of inflammation.

METHODS
Articular chondrocytes were isolated from human subjects and expanded in culture. Liposuction samples were collected from human subjects and processed similarly to AFT protocols to isolate an ADSC-rich stromal vascular fraction (SVF). A negative control group was treated with standard growth media and a positive control group, or OA group, was treated with inflammatory cytokines IL-1β and oncostatin-M (OSM). To mimic AFT, experimental groups received IL-1β + OSM plus either a low-dose or high dose of SVF cells. Gene expression of various inflammatory and anti-inflammatory genes, including IL-1β, IL-1 receptor antagonist (IL-1 RA), and matrix metalloproteinases (MMPs) was measured on days 1-3 post-treatment by reverse-transcription polymerase chain reaction.
RESULTS
Compared to the OA group, significant decreases in IL-1ß, MMP3, and MMP13 expression on treatment day 3 were found in the high-dose SVF group while MMP13 expression was also significantly decreased in the low-dose SVF group on day 3.

SUMMARY
• Compared to the positive control group, the addition of SVF to chondrocytes grown in an inflammatory milieu significantly reduced the expression of IL-1ß, MMP3 and MMP13, which are all important inflammatory mediators of osteoarthritis. • These results support an anti-inflammatory mechanism of action for AFT in the treatment of basal joint OA.

REFERENCES:
**Figure 2:** Expression of MMP3 and MMP13 were significantly decreased in the high dose SVF treatment group on day 3 compared to the OA group, MMP13 expression was also decreased in the low dose treatment group.
INTRODUCTION
Inferior tilt of the baseplate was originally proposed to improve baseplate fixation, but studies have produced conflicting results regarding the effect of inferior tilt on impingement and notching. We hypothesized that inferior tilt does not affect impingement. The secondary effects of glenosphere lateralization and diameter and neck-shaft angle on impingement were also evaluated.

HYPOTHESIS
We hypothesized that inferior tilt does not affect impingement.

METHODS
Twenty patients without glenoid bone loss undergoing RSA at a single institution underwent computed tomography (CT) scans of the entire scapula and proximal humerus for preoperative planning in Blueprint (Wright Medical, Bloomington, MN). For each patient, a 25mm glenoid baseplate (PERFORM Reversed, Wright Medical, Memphis, TN) was digitally implanted. Impingement-free range of motion (ROM) was then simulated with 16 different implant configurations: baseplate tilt (0° versus -10°), glenosphere lateralization (0 versus +6mm), glenosphere size (36mm versus 42mm), and neck-shaft angle (NSA) (135° versus 145°). The primary endpoint was external rotation at the side, based on in-vivo analyses that reveal that notching occurs primarily with external rotation at the side. Data was compared with paired t-tests, and a multivariable regression analysis.

RESULTS
Inferior tilt of the glenoid component was associated with a mean 27% decrease in impingement-free external rotation (p<0.01 in all cases) (Table 1). The magnitude of this effect was greatest in medialized glenospheres (2.8x), less in smaller glenospheres (1.7x), and least in more valgus humeri (1.3x). Multivariable regression analysis showed that offset had the most impact on impingement-free external rotation (β = 0.473, p<0.001), followed by glenosphere size (β = 0.427, p<0.001), neck-shaft angle (β = − 0.328, p<0.001), and inclination (β = 0.206, p<0.001).
**SUMMARY**

Inferior tilt of the baseplate led to a consistent decrease for every implant configuration in impingement-free external rotation at the side, which is the primary mode of in-vivo notching. The effect is magnified when using a medialized glenosphere, a smaller glenosphere, and/or a more valgus humeral component.

**REFERENCES:**
Kolmodin J, Davidson IU, Jun BJ, Sodhi N, Subhas N, Patterson TE, Li ZM, Iannotti JP, Ricchetti ET. Scapular notching after reverse total shoulder arthroplasty: prediction using patient-specific osseous anatomy, implant location, and shoulder motion. J Bo

**Table 1: External Rotation at the Side**

<table>
<thead>
<tr>
<th>NSA</th>
<th>Diameter</th>
<th>Lateralization</th>
<th>Tilt</th>
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<th>% of simulations w/ ER deficit</th>
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<td>42</td>
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<td>0°</td>
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<td></td>
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<td>27%</td>
<td>&lt;0.001</td>
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<td>-10°</td>
<td>24°</td>
<td>32%</td>
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</table>
Figure 1: Example Simulation
RF: Poster 18: Weight Bearing Restrictions with Distal Radius Wrist Spanning Dorsal Bridge Plates

Category: Bone and Joint; Other Clinical Topics

Treatment; Prognosis/Outcomes; Basic Science
Level of Evidence: N/A

Jeremy E. Raducha, MD
Andrew Hresko
Janine Molino, PhD
Christopher J. Got, MD
Julia Katarincic, MD
Joseph A Gil, MD

HYPOTHESIS
Fixation of highly comminuted distal radius fractures with wrist spanning dorsal bridge plates has been shown to have good post-operative results and allows for early platform weight bearing. Some authors have advocated allowing immediate full weight bearing after dorsal bridge plate placement, but a prior biomechanical study showed that plates failed at the loads required for crutch weight bearing. Since that study used the thinnest available bridge plate, we hypothesized that using a thicker bridge plate construct would result in less fracture deformation with loads required for immediate crutch weight bearing.

METHODS
Seven cadaveric forearms were tested. A comminuted, extra-articular fracture was reproducibly simulated with a 1 cm osteotomy block. The fracture was fixed with a TriMed dorsal bridge plate using 2.7 mm screws distally and 3.2 mm screws proximally. The specimens were potted proximally and fixed distally to simulate crutch/walker weight bearing. All the specimens were then axially loaded to specimen failure. Axial load to failure and mode of failure were measured using 2 mm and 5 mm osteotomy deformation as cut offs. 50% weight bearing is representative of the force transmitted through crutch weight bearing and 22% is representative of the force transmitted through walker weight bearing.

RESULTS
The load to failure at 2mm gap deformation was significantly lower than the load required for 50% weight bearing (110.4N vs. 339.2N, p=0.001). The load to failure at 5mm deformation was significantly greater than the load required for 22% weight bearing (351.8N vs. 149.2N, p=0.03). There was no significant difference between the load to failure at 2mm deformation and 22% weight bearing or between the load at 5mm deformation and 50% weight bearing (110.4N vs. 149.2N, p=0.30, and 351.8N vs. 339.2N, p=0.87, respectively). All constructs ultimately failed by plate bending.
SUMMARY
· All constructs failed through plate bending at forces that were not significantly greater than the 50% weight bearing force required for full crutch weight bearing, using neither the 2 mm nor 5 mm deformation as cut offs for failure. · plates supported forces significantly greater than the 22% body weight required for walker weight bearing when using 5 mm of deformation as the cut off for failure. ·Walker dependent patients may be able to use their walker to ambulate and transfer as tolerated immediately after dorsal bridge plate fixation. ·Patients should not be allowed to bear full weight through crutches immediately after placement of a bridge plate construct

REFERENCES:
HYPOTHESIS
Treatment of scapholunate (SL) instability can be unpredictable.1 Many methods of reconstruction have been described, but no procedure demonstrates clear superiority. New methods propose use of SutureTape (Arthrex, Naples, FL) either alone or as an augment with tendon autograft for SL ligament injuries.2, 3 We hypothesize SutureTape augmentation of dorsal intercarpal ligament capsulodesis will provide more durable repair than SutureTape with tendon autograft.

METHODS
Ten fresh-frozen, matched-pair, proximal, forearm-to-hand specimens were utilized. Serial sectioning of the SL ligament was performed in stages and scapholunate interval measured with CT. Reconstruction of the scapholunate ligament was performed with SwiveLock (Arthrex, Naples, FL) anchors and SutureTape with incorporation of either tendon autograft (IB+T) or dorsal intercarpal ligament (DIC+IB), or dorsal capsulodesis with the dorsal intercarpal ligament was performed alone (DIC). Scapholunate interval was measured with CT. (Figure 1) Specimens underwent 500 weighted cycles on a jig and were reimaged. Differences in SL interval following repair and cycling were compared. Paired sample t-test was used to compare interventions.

RESULTS
All reconstruction methods demonstrated improvement in SL interval reduction that approached native state following full release of the dorsal SL ligament (stage 4) and dorsal intercarpal ligament from the lunate (stage 5). DIC+IB demonstrated better SL interval reduction than IB+T before cycling by 0.95 ± 0.75mm (mean, SD) (p<0.05; 95% CI [0.02, 1.88]) and after cycling by 0.90 ± 0.71mm (p<0.05; 95% CI [0.02, 1.78]). DIC alone was inferior to DIC+IB after cycling, with loss in reduction of 0.65 ± 0.37mm (p<0.02; 95% CI [-1.11, -0.19]). (Table 1)
SUMMARY
SutureTape augmentation of dorsal intercarpal ligament capsulodesis (DIC+IB) maintains better SL interval reduction than SutureTape with tendon autograft (IB+T) before and after cyclic loading. DIC+IB better maintains SL interval after cyclic loading than DIC capsulodesis alone. SutureTape augmentation of SL ligament reconstruction may provide more durable repair than capsulodesis or tenodesis procedures alone by providing bone-ligament fixation and preventing viscoelastic stretch of ligament or tendon graft. This work serves as a stepping-stone for further study of the biomechanical strength and clinical application of SutureTape technology in the repair of SL instability.

REFERENCES:

Table 1. Differences in Scapholunate Interval Amongst Repair Techniques

<table>
<thead>
<tr>
<th></th>
<th>DIC+IB vs. IB+T</th>
<th>DIC+IB vs. IB+T cycled</th>
<th>DIC vs. DIC+IB</th>
<th>DIC vs. DIC+IB cycled</th>
<th>IB+T vs. DIC</th>
<th>IB+T vs. DIC cycled</th>
<th>Native vs. S5</th>
<th>Native vs. S4</th>
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<tr>
<td>N</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>10</td>
<td>8</td>
<td>6</td>
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<tr>
<td>Mean Difference</td>
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<td>0.90</td>
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<td>SD</td>
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<td>p-value</td>
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<td>p=0.19</td>
<td>p=0.02*</td>
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<td>p=0.29</td>
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<tr>
<td>95% CI</td>
<td>0.02, 1.88</td>
<td>0.02, 1.78</td>
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<td>-1.11, -0.19</td>
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<td>0.03, 0.64</td>
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</tr>
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</table>

Figure 1: Representative images of changes and measurements of scapholunate interval width following specified repair method.
RF: Poster 20: The Effect of Forearm Shortening on Forearm Range of Motion

Category: Bone and Joint

Prognosis/Outcomes; Anatomy; Basic Science
Level of Evidence: N/A

Gonzalo Barinaga, M.D.
Charles Rodriguez-Feo, M.D.
Elizabeth Rasmussen, B.S.
Scott Telfer, PhD
Nicholas Iannuzzi, M.D.

HYPOTHESIS
We hypothesize that osseous shortening of the forearm after replantation leads to changes in forearm biomechanics. Our study aims to quantify these effects using internal fixation after 2, 4, and 6cm of mid radius shortening.

METHODS
A volar Henry approach and a direct approach to the ulna were used on eight cadaveric specimens. Forearms were sequentially shortened 2, 4, and 6cm. Fixation was performed on the volar surfaces of the radius and ulna using 3.5mm limited contact dynamic compression plates. For all conditions (baseline and after fixation of each osteotomy), the arm was mounted on a robotic testing system, and pronation and supination of the forearms was measured with internal and external torques of 0.5Nm, 0.75Nm, and 1Nm applied. Radiographs and measurements were obtained at each phase to determine maximum radial bow, radial ulnar gap, and radial bow location. Data was analyzed using a linear mixed-effects model, followed by pairwise comparisons via Tukey’s range test. Associations between anatomical measurements and biomechanical changes in the arm were also determined.

RESULTS
Greater shortening of the radius and ulna led to progressively greater reductions in both pronation and supination (p < 0.001, p < 0.0001 respectively). Larger differences were seen in supination with 2-4cm shortening and in pronation with 4-6cm shortening. Supination of arms was found to be associated with radial bow and radial ulnar gap (R2 = 0.26, R2 = 0.20 respectively); pronation was found to be associated with radial bow and radial bow location (R2 = 0.27, R2 = 0.28 respectively).

SUMMARY
• This study demonstrates that quantifiable effects on forearm biomechanics occur after osseous shortening of the forearm. • Standard of care internal fixation techniques were used, and the specimens were tested using a robot while carefully applying up to 1Nm. • Our results do not show a linear relationship between loss of forearm range of motion and the amount
shortened. • Supination is impacted at smaller amounts of shortening, while pronation is affected by larger amounts of shortening; supination is associated with the radial bow and the radial-ulnar gap, while pronation is associated with the radial bow and the radial bow location.

REFERENCES:

Figure 1 – Changes in pronation (top) and supination (bottom) range of motion after shortening at different levels of loading
RF: Poster 21: Surgeons Experience Occupational Risk for Cubital Tunnel Syndrome: Results of a Pilot Study

Category: Nerve

Evaluation/Diagnosis
Level of Evidence: 2

Adam Domico
Derek Klaus
Michael McKernan

HYPOTHESIS
Cubital tunnel syndrome (CuTS) is the second most common compressive neuropathy of the upper extremity. Previous literature has identified specific occupations at risk the development of this disease process. However, current literature has failed to identify surgical professions as an “at-risk” occupation. Our belief is that surgical physicians will have more cubital tunnel symptoms compared to medical physician colleagues.

METHODS
A prospective pilot study was devised. Surveys, utilizing the Patient Reported Ulnar Nerve Evaluation (PRUNE), were distributed to all practicing physicians within a single health system to assess cubital tunnel symptoms. In this pilot study, we had responses from 16 non-surgical and 50 surgical physicians. Additional variables including specialty, years in practice/PGY year, smoking history (pack/years), gender, age, and previous diagnosis of cubital tunnel syndrome were also obtained. The primary outcome, PRUNE survey scores, was reported using means and standard deviations. Cohen’s d mean effect size between the groups was determined. Secondary analysis was conducted using Fischer’s exact test and Man-Whitney U tests to further investigate the subscale outcomes of the PRUNE questionnaire and determine equality between the groups.

RESULTS
Non-surgical physicians (16) had an average PRUNE score of 1.31. Surgeons (50) had a mean score of 4.1. The Cohen’s mean effect size (d=0.38, p=0.076) was calculated. The study cohorts did have a statistically significant different tobacco use. A power analysis to allow for two-sided testing with a 5% alpha and 80% power was determined. 70 non-surgical and 219 surgical participants are required for an appropriately powered study.

SUMMARY
• Our pilot study demonstrates increased ulnar nerve symptoms in surgeons compared to non-surgical colleague. • Our results have also established an appropriate power analysis that can be used moving forward for our formal investigation.
REFERENCES:
HYPOTHESIS
Surgical options for a neglected Bennett’s fracture malunion options include intra-articular/extra-articular osteotomy, trapezial resection with or without tendon interpositional arthroplasty, or basal joint arthrodesis. These are limited in providing symptomatic relief and have their own limitations in restoring strength and motion. We report a viable treatment option of a malunited Bennett’s fracture in a young, active athlete utilizing a modified Bunnell technique we refer to as hemiresection arthroplasty to maintain the integrity of the Trapeziometacarpal (TM/TMC) joint and to allow for a full recovery.

METHODS
In this case report, a patient presents five months after a neglected injury to their dominant right hand with increased pain, loss of motion and weakness about the first carpometacarpal (CMC) joint who was determined to pursue a career in elite military services. A Wagner approach to the TMC joint was performed to obtain direct articular visualization. Consideration for the deforming forces about the joint was addressed by detaching the abductor pollicus longus (APL) at its insertion. Utilizing an osteotome, hemiresection arthroplasty was performed to remove the articular step-off at the proximal radial metacarpal shaft with maintenance of the initial volar-ulnar fracture fragment without an interpositional graft. At the osteotomy site, two drill holes were made and 3-0 Supramid suture was utilized to relocate the deforming force of the APL tendon. The patient was evaluated for DASH-9 score, motion, grip strength, and a visual analog scale (VAS) pain score before surgery and 11-months later.

RESULTS
At initial pre-operative visit the patient presented with deferred range of motion and 5/10 pain with a DASH-9 score of 33. At 1-month follow-up, the patient had full range of motion about the Trapeziometacarpal (TMC) joint with a DASH-9 score of 0. The patient had only an initial assessment by occupational therapy and was swiftly discharged to a home exercise program. At 11-month follow-up, the patient’s VAS was 0, DASH-9 score of 0, Palmar abduction of 45, radial abduction 51, and grip strength increased from deferred to 52kg. The patient returned to full sport activities and completed elite level trials for the military without complication.
SUMMARY
Bennett’s fracture is unstable, and with inadequate treatment leads to post-traumatic arthritis, loss of function, weakness, and/or malunion. Comprehensive knowledge of pertinent anatomy at the TMC joint and deforming forces is essential in surgical decision making. Hemiresection arthroplasty for a malunited Bennett fracture is a viable treatment option with minimal alteration.

REFERENCES:
Carlsen BT, Moran SL. Thumb Trauma: Bennett Fractures, Rolando Fractures, and Ulnar Collateral Ligament Injuries. J Hand Surg 2009;34A:945-952

Figure 1: Right thumb lateral radiograph demonstrating five months post-injury and initial visit. The imaging demonstrates a malunion of a Bennett’s fracture with 4-millimeter step-off at the articular surface.
Figure 2: Right thumb lateral radiograph demonstrating 11-month post-operative imaging. Note the hemi-resection portion of the malunion and a congruent joint line without signs of arthrosis and normal appearing articular cartilage.
HYPOTHESIS
Prior investigations have compared the cost [1-3] and outcomes [4,5] of open and endoscopic carpal tunnel release (OCTR and ECTR), but to our knowledge this comparison has not included endoscopic release under local anesthesia without tourniquet (LOCTR or LECTR). This study sought to identify costs associated with OCTR vs ECTR when either procedure was performed under monitored anesthesia care sedation (MOCTR or MECTR) versus LOCTR or LECTR.

METHODS
Patients >18 years old undergoing isolated unilateral carpal tunnel release from 2013 to 2018 at a single academic medical center outpatient surgery department were identified through a retrospective chart review. Cost data were obtained from our institution’s electronic database and normalized to the cost of the least expensive treatment option, LOCTR, as determined by prior analyses. Data calculated included operating cost, direct cost, indirect cost, fixed cost, and variable cost (Table 1). Costs between LOCTR and other groups were compared with Kruskal-Wallis tests and pairwise with Wilcoxon rank-sum tests.

RESULTS
Data included 206 CTRs which were performed in 169 patients. Average age was 59.9 ± 15.2 years old. 68% were female. The median operating costs varied significantly between groups, with LECTR, MOCTR, and MECTR being 1.17-times, 1.27-times, and 1.41-times the cost of LOCTR, respectively (Table 2). The cost category that most widely differed between the endoscopic and local groups was variable cost, with a 35% increase in the endoscopic group. The variable cost subcategory of direct variable supplies contributed most of the difference between endoscopic and local groups. The indirect and fixed costs were also significantly different when compared pairwise among groups in similar magnitudes to the overall operating cost (p < 0.01). Direct costs were significantly different among groups (p <0.01), with the exception of the LECTR and MOCTR pair, which were not significantly different by Wilcoxon rank-sum testing (p = 0.69).
SUMMARY
• Local anesthesia only was utilized in 62% (127/206) of all CTR performed; OCTR was performed in 65% (133/206) of hands and ECTR performed in 35% (73/206) • LOCTR was found to be the least expensive procedure for CTR. LECTR was the next least expensive option with a median operating cost 1.17 times that of LOCTR. • Cost differences between LECTR and LOCTR were smaller than expected, providing less expensive options for CTR when performed under local anesthesia.

REFERENCES:
### Table 1. Description of Cost Categories.

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<th>Cost Category</th>
<th>Description</th>
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<td>Operating cost</td>
<td>Total cost&lt;br&gt;Direct cost + indirect cost&lt;br&gt;Fixed cost + variable cost</td>
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<tr>
<td>Direct cost</td>
<td>Expenses in cost centers that provide and charge for patient care. Also includes cost centers such as radiology administration that are closely tied to those cost centers.</td>
</tr>
<tr>
<td>Indirect cost</td>
<td>Expenses in cost centers that do not prove and charge for patient care. Sometimes referred to as “overhead.”</td>
</tr>
<tr>
<td>Variable cost</td>
<td>Expenses that increase or decrease depending on patient volumes. Radiology technologist expenses, for example, increase as the patient load increases.</td>
</tr>
<tr>
<td>Fixed cost</td>
<td>Expenses that do not generally increase or decrease based on patient volume. For example, the cost of a director of an ancillary service department.</td>
</tr>
<tr>
<td>Direct variable supply cost</td>
<td>All supplies not included in variable implant cost</td>
</tr>
<tr>
<td>Direct variable implant cost</td>
<td>Implants, such as prosthetic knees, hips, etc.</td>
</tr>
<tr>
<td>Direct fixed equipment depreciation cost</td>
<td>Depreciation for major equipment</td>
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<tr>
<td>Direct variable drug cost</td>
<td>Pharmacy, medications</td>
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</table>

### Table 2. Relative Costs. A heat map of relative costs normalized to LOCTR. The increasing intensity of green represents increasing relative cost.

<table>
<thead>
<tr>
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<th>Operating Cost</th>
<th>Direct Cost</th>
<th>Fixed Cost</th>
<th>Indirect Cost</th>
<th>Variable Cost</th>
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<td>LOCTR</td>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
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<td>MOCTR</td>
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<tr>
<td>LECTR</td>
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<td>1.07</td>
<td>1.07</td>
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<td>MECTR</td>
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<td>1.44</td>
<td>1.36</td>
<td>1.31</td>
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HYPOTHESIS
Pneumatic tourniquets are widely used in hand surgery. Elevated pressures can be associated with complications, and thus, guidelines based on patient specific tourniquet pressures have been recommended.1-4 The primary aim of this study was to determine whether lower tourniquet values based on systolic blood pressure (SBP) could be effectively applied in upper extremity surgery. Our hypothesis was that a tourniquet pressure based on SBP would result in a lower mean tourniquet pressure and provide a bloodless field.

METHODS
A prospective case series of 107 consecutive patients undergoing upper extremity surgery with use of a pneumatic tourniquet was performed. Tourniquet pressure used was based on the patient’s SBP. The tourniquet was inflated based on our predetermined guidelines: 60 mmHg was added for SBP < 130 mmHg, 80 mmHg for SBP between 131 mmHg and 190 mmHg, and 100 mmHg for SBP > 191 mmHg. The outcome measures included intra-operative tourniquet adjustment, surgeon rated quality of bloodless operative field, and complications. Descriptive statistics were used to provide a quantitative summary of the data in the study. Specifically, the analysis performed included measures of central tendency and measures of variability.

RESULTS
There was nearly even distribution of tourniquet application to the proximal forearm (48%) and high arm (52%), with a mean circumference of 26.6 ± 3.8 cm and 31.4 ± 4.6 cm, respectively. The mean tourniquet pressure was 182.7 ± 26.3 mmHg with a mean tourniquet time of 34.1 ± 30.5 minutes. There were no instances of intraoperative tourniquet adjustment. The surgeon rated quality of bloodless operative field was excellent in all patients. No complications were associated with the use of a tourniquet.

SUMMARY
• Tourniquet inflation pressure based on SBP is an effective method to provide a bloodless surgical field in upper extremity surgery at significantly lower inflation pressures than are the current standards. • Given the well-characterized association between tourniquet pressure and
soft tissue injury, the reduction of tourniquet pressure using this method adds to the body of literature aiming to mitigate these complications. This method provides a safe and simple guideline for personalizing tourniquet pressures for use in commonly performed upper extremity procedures.

REFERENCES:

<table>
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<th>TABLE 1</th>
<th>Extremity &amp; Tourniquet Characteristics</th>
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<td>Location</td>
<td>Proximal Forearm</td>
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<td>48</td>
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<tr>
<td>Extremity Circumference (cm)</td>
<td>26.6 +/- 3.8</td>
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<tr>
<td>Systolic Blood Pressure (mmHg)</td>
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<tr>
<td>Mean</td>
<td>118.5 +/- 19.8</td>
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<tr>
<td>&lt; 130</td>
<td>78%</td>
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<td>130 to 190</td>
<td>22%</td>
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<td>&gt; 190</td>
<td>0%</td>
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<tr>
<td>Tourniquet Pressure (mmHg)</td>
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<tr>
<td>Mean</td>
<td>182.7 +/- 26.3</td>
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<td>Min</td>
<td>140</td>
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<td>Max</td>
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<td>Tourniquet Time (min)</td>
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<tr>
<td>Mean</td>
<td>34.1 +/- 30.5</td>
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<td>Tourniquet Performance</td>
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<td><strong>Tourniquet Adjustment</strong></td>
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**Quality of Bloodless Operative Field**

<table>
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<th>Percentage</th>
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<td>3 (Fair)</td>
<td>0</td>
</tr>
<tr>
<td>4 (Poor)</td>
<td>0</td>
</tr>
</tbody>
</table>

**Complications**

0

1 (excellent) = no blood in surgical field, 2 (Good) = some blood in the surgical field but no interference with surgery, 3 (Fair) = blood in the surgical field but no significant interference with surgery, 4 (Poor) = blood in the surgical field obscures the view throughout the procedure.
RF: Poster 29: Comparison of Triceps Tongue versus Olecranon Osteotomy Approach for Treatment of Intra-articular Distal Humerus Fractures: A Matched Cohort Study

Category: Bone and Joint

Anatomy
Level of Evidence: 3

Morgan Weber
Elizabeth Cho
Imad Abushahin
Peter J Evans
Blaine T Bafus

HYPOTHESIS
The purpose of this study is to compare the outcomes of the triceps tongue approach with olecranon osteotomy when used for osteosynthesis of distal humerus fractures, hypothesizing decreased complications, improved range of motion and improved patient reported outcome scores, as assessed by the QuickDASH, with the triceps tongue approach.

METHODS
Retrospective review was performed on patients with intra-articular distal humerus fractures, treated with open reduction and internal fixation between January 2000-May 2018 utilizing olecranon osteotomy (OO) and triceps facial tongue (TT) approach for articular exposure. TT patients were matched, in a 1:1 ratio based on age, sex, and fracture characteristics to OO patients. Surgical time, intraoperative blood loss, elbow motion, fracture union, complications, and QuickDASH* scores were compared. Statistical analysis was performed using t-test between two groups and fisher-test for categorical data, with p<0.05 considered significant.

RESULTS
The matched TT and OO cohorts were each comprised of 26 patients, and did not differ significantly in demographic data, age (TT: 63.4 ± 12.8 years vs OO: 60.3 ± 12.2 years, P > .05), or fracture characteristics. Mean clinical follow up was 7.1 ± 5.0 months for TT patients and 21.8 ± 33.5 months (P<.05) for OO patients. The TT group had significantly less intraoperative blood loss (109.6 ± 128.7 mL vs. 206.3 ± 274.0 mL, P< .05), decreased procedure time (154.4 ± 51.5 min vs. 195.7 ± 49.4 min, P<.005) decreased number of surgeries (1.2 ± 0.4 vs. 1.5 ± 0.8, P<.05), increased flexion (125.8°± 13.7° vs. 118.8° ± 14.9° p < .05), and increased range of elbow motion (107.6° ± 23.3 vs 96.3° ± 26.5°, P<.05) at final follow-up. No differences were found for post-operative complications including heterotopic ossification, ulnar nerve symptoms, delayed union, malunion, symptomatic hardware, or infection.
SUMMARY
• The triceps tongue approach for treatment of intra-articular distal humerus fractures has decreased blood loss, decreased procedure time, fewer total surgeries, and increased range of motion when compared to olecranon osteotomy approach. • There were no differences in post-operative complications between tongue and osteotomy approaches to distal humerus fractures. • Triceps tongue approach provides excellent exposure in treating distal humerus fractures and is an acceptable alternative to olecranon osteotomy when treating intra-articular distal humerus fractures. *QuickDASH scores still being collected, and thus data analysis not yet performed.

REFERENCES:
Fei TT, Evans PJ, Bafus BT. Triceps fascial tongue exposure for intra-articular distal humerus fracture: revisiting the Van Gorder approach. JSES Open Access. 2019
<table>
<thead>
<tr>
<th>Comparison of Outcomes and Complications</th>
<th>Triceps Tongue Group (N=26)</th>
<th>Osteotomy Group (N=26)</th>
<th>P-Value</th>
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</thead>
<tbody>
<tr>
<td>Intraoperative blood loss (mL)</td>
<td>109.6 ± 129.7</td>
<td>206.3 ± 274.0</td>
<td>&lt;.05</td>
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<tr>
<td>Procedure Time (min)</td>
<td>154.4 ± 51.5</td>
<td>195.7 ± 49.4</td>
<td>&lt;.005</td>
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<tr>
<td>Total # of Surgeries</td>
<td>1.2 ± 0.4</td>
<td>1.5 ± 0.8</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Flexion at final f/u (Degrees)</td>
<td>125.8 ± 13.7</td>
<td>110.8 ± 14.9</td>
<td>&lt;.05</td>
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<tr>
<td>Extension at final f/u (Degrees)</td>
<td>18.2 ± 13.4</td>
<td>22.5 ± 14.4</td>
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<tr>
<td>Range of flexion and extension (Degrees)</td>
<td>107.6 ± 23.3</td>
<td>96.3 ± 26.5</td>
<td>&lt;.05</td>
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</table>

**Complications**

<table>
<thead>
<tr>
<th></th>
<th>Triceps Tongue Group (N=26)</th>
<th>Osteotomy Group (N=26)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ulnar Nerve Neuropraxia</td>
<td>5</td>
<td>7</td>
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</tr>
<tr>
<td>Heterotopic Ossifications</td>
<td>7</td>
<td>9</td>
<td>0.4</td>
</tr>
<tr>
<td>Symptomatic Hardware</td>
<td>1</td>
<td>4</td>
<td>0.2</td>
</tr>
<tr>
<td>Wound Infection</td>
<td>1</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>Delayed Union, Nonunion</td>
<td>1</td>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>Hardware Failure</td>
<td>0</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Varus Deformity</td>
<td>0</td>
<td>1</td>
<td>~</td>
</tr>
<tr>
<td>Total Complications</td>
<td>15</td>
<td>27</td>
<td>~</td>
</tr>
<tr>
<td>Total Patients with 1+ Complications</td>
<td>8</td>
<td>11</td>
<td>0.3</td>
</tr>
</tbody>
</table>
HYPOTHESIS
We compare pre- and post-operative Patient Reported Outcomes Measurement Information Systems (PROMIS) scores between patients treated both operatively and non-operatively for lateral epicondylitis. Our hypothesis is that patients with lower initial scores will see the most improvement.

METHODS
Patients presenting to a tertiary academic medical center from February 2015 to December 2018 with a diagnosis of lateral epicondylitis were identified. Those with initial and follow-up PROMIS physical function (PF), pain interference (PI), and depression scores were included and stratified according to treatment. Patients with incomplete scores, uncertain laterality, and other diagnoses were excluded. Patients with multiple treatment modalities were excluded from final analysis. Using a minimum clinically important difference (MCID) of 4, patients were stratified as improved, no change or worsened at final follow-up. Single factor ANOVA with post hoc Tukey’s comparison test and multiple linear regression was used to compare initial PROMIS PF, PI, and Depression scores based on their post-treatment group.

RESULTS
A total of 982 patients were initially identified with the diagnosis of lateral epicondylitis and initial PROMIS data. After excluding patients without follow-up PROMIS scores and concomitant diagnosis, the cohort consisted of 230 patients. Patients who saw improvement with physical therapy presented with lower average initial PROMIS PF scores 41.09 ± 1.76 (p < 0.0002) when compared to patients who saw minimal change or worsened. (fig. 1) Patients who saw improvement with surgery were found to have significantly lower average initial PROMIS Depression scores 38.06 ± 1.31 (p < 0.02). (fig. 2) When all treatments were grouped together, patients who did worse after treatment were found to have significantly higher starting PF and Depression scores: 49.94 ± 1.13 (p < 0.001) and 50.62 ± 1.31 (p < 0.002) respectively. There were no statistically significant relationships for PROMIS PI.

SUMMARY
• When looking at all included interventions, patients who saw regression with treatment in PROMIS PF and PD scores had better initial scores. • However, for physical therapy and
surgery, worse starting function and depression scores, respectively, were found to be associated with to have improved with intervention. • These may offer insight on counseling patients for these interventions.
RF: Poster 35: Baseplate Specifications in Reverse Total Shoulder Arthroplasty After Introduction of Preoperative Templating and Intraoperative Navigation

Category: Bone and Joint

Surgical Technique
Level of Evidence: 4

Charlie Dee Wilson
Gregory Sprowls
Wells Stewart
Nathan Baruch
Russell Ward
Brett Robin

HYPOTHESIS
Intraoperative computer navigation results in the use of longer screws and fewer screws for glenoid baseplate fixation in reverse total shoulder arthroplasty (RSA). In addition, the use of preoperative templating software may affect the frequency of augmented baseplate utilization.

METHODS
Fifty-one patients who underwent navigated RSA were compared against 63 controls who underwent conventional RSA at a single institution. The same reverse shoulder system was used in both groups. Primary outcomes compared between the groups included length of screws and total number of screws used for glenoid baseplate fixation. Secondary outcomes included use of augmented baseplates.

RESULTS
Navigation allowed for use of significantly longer screws (36.7 mm vs. 30 mm, p < 0.0001) and fewer screws (2.5 ± .7 vs. 2.8 ± 1, p = 0.0472). In the navigated group, there was more frequent augmented baseplate utilization (76.5% vs. 19.1%, p < 0.0001).

SUMMARY
• After employing navigation at our institution, surgeons tended to use longer screws and fewer screws for glenoid baseplate fixation, relative to conventional reverse total shoulder arthroplasty. • While no biomechanical conclusions may be drawn from the differences in screw utilization, these differences do reflect the impact of navigation on surgeon experience. Future studies will examine whether placing screws under navigation allows for more accurate screw trajectory through safe corridors and whether employing fewer screws preserves more scapular bone stock in case of revision arthroplasty. • The dramatic increase in utilization of baseplate augmentation was unexpected, and likely due to use of preoperative planning software.
REFERENCES:
Table 3. Bivariate Comparison of Operative Variables in Non-Navigated and Navigated rTSA groups.

<table>
<thead>
<tr>
<th></th>
<th>Non-Navigated rTSA</th>
<th>Navigated rTSA</th>
<th>P value</th>
</tr>
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<tr>
<td></td>
<td>Mean ± SD or Median (Range)</td>
<td>Mean ± SD or Median (Range)</td>
<td></td>
</tr>
<tr>
<td><strong>Surgeon:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgeon 1</td>
<td>49 (77.8%)</td>
<td>36 (70.6%)</td>
<td>0.3808</td>
</tr>
<tr>
<td>Surgeon 2</td>
<td>14 (22.2%)</td>
<td>15 (29.4%)</td>
<td>0.3808</td>
</tr>
<tr>
<td><strong>Baseplate Screws:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Screws Used</td>
<td>2.8 ± 1</td>
<td>2.5 ± 1</td>
<td>0.0472</td>
</tr>
<tr>
<td>Individual Screw Length (mm)</td>
<td>30 (20)</td>
<td>36.7 (22)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Composite Screw Length (mm)</td>
<td>76 (90)</td>
<td>84 (86)</td>
<td>0.0481</td>
</tr>
<tr>
<td>Frequency of Two Screws Used Total</td>
<td>32 (50.8%)</td>
<td>35 (68.6%)</td>
<td>0.0472</td>
</tr>
<tr>
<td><strong>Baseplate Type:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>51 (81%)</td>
<td>12 (23.5%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Augmented</td>
<td>12 (19.1%)</td>
<td>39 (76.5%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Operative Time (minutes)</td>
<td>85.8 ± 18.7</td>
<td>98.6 ± 19.5</td>
<td>0.0006</td>
</tr>
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</table>
HYPOTHESIS
We hypothesize that patient satisfaction does not correlate with patient reported outcome following surgery.

METHODS
A retrospective analysis was performed of patients at our institution who had undergone surgery for finger or thumb arthritis under the care of a single surgeon. Their pre-operative and 60-day post-operative DASH scores were compared to their 60-day post-operative Net Promoter Score (obtained via a survey administered by our hospital system to all patients after every clinical visit) to examine if there was a correlation between patient reported functional outcome and patient satisfaction. The Net Promoter Score (NPS) is widely used in service industries as a measure for patient satisfaction, assessing the likelihood (on a 0 to 10 scale) that a customer will recommend a service/product to others. This will be a descriptive study and no statistical analyses will be made.

RESULTS
13 patients were analyzed. Most patients had significantly improved post-operative DASH scores and indicated high satisfaction with NPS 9 to 10. 1 patient had improvement of DASH score from 16 to 3.3 but was the least satisfied within the group with an NPS of 8. 1 patient had worsening of DASH score from 5 to 22.5 but was highly satisfied with an NPS of 10. 1 patient reported similar pre-operative and post-operative DASH scores, going from 52.5 to 50, but remained highly satisfied with an NPS of 10.

SUMMARY
• Following surgery, the outcome may not reliably predict patient satisfaction. • Patient satisfaction is a complex concept, affected by factors beyond the outcome measures typically used to judge surgery effectiveness.

REFERENCES:
RF: Poster 43: Initial Experiences with Upper Extremity 3D-Printed Ventilated Casts

Category: Bone and Joint; Other Clinical Topics

Treatment; Prognosis/Outcomes
Level of Evidence: 4

Michael Sun
Juntian Wang
Connor Byrne
David Kulber
Eugene Tsai
Ryu Yoshida

HYPOTHESIS
We hypothesize that 3-dimensional printed ventilated casts may act as a viable alternative to traditional cast or splinting techniques for fracture and post-surgical immobilization.

METHODS
A retrospective review was performed of all patients at our institution since May 2019 who were immobilized with a 3D-printed cast following upper extremity injury or surgery. Charts were reviewed for cast related complications (i.e. rubbing, tightness, skin irritation) that were reported in clinic, the emergency department, or in a telephone encounter. In cases which the 3D-printed cast was used for fracture care, follow up imaging was reviewed for signs of fracture healing to indicate that adequate immobilization had been achieved. Results were descriptive in nature and thus no statistical analyses were performed.

RESULTS
During the study period, 32 patients were fitted with a 3D-printed cast and had adequate follow up. 1 patient reported poor cast fitment and required re-fabrication of the cast. No cast related complications were reported in clinic, the emergency department, or over the telephone. In 13 patients, the 3D-printed cast was used for fracture care. Of these, 12 were noted to have fracture healing as expected on follow up imaging, and 1 did not have signs of fracture healing after a prolonged period, prompting the surgeon to switch the patient back into a traditional cast.

SUMMARY
- Patient-specific 3D-printed ventilated casts offer a viable alternative to traditional cast or splinting techniques.  
- In our initial experience, no patients reported any cast complications.  
- When used for fracture care, the casts provided adequate immobilization to achieve fracture healing in all but one patient.  
- Theoretical advantageous over traditional casts or splints include being lighter weight, easier to bathe in, and easier to take off and put back on.
REFERENCES:
HYPOTHESIS
Alignment of the carpal bone is important, but there are few reports on axial alignment which is affected by total wrist arthroplasty (Matsui, et al.). The hypothesis is that the carpal axial alignment of Caucasians and Asians is different.

METHODS
Forty patients without malalignment of wrists were studied using Canon Medical Systems CT (Aquillion ONE ViSION). The mean age of the patients was 36.4 years, with a range of 19-56 years. There were 25 males and 15 females. A standard posteroanterior and lateral radiograph was made for each subject to exclude any radiological abnormality. Scanning of the wrist joint was performed with subjects sitting keeping the ipsilateral shoulder abducted at 90˚ with elbow flexed at 90˚ and palm facing down flat on the table. The reference line for measuring the axial alignment was drawn as the line joining the volar and the dorsal lips of the ulnar notch and termed the radial axis. Angles formed by the axes of scaphoid, lunate and capitohamate with that of the radial axis were termed radio-scaphoid (R-S), radio-lunate (R-L) and radio-capitohamate (R-CH) angle (Fig. 1a-c). Similarly, angles formed by the line joining the scaphoid tubercle and the hook of hamate and the line joining the tubercle of trapezium and the hook of hamate with that of the radial axis were termed radio-scaphohamate (R-SH) and radio-trapeziumhamate (R-TmH) angle (Fig. 1d and 1e). Approval from the ethical committee was obtained.

RESULTS
The mean angles of R-S, R-L, R-CH, R-SH and R-TmH were found to be 35.1˚, 21.2˚, 11.0˚, 82.8˚ and 84.3˚. Measurements of various carpal axes and angles are shown in Tables 1. Gupta, et al. conducted a similar study in Kuwaiti population and reported that R-S, R-L and R-CH were 20.5˚, 23.6˚ and 13.6˚. However, they have not measured R-SH and R-TmH, which seem to representative the rotation of the hand.
SUMMARY
We reported normal carpal axial alignment using CT images. R-S angle of Asians was greater than that of Caucasians. Based on this study, it is possible to evaluate the carpal axial alignment after the total wrist arthroplasty.

REFERENCES:


Table 1. Mean values of various carpal angles in degrees (n = 40)

<table>
<thead>
<tr>
<th>Angles</th>
<th>Mean (SD) in degrees</th>
<th>Range In degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio-scaphoid</td>
<td>35.1 (11.2)</td>
<td>14 to 66</td>
</tr>
<tr>
<td>Radio-lunate</td>
<td>21.2 (6.0)</td>
<td>9 to 37</td>
</tr>
<tr>
<td>Radio-capitohamate</td>
<td>11.0 (6.7)</td>
<td>0 to 25</td>
</tr>
<tr>
<td>Radio-scaphohamate</td>
<td>82.8 (5.3)</td>
<td>70 to 90</td>
</tr>
<tr>
<td>Radio-trapeziumhamate</td>
<td>84.3 (4.8)</td>
<td>75 to 90</td>
</tr>
</tbody>
</table>
RF: Poster 47: Pronated Grip View with Wrist Deviation: Effect on Ulnocarpal Relationships

Category: Bone and Joint; Skin and Soft Tissue

Evaluation/Diagnosis; Anatomy
Level of Evidence: N/A

Anthony L. Logli
Laurel A. Littrell
Beth A. Schueler
Sanjeev Kakar

HYPOTHESIS
To highlight ulnar impaction, we hypothesize that a radiograph taken with the wrist in a position of radial deviation during pronated grip will place the lunate in closest proximity to the distal ulna, thereby making it the most favorable position for ulnocarpal impaction (UCI) to occur.

METHODS
After institutional research board approval, we prospectively enrolled 10 adult volunteers with no prior wrist pain or pathology. We obtained fluoroscopic images of each wrist in 12 different positions using a standardized protocol. Distances from the ulna to the lunate (UL), ulna to the triquetrum (UT), and lunate uncoverage ratio (LUR) were digitally measured. Means were analyzed by analysis of variance and Tukey formal post hoc testing.

RESULTS
A pronated grip view significantly shortened the ulnocarpal distance when compared to a standard PA (p<0.0001 for both UL and UT distances). Radial deviation during a pronated grip resulted in the lowest mean UL distance (1.2 mm), which was significantly different than the distance measured in 8 of the 11 other wrist positions (p<0.05). UT distance was minimized by a position of ulnar deviation during a pronated grip (3.1 mm), which was significantly different than the distance measured in 7 of the 11 other wrist positions (p<0.05). In all wrist positions, LUR increases as the wrist moves from ulnar deviation to radial deviation.

SUMMARY
Radial deviation minimizes UL distance while ulnar deviation minimizes the UT distance during a pronated grip maneuver. Wrist deviation radially incrementally increases lunate uncoverage. A pronated grip radial deviation view may place the ulnar carpus at greatest risk for UCI.
FIGURE 1. Left wrist demonstrating a pronated grip view with radial deviation (left) and ulnar deviation (right). The shortest distance between the ulna and lunate (red line) and ulna and triquetrum (blue line) was measured to determine the ulnolunate (UL) and ulnotriquetral (UT) distances, respectively. The UL distance measured 1.8 mm and UT distance 4.9 mm in this example.

FIGURE 2. Mean ulnolunate (UL) and ulnotriquetral (UT) distances measured in various dynamic positions.
RF: Poster 48: Does Surgical Experience Reduce Radiation Exposure in the Operating Room?

Category: Bone and Joint; Other Clinical Topics

Treatment; Prognosis/Outcomes; Ethics/Professionalism; Residents/Fellow/Educator Resources

Level of Evidence: 4

Lacey Magee, BA
Alexa Karkenny, MD
Faris Fazal, BS
Jie Nguyen, MD, MS
Divya Talwar, PhD, MPH
Apurva Shah, MD, MBA

HYPOTHESIS
Years of surgical experience does not influence total dose of radiation used in pediatric procedures with fluoroscopy.

METHODS
This was a retrospective cohort study of all supracondylar humerus (SCH) fractures that presented to a Level I Pediatric Trauma Center between the years 2016-2019 and treated with closed reduction and percutaneous pinning (CRPP). For each procedure, information pertaining to radiation dosage was gathered that included fluoroscopy time (s), total images acquired, number of images saved, and dose associated product (DAP, mGy/cm²). Demographic information of the patient along with information pertaining to the training level of trainees and years of experience for the surgeons were recorded. Descriptive statistics were used to describe the population, and linear regression was used to compare continuous variables.

RESULTS
A total of 759 cases were included and treated by 17 attending surgeons with 16 fellows and 303 residents between years 2016 and 2019. The average attending experience was 11.7 years, ranging from 0.13 to 35.0 years. A trainee was present in 98.4% of cases. Of these cases, residents were first assist in 43.2%, and fellows were first assist in 55.2%. Median fluoroscopy time was 35.5 seconds (IQR: 26.0-53.1), with a median DAP of 75.4 mGy/cm² (IQR: 42.2-135.2). Average total number of images acquired were 58.7 +/- 38.9 images, with an average 4.2 +/- 2.1 images saved. Increasing surgeon years of experience was associated with a decrease in fluoroscopy time (p=.044) and total number of images acquired (p=.014). When stratified by Gartland fracture type, surgeon years of experience was associated with decreased radiation used for every fracture type (Type 2, p = 0.022, Type 3, p = .209, Type 4, p = .048). There was a significant difference in fluoroscopy time, DAP and total number of shots in attendings with less than 1 year of experience, compared to surgeons with 1-5 years, 5-10 years and greater than 10 years of experience (p = .001, p = .001, p = .008 for each category respectively).
SUMMARY
Increased surgical experience was associated with significantly decreased fluoroscopy time, DAP, and number of images acquired. Surgeons use significantly more radiation and fluoroscopy time during their first year attending than in the years afterward. Improving fellow education could result in an earlier decrease in radiation used and improvement in fluoroscopy time by the first year attending.

Figure 1: Decreasing fluoroscopy time, total shots taken, and DAP (radiation used) by surgeons with gradually increasing years of experience. Each variable with appropriate units in parentheses.
RF: Poster 53: Surgical Elbow Dislocation Approach to the Distal Humerus for Apparent Capitellar and Lateral Condyle Fractures in Adults

Category: Bone and Joint

Evaluation/Diagnosis; Surgical Technique
Level of Evidence: N/A

Benjamin W Hoyt
Desraj M Clark
Sarah A Walsh
Raymond A Pensy

HYPOTHESIS
This anatomic cadaveric study aims to evaluate the articular exposure obtained through a novel approach to the distal Humerus. We hypothesize that a surgical dislocation approach to the distal humerus will provide superior exposure of the anterior joint surface than the exposure obtained via olecranon osteotomy.

METHODS
After obtaining institutional approval, we obtained eight elbows from four cadavers and performed either a surgical dislocation or olecranon osteotomy approach in matched elbows. The surgical elbow dislocation was achieved through a laterally based exposure using the interval between extensor digitorum communis (EDC) and extensor carpi ulnaris (ECU) in the forearm and the intermuscular septum of the brachium between brachioradialis and triceps. The lateral collateral ligament (LCL) origin is then reflected off the humerus, allowing dislocation of the elbow and visualization of the joint. We used methylene blue dye to demarcate visualized articular surface and then disarticulated the elbows and used a grid reference and high-resolution photographs to measure the amount of labeled articular surface with ImageJ software. Visualized articular surface was measured by three independent raters and intra-class correlation coefficients were calculated. Average achieved visualization relative to the total surface was compared for each surgical approach using unpaired parametric t-tests.

RESULTS
Intraclass correlation between raters was 0.995. The median exposed articular surface for the surgical dislocation and olecranon osteotomy approaches was 62.8% and 90.0%, respectively. The overall exposure was significantly greater for the dislocation technique (p=0.0003). With respect to specific regions of the distal humeral articular surface, elbow dislocation allowed significantly greater visualization of the anterior surface (95.9% versus 48.9%, p<0.0001) and capitellum (100% versus 40.4%, p<0.0001).
SUMMARY
The surgical elbow dislocation approach to the distal humerus permits near total exposure of the anterior articular surface and the entirety of the capitellum. This approach may be advantageous for lateral condylar fractures and apparent capitellar fractures involving the capitellum and some portion of the trochlea medially, particularly when the lateral collateral ligament is functionally destabilized.

REFERENCES:
Figure 2. Clinical photographs of cadaveric elbows demonstrating (A) surgical dislocation and (B) olecranon osteotomy. Methylene blue was applied to all visualized surfaces for the (C) surgical dislocation and (D) olecranon osteotomy, and elbows were then disarticulated for measurement of the relative exposed (E) anterior surface, (F) posterior surface, and (G) capitellum.

SD = Surgical Dislocation, OO = Olecranon Osteotomy
HYPOTHESIS
The purpose of this study was to assess the reliability of the Soong classification between intraoperative fluoroscopy and post-operative radiographs for distal radius volar plate position. Additionally, we assessed reliability of the Soong classification system among different levels of orthopedic resident training. We hypothesized that the Soong classification system is reliable during intraoperative fluoroscopic imaging and post-operative radiographs.

METHODS
Ten orthopedic resident physicians (3 PGY1, 2 PGY2, 3 PGY3, 2 PGY4) were asked to classify images using the Soong classification. Physician observers were blinded to the previously assigned classification and to clinical information regarding the patient. Lateral and anterior-posterior (AP) views for both fluoroscopy and x-ray from 30 patients were included and randomized. Additionally, 30% of the images were duplicated and included for intrarater reliability. A total of 156 images were randomized and presented to each observer in one consecutive session. Intraclass correlation coefficients were calculated to evaluate the intraobserver and interobserver reliability.

RESULTS
Intraoperative fluoroscopic images and post-operative radiographs of the lateral wrist demonstrated moderate intrarater reliability overall (ICC = 0.718, 95% confidence interval [CI] = 0.63-0.787). Intraobserver reliability tended to improve based on year of training. (PGY1 ICC = 0.399, 95% CI = 0.156-0.596; PGY 2 ICC = 0.677, 95% CI = 0.459-0.818; PGY3 ICC = 0.829, 95% CI = 0.726-0.896; PGY4 ICC = 0.818, 95% CI = 0.677-0.901). There was a statistically significant improvement in intraobserver reliability between PGY1 and PGY3,4 observers. Interobserver reliability also improved based on year of training (PGY1 ICC = 0.144, 95% CI = 0.012-0.293; PGY2 ICC = 0.582, 95% CI = 0.415-0.715; PGY3 ICC = 0.648, 95% CI = 0.537-0.744; PGY4 ICC = 0.800, 95% CI = 0.704-0.867). Although, overall interobserver reliability was poor (ICC = 0.498, 95% CI = 0.412-0.593). There was a statistically significant improvement in interrater reliability comparing PGY1 with PGY2,3 and PGY4 observers. AP images demonstrated poor intraobserver (fluoroscopy ICC= 0.587, 95% CI =0.450-0.697; radiograph ICC= 0.487, 95% CI 0.268-0.658) and
interobserver reliability (fluoroscopy ICC = 0.323, 95% CI = 0.217-0.463; radiograph ICC = 0.266, 95% CI = 0.163-0.412)

SUMMARY
When applying the Soong classification system for distal radius volar plate fixation, there is moderate agreement between the lateral images of intraoperative fluoroscopy and post-operative radiographs. With more education and experience, inter- and intrarater reliability improves, with the largest jump occurring within the first year of training, from PGY1 to PGY2 years.

REFERENCES:

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<th>ICC</th>
<th>95% Lower CI</th>
<th>95% Upper CI</th>
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<tbody>
<tr>
<td>PGY1</td>
<td>0.399</td>
<td>0.156</td>
<td>0.596</td>
</tr>
<tr>
<td>PGY2</td>
<td>0.677</td>
<td>0.459</td>
<td>0.818</td>
</tr>
<tr>
<td>PGY3</td>
<td>0.829</td>
<td>0.726</td>
<td>0.896</td>
</tr>
<tr>
<td>PGY4</td>
<td>0.818</td>
<td>0.677</td>
<td>0.901</td>
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</table>

Table 2: Lateral images interobserver reliability

<table>
<thead>
<tr>
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<th>ICC</th>
<th>95% Lower CI</th>
<th>95% Upper CI</th>
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<tbody>
<tr>
<td>All lateral images</td>
<td>0.498</td>
<td>0.412</td>
<td>0.593</td>
</tr>
<tr>
<td>PGY1</td>
<td>0.144</td>
<td>0.012</td>
<td>0.293</td>
</tr>
<tr>
<td>PGY2</td>
<td>0.582</td>
<td>0.415</td>
<td>0.711</td>
</tr>
<tr>
<td>PGY3</td>
<td>0.648</td>
<td>0.537</td>
<td>0.744</td>
</tr>
<tr>
<td>PGY4</td>
<td>0.800</td>
<td>0.704</td>
<td>0.867</td>
</tr>
</tbody>
</table>
HYPOTHESIS
Handwritten consent forms carry a risk of documentation errors. We hypothesized that a significant portion of the handwritten consents used in our institution would be associated with issues related to accuracy, legibility, and completeness.

METHODS
This study was a retrospective review of written consents performed at an orthopedic specialty hospital from 12/2014 to 5/2017; 14,868 surgeries were performed over this time period. A sample of 1800 charts was selected. Consents were assessed for procedure type, physician details, abbreviations, consistency, and legibility. Exclusion criteria included absence of a patient-signed consent form or an incomplete or missing operative report. Descriptive analysis was performed for the variables of interest.

RESULTS
1309 charts met inclusion criteria. 1,046 patients were consented for an inpatient procedure, and 263 were consented for an outpatient surgery. Two hundred and eight consents (16%) contained an illegible word. The name of the consenting physician was not listed or illegible on 114 consents (8.7%). Abbreviations were found on 1.8% of all included consents, and 19 consent forms contained a crossed out word or correction. There were no instances in which the procedure performed was different than the procedure consented for, including laterality of the procedure.

SUMMARY
Although the majority of the handwritten consents were complete, accurate, and legible, there were notable errors in the consenting process at our institution. Documentation errors have medical and ethical ramifications. Further research into consenting practices is necessary to improve the quality of consent forms and the process of informed consent.
HYPOTHESIS
The purpose of this study was to examine the outcomes and return to play with early rehabilitation in athletes who sustained unstable extraarticular distal radius fractures treated with a purpose-designed threaded pin technique.

METHODS
This was a prospective study examining athletes with displaced, unstable, distal radius fractures treated surgically with purpose-designed threaded pins. All patients were enrolled in an early rehabilitation protocol, with formal therapy initiated on postoperative days 1-to-3. Range of motion values and strength measurements were documented throughout the postoperative period, noting the duration of time until return to athletic competition. Radiographs were reviewed to determine maintenance of alignment. These results were compared to historical values utilizing other forms of fixation. Patients were monitored for postoperative complications and maintenance of fracture reduction.

RESULTS
19 athletes, average age 35 years (range, 17 - 44 years) were treated with threaded pin technique with early rehabilitation, all with complete healing and maintained alignment based on radiographic evaluation. The average time span between surgery and release to competition was 8 weeks with all but one patient (18/19) returning to sport within 12 weeks of injury. Average postoperative flexion measured 58 degrees, extension 57 degrees, pronation 81 degrees, and supination 74 degrees. JAMAR grip strength in position 3 measured 55.6 pounds, which equated to 73% of the uninjured side’s grip strength at the time of release to play.

SUMMARY
• Surgical fixation with a closed technique utilizing a purpose-designed threaded pin is a useful alternative to volar plating for isolated radial styloid and extraarticular distal radius fractures in athletes. • By minimizing soft tissue dissection, the purpose-designed threaded pin may afford athletes rapid recovery during the early postoperative period, preserving strength and dexterity and minimizing time lost before return to play. • The analysis of grip strength can also aide in
determining the appropriate time to resume play, as most athletes returned when they reached around 75% of their grip strength.
HYPOTHESIS
To assess the results of threaded distal radius pin (TDRP) fixation when compared to volar plate fixation (VP) of extraarticular distal radius fractures

METHODS
A prospective, nonrandomized evaluation of patients undergoing operative fixation of distal radius fracture and postoperative therapy was performed. Clinical variables included implant type, and assessment of volar tilt, radial height, postoperative wrist flexion, extension, pronation, supination, key pinch and grip strength. The number and duration of therapy visits was recorded. An independent T-test was used to compare 2 groups.

RESULTS
A total of 43 patients (21 TDRP, 22 volar plate) were identified (mean age 46.3 TDRP, 53.7 years volar plate) with mean follow-up duration of 7.4 months. Pre- and postoperative radiographic parameters were statistically similar for both groups with both groups maintaining reduction. There were no statistically significant differences for postoperative range of motion (ROM), pinch strength, or grip strength at the time of discharge from therapy. The average number of postoperative therapy visits was 10.8 for the TDRP (mean 68 days) and 17.2 for the volar plate group (mean 132 days). 20% of the volar plate cases required hardware removal while no threaded pins required removal.

SUMMARY
• Both groups achieved equivalent ROM and functional recovery; however, the threaded pin group recovered in significantly less time than the volar plate group. • The threaded pin group was discharged from therapy an average of 64 days earlier than the volar plate group. •
HYPOTHESIS
Robinow syndrome (RS) is a rare, phenotypically heterogenous dwarfing syndrome presenting as craniofacial, genital, and extremity anomalies. Description of the associated upper extremity anomalies and their correlation to specific genetic defects will aid in the expedient diagnosis of RS.

METHODS
Patients previously identified as having clinical RS underwent evaluation. 18 patients were evaluated by a multi-disciplinary team including plastic surgery, urology, orthopedic surgery, neuropsychology, and genetics specialists. Of this cohort, 12 patients were confirmed to have one of the several genetic variants seen in RS. Extremity anomalies were evaluated by three members of the plastic surgery team, and upper limb findings were compared against inheritance patterns and individual genetic variants to identify any correlations.

RESULTS
A total of 5 genetic variants were identified. Each patient displayed skeletal dysplasia, of which mesomelia (47%) was observed most frequently. Rhizomelia (33%) was seen only in patients with variants of the DVL1 and NXN genes. Survey of the hand identified 8 different anomalies. Among these, brachydactyly (92%), broad thumbs (83%), and clinodactyly (75%) were most common. All three of these findings were observed in patients with mutations of the DVL1, ROR, or GPC4 genes. Decreased forearm rotation was the prevalent functional deficit and manifested by all mutations other than the X-linked GPC4 variant. Hand anomalies were absent in one patient with an autosomal-recessive NXN gene variant.

SUMMARY
• A trained hand surgeon should be aware of the common extremity anomalies seen in RS, as this may aid in timely identification and early management of sequelae. • Types and severity of skeletal dysplasia and upper extremity anomalies may correlate with specific genetic variants and inheritance patterns of Robinow Syndrome.
REFERENCES:

Figure 1. Skeletal dysplasias stratified by genetic variants.

<table>
<thead>
<tr>
<th>Skeletal Dysplasia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesomelia</td>
</tr>
<tr>
<td>Micromelia</td>
</tr>
<tr>
<td>Rhizomelia</td>
</tr>
</tbody>
</table>

*DVLI*, disheveled segment polarity protein 1; *NXN*, Nucleoredoxin; *ROR2*, Receptor Tyrosine Kinase Like Orphan Receptor 2; *WNT5A*, Wnt Family Member 5A; *GPC4*, Glypican 4.
Figure 2. Hand phenotypes stratified by genetic variants.

Hand Anomalies

- Brachydactyly
- Short thumbs
- Glaucoma
- Neuronal hypoplasia
- Dermatoglyphic abnormalities
- Hypoplastic phalanges
- Distal phalangeal duplication
- Ectrodactyly
- Campodactyly
- Polydactyly
- Fusion of phalanges
- Fusion of carpals bones

DVL1, disheveled segment polarity protein 1; NXN, Nucleoredoxin; ROR2, Receptor Tyrosine Kinase Like Orphan Receptor 2; WNT5A, Wnt Family Member 5A; GPC4, Glypican 4.
RF: Poster 64: Morphometric Remodeling of Human Motor Endplates after Peripheral Nerve Injury
Category: Nerve; Skin and Soft Tissue

Evaluation/Diagnosis; Treatment; Basic Science
Level of Evidence: N/A

Justin Chan
Jennifer Uong
Winnie Palispis
Oswald Steward
Ranjan Gupta

HYPOTHESIS
Following peripheral nerve injury in a human, motor endplates in a denervated muscle will undergo morphometric remodeling and complete dispersion after the injury.

METHODS
Eighteen patients with traumatic brachial plexus and axillary nerve injuries, ranging from 3 days to 6 years after injury, underwent biopsy of denervated muscles from the upper extremity. Specimens were immediately snap frozen in the operating room and then processed for immunohistochemistry and visualized by confocal microscopy with argon and helium-neon lasers. Motor endplates were labeled directly with alpha-bungarotoxin, Alexa Fluor® 594 conjugate. Presynaptic vesicles were labeled with recombinant mouse anti-human synaptophysin, and axons with purified mouse anti-human neurofilament. Secondary antibodies were conjugated to donkey anti-mouse Alexa Fluor® 488. Images were acquired with a Zeiss LSM 780 using a Plan-Apochromat dry 20x/0.8 and 40x/1.3 oil immersion objective lens. Two-Photon excitation was achieved by using an 810nm laser to excite both fluorophores simultaneously. Images were acquired with a custom microscope system by Intelligent Imaging Innovations™ using a 20x/0.8 water immersion objective lens. Images obtained from two-photon excitation microscopy were used to create three-dimensional reconstructions with Volocity imaging software (Perkin Elmer) to allow for precise quantification of morphometric properties of neuromuscular junctions.

RESULTS
Immunohistochemical analysis demonstrated varying degrees of fragmentation and acetylcholine receptor dispersion in denervated muscles. Three dimensional reconstructions revealed a significant decrease in motor endplate (MEP) surface area and volume, as well as a trend towards immature endplate morphology. The magnitude of morphometric remodeling progressively increased with greater denervation time. Surprisingly, innervated and structurally intact MEPs persisted in muscle specimens from multiple patients that had been denervated for greater than 5 years.
SUMMARY
· Morphometrical remodeling does occur in denervated human motor endplates, but the motor endplates do persist for at least ten months following a peripheral nerve injury. · Motor endplates persist and can retain their structure in muscles which have been denervated for up to six years, which is far beyond the empiric six-month window for surgical intervention based on clinical observations. · Pre-operative muscle biopsy in patients being considered for nerve transfer may be a useful prognostic tool to determine motor endplate viability in denervated muscle. Furthermore, neuromuscular junction survival may be a target for adjuvant therapy in peripheral nerve injuries.

Figure 1. A-E) Hematoxylin & eosin staining of cross-sectional deltoide muscle fibers. Scale bars = 100μm (10x) F-J) Two-photon excitation microscopy of human MEPs. Red for α-bungarotoxin, green for neurofilament and synaptophysin. Scale bars = 50μm (20x)

Figure 2. Regression analysis of human MEP morphometry from normal and denervated human deltoids. A) MEP volume and B) MEP surface area. Data points represent mean ± S.E.M.
HYPOTHESIS
Distal radius fractures are extremely common injuries affecting a wide range of patient demographics. The purpose of this study was to evaluate the outcomes of distal radius fractures managed initially with closed reduction and immobilization in either a below elbow volar-dorsal splint vs sugar-tong splint prior to conversion into a short arm cast. We hypothesize a higher loss of reduction in the sugar-tong than volar-dorsal splint group.

METHODS
We performed a retrospective study of patients with distal radius fractures evaluated by the orthopedic surgery department at our tertiary referral center from 2016-2018. Anteroposterior and lateral radiographs were evaluated immediately after closed reduction and placement into either a sugar-tong or volar-dorsal splint. The radial inclination, radial length, volar tilt, and intra-articular displacement were measured. These measurements were repeated at each outpatient follow up visit until conversion into a short arm cast. Statistical analysis was performed to evaluate differences in loss of reduction between the two splint groups.

RESULTS
There were 1600 records screened of which 400 were reviewed and 115 fit the inclusion criteria. Of those, 81 had complete data regarding type of splint and corresponding clinic note and radiographs. The average age in the sugar-tong group (ST) was 58.8 and 59.6 for the Volar-Dorsal which was not significantly different (P= 0.8766). There was no significant difference for any radiographic parameter between groups on the initial post-reduction radiographs. The initial clinic follow up radiographs illustrated significantly lower radial inclination in the sugar-tong group than volar-dorsal group (17.1 vs 19, P=0.0443). Follow up mean radial length was not significantly lower in the sugar tong than volar-dorsal group. Palmar tilt and articular step-off was not significantly different between splint types. The loss of reduction was 28.8% for the sugar-tong and 25.0% for the volar-dorsal group (P=0.696).
SUMMARY
• Our results did not demonstrate a significant difference in loss of reduction rates between the two splint groups. • There was no significant difference between the sugar-tong and volar-dorsal groups in terms of loss of radial length and volar tilt. • No significant difference in the degree of intra-articular displacement between the initial post-reduction radiographs and the clinic follow up x-rays. • Loss of reduction were similar between groups suggesting no advantage of a volar-dorsal splint compared to a sugar-tong splint.

Table 1 Clinical and Demographic Differences Between Splint Groups

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sugar-Tong N=45</th>
<th>SD</th>
<th>Volar-Dorsal N=36</th>
<th>SD</th>
<th>P &lt;0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>58.8</td>
<td>18.6</td>
<td>59.6</td>
<td>20.0</td>
<td>0.8766</td>
</tr>
<tr>
<td>Sex (% Male)</td>
<td>15.56%</td>
<td>-</td>
<td>11.11%</td>
<td>-</td>
<td>0.747</td>
</tr>
<tr>
<td>Race White/Non-White</td>
<td>23/22</td>
<td>-</td>
<td>26/36</td>
<td>-</td>
<td>0.291</td>
</tr>
<tr>
<td>Handedness (Right/Left)*</td>
<td>36/2</td>
<td>-</td>
<td>24/3</td>
<td>-</td>
<td>0.392</td>
</tr>
<tr>
<td>Insurance: Private</td>
<td>12</td>
<td>-</td>
<td>11</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>21</td>
<td>-</td>
<td>18</td>
<td>-</td>
<td>0.995</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
<td>-</td>
<td>7</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>15.5%</td>
<td>-</td>
<td>19.4%</td>
<td>-</td>
<td>0.317</td>
</tr>
<tr>
<td>Loss of Reduction (%)</td>
<td>28.8%</td>
<td>-</td>
<td>25.0%</td>
<td>-</td>
<td>0.696</td>
</tr>
<tr>
<td>Days in Splint</td>
<td>9.6</td>
<td>4.9</td>
<td>9.9</td>
<td>5.2</td>
<td>0.7909</td>
</tr>
<tr>
<td>Primary Care Provider (Y%)</td>
<td>48.78%</td>
<td>-</td>
<td>51.22%</td>
<td>-</td>
<td>0.286</td>
</tr>
<tr>
<td>Osteoporosis or Osteopenia (Y%)</td>
<td>8.89%</td>
<td>-</td>
<td>5.06%</td>
<td>-</td>
<td>0.688</td>
</tr>
</tbody>
</table>

*Unknown in 16

Table 2 Radiographic Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sugar-Tong N=45</th>
<th>SD/IQR†</th>
<th>Volar-Dorsal N=36</th>
<th>SD/IQR†</th>
<th>P &lt;0.05</th>
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</thead>
<tbody>
<tr>
<td>V1 Radial Inclination</td>
<td>19.9</td>
<td>3.11</td>
<td>20.9</td>
<td>2.8</td>
<td>0.1352</td>
</tr>
<tr>
<td>V1 Palmar Tilt†</td>
<td>6</td>
<td>14</td>
<td>5</td>
<td>11</td>
<td>0.8639</td>
</tr>
<tr>
<td>V1 Radial Length</td>
<td>10.0</td>
<td>2.0</td>
<td>10.5</td>
<td>1.5</td>
<td>0.2229</td>
</tr>
<tr>
<td>V1 Articular Step-off†</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2505</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sugar-Tong N=43</th>
<th>SD/IQR†</th>
<th>Volar-Dorsal N=36</th>
<th>SD/IQR†</th>
<th>P &lt;0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2 Radial Inclination</td>
<td>17.1</td>
<td>4.3</td>
<td>19</td>
<td>4.1</td>
<td>0.0443</td>
</tr>
<tr>
<td>V2 Palmar Tilt†</td>
<td>0</td>
<td>19</td>
<td>2.5</td>
<td>13.5</td>
<td>0.4569</td>
</tr>
<tr>
<td>V2 Radial Length</td>
<td>8.4</td>
<td>2.1</td>
<td>9.2</td>
<td>2.0</td>
<td>0.0848</td>
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<tr>
<td>V2 Articular Step-off†</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.2165</td>
</tr>
</tbody>
</table>

†Median, Interquartile Range, Wilcoxon rank sum test

V1 = Visit 1 ; V2 = Visit 2
RF: Poster 68: Comparison of Upper Extremity Infections Requiring Surgical Debridement Between IVDU and non-IVDU Patients

Category: Skin and Soft Tissue

Prognosis/Outcomes
Level of Evidence: 4

Dr. Mona Ascha
Leila Katabi
Yuwei Wu-Fienberg
Blaine Todd Bafus
Kyle Chepla

HYPOTHESIS
Opioid abuse resulted in approximately 46,802 deaths in 2018, and intravenous or intradermal opioid injection is a common cause of upper extremity morbidity. The aim of the present study was to compare demographic variables among IVDU patients and non-IVDU patients requiring operative debridement for upper extremity infections. We hypothesize that IVDU patients hospitalized for upper extremity infection will have greater morbidity and mortality than non-IVDU patients.

METHODS
A retrospective chart review was conducted from January 2012 – December 2017. Current Procedural Terminology codes were used to identify patients age 18 years and above with a debridement related to an infection. Demographic, financial, and treatment-related variables were collected and analyzed with descriptive statistics.

RESULTS
We identified 43 patients, 19 IVDU patients and 22 controls. Both groups were comparable in terms of sex, employment status, and ethnicity. The IVDU group was significantly younger (p=0.007) and had significantly more smokers (p=0.016). Hepatitis C was significantly more common in the IVDU group (p=0.001). Both groups had a median of one operative debridement. Infection with methicillin resistant staphylococcus aureus (MRSA) was slightly more common in the IVDU group. Both groups had similar rates of polymicrobial infection. In terms of anatomic location of infection, patients in the IVDU group had infections ranging throughout the entire upper extremity, while patients in the control group typically had infections in the finger and hand. The IVDU group had a significantly higher rate of necrotizing fasciitis (p = 0.049). The median length of stay was also significantly higher in the IVDU group (p = 0.007). IVDU patients were also greater utilizers of the healthcare system, with a significantly greater number of prior emergency room visits (median of 15 compared to median of 2.5, p = 0.014). There were four deaths in the IVDU group and four deaths in the control group. Average hospital charges, collected charges, and outstanding charges were higher in the IVDU group, however none of these were significant (p = 0.227, 0.274, and 0.216 respectively).
SUMMARY
IVDU patients with upper extremity infections requiring debridement had greater morbidities such as Hepatitis C and smoking status compared to their non-IVDU counterparts, however there was no increased mortality. The IVDU group also had more severe infections of the upper extremity. Average hospital charges and outstanding charges were greater, however this was not significant.

REFERENCES:
<table>
<thead>
<tr>
<th>Variable</th>
<th>Control</th>
<th>IVDU</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant Extremity is</td>
<td>Yes</td>
<td>10 (47.6)</td>
<td>6 (31.6)</td>
</tr>
<tr>
<td>Injured Extremity (n (%))</td>
<td>No</td>
<td>11 (52.4)</td>
<td>13 (68.4)</td>
</tr>
<tr>
<td>Number of OR Visits (Median (IQR))</td>
<td></td>
<td>1 (1-2)</td>
<td>1 (1-2)</td>
</tr>
<tr>
<td>Depth of Injury (n (%))</td>
<td>Skin</td>
<td>4 (18.2)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td></td>
<td>Subcutaneous Tissue</td>
<td>11 (50.0)</td>
<td>12 (63.2)</td>
</tr>
<tr>
<td></td>
<td>Muscle</td>
<td>5 (22.7)</td>
<td>7 (36.8)</td>
</tr>
<tr>
<td></td>
<td>Bone</td>
<td>2 (9.1)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Diagnosis of Necrotizing Fasciitis (n (%))</td>
<td>Yes</td>
<td>1 (4.5)</td>
<td>6 (33.3)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>21 (95.5)</td>
<td>12 (66.7)</td>
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<tr>
<td>Length of Stay (Days) (Median (IQR))</td>
<td></td>
<td>0.5 (0-3.75)</td>
<td>4 (2.5-7)</td>
</tr>
<tr>
<td>Number of Prior Hospitalizations (Median (IQR))</td>
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<td>0.5 (0-3.5)</td>
<td>1 (0-8)</td>
</tr>
<tr>
<td>Number of Prior Emergency Room Visits (Median (IQR))</td>
<td></td>
<td>2.5 (0-6.75)</td>
<td>15 (4-18.5)</td>
</tr>
<tr>
<td>Number of Prior Surgeries (Median (IQR))</td>
<td></td>
<td>1 (0-2)</td>
<td>0 (0-0.5)</td>
</tr>
<tr>
<td>Infectious Disease Consult (n (%))</td>
<td>Yes</td>
<td>8 (36.4)</td>
<td>13 (68.4)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>14 (63.6)</td>
<td>6 (31.6)</td>
</tr>
<tr>
<td>Payor (n (%))</td>
<td>Medicaid</td>
<td>9 (45.0)</td>
<td>16 (84.2)</td>
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<td></td>
<td>Medicare</td>
<td>6 (30.0)</td>
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<td></td>
<td>Prison</td>
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<td>1 (5.3)</td>
</tr>
<tr>
<td>Disposition (n (%))</td>
<td>Home</td>
<td>9 (40.9)</td>
<td>12 (63.2)</td>
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<tr>
<td></td>
<td>Outpatient</td>
<td>10 (45.5)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td></td>
<td>Skilled nursing facility</td>
<td>3 (13.6)</td>
<td>4 (21.1)</td>
</tr>
<tr>
<td></td>
<td>Long term acute care hospital</td>
<td>0 (0.0)</td>
<td>1 (5.3)</td>
</tr>
<tr>
<td></td>
<td>Psychiatric facility</td>
<td>0 (0.0)</td>
<td>1 (5.3)</td>
</tr>
<tr>
<td></td>
<td>Left against medical advice</td>
<td>0 (0.0)</td>
<td>1 (5.3)</td>
</tr>
<tr>
<td>Death (n (%))</td>
<td>Yes</td>
<td>4 (18.2)</td>
<td>4 (21.1)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>18 (81.8)</td>
<td>15 (78.9)</td>
</tr>
</tbody>
</table>
RF: Poster 70: Analysis of Gender Diversity Within Hand Surgery Fellowship Programs

Category: Other Clinical Topics; Miscellaneous Nonclinical Topics

Ethics/Professionalism; Residents/Fellow/Educator Resources

Level of Evidence: 4

Louis C. Grandizio, DO
Elizabeth J. Pavis, MS
Max Duster Gehrman, MD
Joel C. Klena, MD

HYPOTHESIS
The purpose of this investigation is to define and compare the demographics of hand surgery fellowship faculty and fellows, with particular attention to gender. We hypothesize that hand surgery fellowship programs with female faculty are more likely to have had prior female fellows.

METHODS
We determined the gender of each program director for all orthopaedic residency and fellowship programs. Specific to hand surgery, we determined the gender of the fellowship director and all faculty members. Lists of prior hand surgery fellows from 2014-2019 were obtained from official program websites or program coordinators. The gender distribution of the hand fellowship program directors and faculty were compared to the prior fellows.

RESULTS
Hand surgery fellowship programs had the second highest percentage of female fellowship directors (13%) behind orthopaedic oncology (27%). Within hand surgery, 614 total faculty positions were identified and 15% were female. Of the 89 hand surgery programs evaluated, 36 (60%) had at least one female faculty member. For the 849 prior fellows identified, 213 (25%) were female and 79% of programs had at least one female fellow. Hand programs led by a female director did not have a higher percentage of prior female fellows compared to programs with a male director (26% vs 25%). Programs with a female fellowship director were more likely to have had at least one prior female fellow compared to programs with a male fellowship director (100% vs 76%), however these results were not statistically significant.

SUMMARY
• Compared to other orthopaedic fellowship subspecialties, hand surgery has the second highest percentage of female fellowship directors (13%); however, compared to the percentage of female medical students, women remain underrepresented in hand surgery. • While mentorship plays an important role in surgical education, female faculty members do not appear to attract more female fellows.
REFERENCES:
Klyce W, Nhan DT, Dunham AM, Dafrawy MH, Shannon C, LaPorte DM. The times, they are a-changing: women entering academic orthopaedics today are choosing nonpediatric fellowships at a growing rate. J Surg Educ. 2020; 77(3):564-571.

<table>
<thead>
<tr>
<th>Program, N</th>
<th>HAND</th>
<th>RES</th>
<th>SPORTS</th>
<th>FA</th>
<th>PEDS</th>
<th>SPINE</th>
<th>SE</th>
<th>TRAUMA</th>
<th>ONC</th>
<th>RECON</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region, N(%)</td>
<td>89(33%)</td>
<td>193(26%)</td>
<td>90(24%)</td>
<td>46(26%)</td>
<td>42(24%)</td>
<td>71(26%)</td>
<td>29(15%)</td>
<td>51(25%)</td>
<td>3(15%)</td>
<td>108(25%)</td>
<td>0.62</td>
</tr>
<tr>
<td>Northeast</td>
<td>17(19%)</td>
<td>54(28%)</td>
<td>23(26%)</td>
<td>10(22%)</td>
<td>9(21%)</td>
<td>14(20%)</td>
<td>6(21%)</td>
<td>8(13%)</td>
<td>3(20%)</td>
<td>27(25%)</td>
<td></td>
</tr>
<tr>
<td>Midwest</td>
<td>26(29%)</td>
<td>58(30%)</td>
<td>25(28%)</td>
<td>13(28%)</td>
<td>19(45%)</td>
<td>19(27%)</td>
<td>7(24%)</td>
<td>22(36%)</td>
<td>7(47%)</td>
<td>38(35%)</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>20(22%)</td>
<td>30(16%)</td>
<td>29(22%)</td>
<td>11(24%)</td>
<td>5(12%)</td>
<td>20(28%)</td>
<td>5(17%)</td>
<td>13(25%)</td>
<td>2(13%)</td>
<td>24(22%)</td>
<td></td>
</tr>
</tbody>
</table>

| Accredited Programs, N(%) | 89(100%) | 193(100%) | 90(100%) | 46(100%) | 42(100%) | 71(100%) | 29(100%) | 51(100%) | 3(100%) | 12(100%) | 23(100%) | <0.05 |
| Positions, Mean(SD) | 2.1(1.4) | 23(9.8) | 2.7(1.6) | 1.6(1.0) | 1.6(1.0) | 1.9(1.0) | 1.4(0.7) | 1.5(0.9) | 1.6(0.7) | 2.0(1.3) | <0.05 |
| Female PD, N(%) | 12(13%) | 18(9%) | 3(3%) | 24(4%) | 5(12%) | 3(4%) | 1(3%) | 3(5%) | 4(27%) | 0(0%) | <0.05 |
| Allopecic PD, N(%) | 88(99%) | 163(84%) | 90(100%) | 45(98%) | 42(100%) | 71(100%) | 29(100%) | 59(97%) | 15(100%) | 107(99%) | <0.05 |

TABLE 1. Program demographics of hand surgery fellowship compared to orthopaedic residencies and other fellowship subspecialties (2019).

<table>
<thead>
<tr>
<th>HAND FELLOWSHIP PROGRAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Programs, N</td>
</tr>
<tr>
<td>Program Type, N(%)</td>
</tr>
<tr>
<td>Female Program Director, N(%)</td>
</tr>
<tr>
<td>Total Faculty Positions, N</td>
</tr>
<tr>
<td>Female Faculty, N(%)</td>
</tr>
<tr>
<td>Male Faculty, N(%)</td>
</tr>
<tr>
<td>Programs with Any Female Faculty, N(%)</td>
</tr>
</tbody>
</table>

TABLE 2. Additional program and faculty demographics for hand surgery fellowships (2019).
<table>
<thead>
<tr>
<th>Programs with Identifiable Fellows, N (% of total programs)</th>
<th>77 (87%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region, N(%)</td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>24 (31%)</td>
</tr>
<tr>
<td>Midwest</td>
<td>16 (21%)</td>
</tr>
<tr>
<td>South</td>
<td>22 (29%)</td>
</tr>
<tr>
<td>West</td>
<td>15 (19%)</td>
</tr>
<tr>
<td>Program Type, N(%)</td>
<td></td>
</tr>
<tr>
<td>Orthopaedics</td>
<td>62 (81%)</td>
</tr>
<tr>
<td>Plastic Surgery</td>
<td>15 (19%)</td>
</tr>
<tr>
<td>Female Program Director, N(%)</td>
<td>11 (14%)</td>
</tr>
<tr>
<td>Faculty Positions</td>
<td></td>
</tr>
<tr>
<td>Total Faculty Positions, N</td>
<td>537</td>
</tr>
<tr>
<td>Total Female Faculty Members, N(%)</td>
<td>83 (15%)</td>
</tr>
<tr>
<td>Number of Programs with Female Faculty, N(%)</td>
<td>49 (64%)</td>
</tr>
<tr>
<td>Fellow Positions</td>
<td></td>
</tr>
<tr>
<td>Total Fellows Identified, N(%)</td>
<td>849</td>
</tr>
<tr>
<td>Total Female Fellows, N(%)</td>
<td>213 (25%)</td>
</tr>
<tr>
<td>Number of Programs with any Female Fellows, N(%)</td>
<td>61 (79%)</td>
</tr>
</tbody>
</table>

TABLE 3. Program, faculty and fellow demographics for hand surgery fellowship that had identifiable hand fellows.

<table>
<thead>
<tr>
<th>Region, N(%)</th>
<th>Female PD (N=11)</th>
<th>Male PD (N=66)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>2 (18%)</td>
<td>22 (33%)</td>
<td>0.38</td>
</tr>
<tr>
<td>Midwest</td>
<td>4 (36%)</td>
<td>12 (18%)</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>2 (18%)</td>
<td>20 (30%)</td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>3 (27%)</td>
<td>12 (18%)</td>
<td></td>
</tr>
<tr>
<td>Program Type, N(%)</td>
<td></td>
<td></td>
<td>0.44</td>
</tr>
<tr>
<td>Orthopaedics</td>
<td>8 (73%)</td>
<td>12 (18%)</td>
<td></td>
</tr>
<tr>
<td>Plastic Surgery</td>
<td>3 (27%)</td>
<td>54 (82%)</td>
<td></td>
</tr>
<tr>
<td>Fellow Positions</td>
<td></td>
<td></td>
<td>0.87</td>
</tr>
<tr>
<td>Total Fellows Identified, N(%)</td>
<td>176</td>
<td>673</td>
<td></td>
</tr>
<tr>
<td>Total Female Fellows, N(%)</td>
<td>45 (26%)</td>
<td>168 (25%)</td>
<td></td>
</tr>
<tr>
<td>Number of Programs with any Female Fellows, N(%)</td>
<td>11 (100%)</td>
<td>50 (76%)</td>
<td>0.11</td>
</tr>
</tbody>
</table>

TABLE 4. Comparisons of hand surgery fellowship programs with female versus male fellowship directors for the 77/89 (87%) of programs that had identifiable fellows.
Poster 75: Incidence and Management of Radial Nerve Palsies in Humeral Shaft Fractures: A Systematic Review

**Category:** Bone and Joint; Nerve; Other Clinical Topics

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes

Level of Evidence: 4

Michael Polmear
Erik Hegeman
John Scanaliato
Leon Nesti
John Dunn

**HYPOTHESIS**
Radial nerve palsies in humeral closed shaft fractures are common with an incidence of 7-17%. Management of radial nerve palsies in closed fractures is often expectant with 70.7% spontaneously recovering within six months. We hypothesize that radial nerve intervention at this time of intervention will improve resolution of palsy.

**METHODS**
A literature search was conducted for studies on radial nerve palsies in humeral shaft fractures from 2000-2018.

**RESULTS**
Literature search resulted in a total of 196 studies, of which 22 met inclusion and exclusion criteria. A total of 4972 humeral shaft fractures were identified with an incidence of 12.2% of primary radial nerve palsies. Operative fixation of humeral shaft fractures occurred in 69.1% (3439/4972). Nonoperative fixation occurred in 30.8% (1533/4972). In the operative group, the incidence of primary radial nerve palsy was 9.5% (329/3439), and the incidence of secondary radial nerve palsy was 4.7% (165/3439). The rate of radial nerve palsy in the nonoperative group was 15.7% (241/1533). The rate of full neurologic recovery in the operative group without exploration was 75.6%, which increased to 88.4% when early or late explorations. In the non-operative group, the rate of recovery without exploration was 95.4% which increased to 96.2% with late exploration. At time of exploration, no neurological intervention was performed in nearly 41% of cases, and the most common finding was no evidence of any nerve lesion (35%), followed by contusion (30%), entrapment (15%), transection (12%), and laceration (8%). Those who underwent neurolysis were more likely to resolve when compared to primary repair or nerve grafting.

**SUMMARY**
- The incidence of primary radial nerve palsies was 12.2% with a high rate of spontaneous radial nerve palsy recovery (85%).
- Radial nerve exploration statistically increased the rate of radial
nerve palsy resolution. · Radial nerve exploration should be considered at the time of operative fixation if there is complete palsy

REFERENCES:
RF: Poster 76: A Function Restoring Intermediate Reconstructive Option for Treatment of Post-Traumatic Wrist Osteoarthritis

Category: Bone and Joint

Treatment
Level of Evidence: 4

Nicholas L Robbins
Frank A. Scott

HYPOTHESIS
Post-traumatic wrist osteoarthritis (OA) in the cartilaginous segment of carpal bones has been found to be attributed to scapho-lunate advanced collapse (SLAC) and post-traumatic non-union scaphoid fracture (SNAC) in 57% of cases. Current options for surgical interventions vary based on patient needs and stage of OA. Treatment has varied from localized osteotomies, partial carpectomies, denervation, proximal row carpectomy (PRC), four corner fusion (4CF), or total wrist arthroplasty/arthrodesis. To date there has been little to no deviation from wrist salvage surgery to a true intermediate option with lasting efficacy. We believe that meniscal allograft arthroplasty interposition carpal bone resurfacing will serve as a viable intermediate function restoring surgical option for stage II and mild stage III SLAC or SNAC wrists.

METHODS
A Cochrane & Pubmed/NCBI literature search was carried out from 1939 to 2020 with key words: wrist osteoarthritis, wrist arthrodesis, proximal row carpectomy, four-corner fusion, meniscal allograft arthroplasty, and meniscal allograft transplantation. Manuscripts were sorted by impact factor and publication date.

RESULTS
PRC & 4CF have exhibited early failure rates ranging from 5%-12%, 50-60% complete pain relief, 50% maintained range of motion (ROM), and 80% grip strength compared to contralateral limb, DASH averages from 7.8 to 31, and mean VAS scores of 2.3-2.9 post-operatively. Shapiro et al. reported a meniscal allograft arthroplasty interposition carpal bone resurfacing repair of trapeziometacarpal joint in 25 joints. A VAS mean score of 7.7 reduction to 0.9 (p<0.01), increase in grip strength by 28.6% from baseline (p=0.8), and a DASH mean of 42.1% improvement. By similar technique Hoang et al. evaluated a small cohort of SLAC (n=4) and SNAC (n=1) wrists. These exhibited a VAS score reduction of 10 to 0.8 (p<0.01) and total arc ROM improvement of 45-degrees post-operatively (p<0.01).

SUMMARY
With no validated intermediate function restoring procedure for SLAC/SNAC wrists, a meniscal allograft arthroplasty procedure could hold immense promise for the lower grade disease. This is an experimental procedure that our institution will evaluate in much greater depth, allowing us and the field to assess clinical outcomes, stability of graft life, physiologic response to the
graft, and cost efficiency to determine its viability. We believe this technique will offer an intermediate function repairing, joint space preserving, and symptom relieving procedure.

REFERENCES:
Dacho, A.K., et al., Comparison of proximal row carpectomy and midcarpal arthrodesis for the treatment of scaphoid nonunion advanced collapse (SNAC-wrist) and scapholunate advanced collapse (SLAC-wrist) in stage II. J Plast Reconstr Aesthet Surg, 2008. 61
RF: Poster 77: The utility of superb microvascular imaging as a diagnostic ultrasound imaging for carpal tunnel syndrome

Category: Nerve

Evaluation/Diagnosis
Level of Evidence: 3

Takeshi Endo
Yuichiro Matsui
Daisuke Kawamura
Atsushi Urita
Mitsuitoshi Ota
Norimasa Iwasaki

HYPOTHESIS
Although previous ultrasonographic (US) studies have mostly focused on morphological changes of the median nerve to confirm the diagnosis of carpal tunnel syndrome (CTS)1, blood flow changes have attracted attention recently2. In this study, we focus on the utility of the superb microvascular imaging (SMI) technique, which can visualize microvascular flow, and hypothesize that SMI can detect the difference of blood flow between persons with CTS and normal subjects.

METHODS
We performed a retrospective analysis of patients suspected of having CTS in a single institution from 2017 to 2019. Both a nerve conduction test (NCT) and US examination were performed for 68 subjects. Patients with recurrent CTS and other neurologic disorders were excluded. From the US findings, we quantified the nerve compression rate and blood flow area using three different methods: color Doppler ultrasound (CDUS), power Doppler ultrasound (PDUS), and SMI. We made group comparisons between CTS and control groups. Correlation analyses among the blood flow area, distal latency and nerve compression rate were also performed.

RESULTS
A total of 27 subjects with CTS and 11 normal subjects were enrolled. There was no significant difference in age and sex between the two groups. The mean distal latency and nerve compression rate were significantly higher in the CTS group (6.6 ms vs 4.2 ms, 39% vs 21%, respectively). The cutoff value of the nerve compression rate was 35% with sensitivity of 77%, specificity of 91% and an area under the ROC curve of 0.81. Though CDUS and PDUS showed no significant differences in the blood flow area, SMI could detect higher blood flow in the CTS group. Interestingly, the blood flow area had no correlation to distal latency or the nerve compression rate.
SUMMARY
• We analyzed morphological and blood flow changes in patients with CTS using US examination. • As expected, the nerve compression rate was significantly higher in the CTS group. • Unlike the conventional Doppler techniques, the SMI technique could visualize enriched microvascular flow in CTS patients.

REFERENCES:
BACKGROUND
A career in hand surgery in the United States requires a one-year Accreditation Council of Graduate Medical Education (ACGME) accredited fellowship following residency training. Different residency specialty programs may vary in case volume. The purpose of this study was to characterize variation in hand surgery training within and between plastic and orthopaedic surgery residents.

HYPOTHESIS
We hypothesize that orthopaedic residents perform more fracture/dislocation surgeries, while plastic surgery residents perform more nerve repairs and amputations.

METHODS
Publicly available hand surgery case logs for graduating orthopaedic and independent plastic surgery residents during the 2010-2011 to 2018-2019 academic years were obtained through the ACGME website. Two-tailed t-tests were used to compare mean case volumes among similar categories and overall case volume between plastic surgery (PRS) and orthopaedic surgery (OS) residents. Intra-specialty variation was assessed by comparing the 90th and 10th percentiles in each procedure category, using a previously described 1000% change in volume as a threshold to demonstrate considerable variability.1 Changes in annual case volume were analyzed via linear regression and analysis of variance to identify patterns in case variability.

RESULTS
6244 orthopaedic and 1070 plastic surgery graduating residents were included. Case distribution is available in Figure 1. The mean case volume for orthopaedic residents was significantly lower than that for plastic surgery residents (OS 247.8, PRS 401.3, p<0.0001). Orthopaedic residents performed more trauma cases (OS 76.7, PRS 54.8, p<0.0001), but fewer nerve repairs (OS 3.3, PRS 28.5, p < 0.0001) and amputations (OS 6.4, PRS 15.8, p<0.0001) (Figure 2). Nerve decompression case volumes were similar between the two specialties (OS 50.2, PRS 47.3, p = 0.34). Case volumes amongst orthopaedic residents varied considerably in
amputations (1278% change), while plastic surgery residents varied in replantation/revascularization procedures (1119% change). Orthopaedic surgery residents demonstrated a significant decrease in case volume variability in manipulation of forearm/wrist (p = 0.03), total wrist/forearm cases (p = 0.009), carpal tunnel releases (p = 0.006), and total nerve cases (p = 0.044), while plastic surgery residents had decreasing variability in amputation (p = 0.04), fracture/dislocation (p = 0.01), replantation/revascularization (p = 0.03), arthroplasty (p = 0.005), and neoplasm (p = 0.04) cases.

SUMMARY
- Orthopaedic residents performed significantly more trauma cases than plastic surgery residents, but fewer overall cases, nerve repairs, and amputations
- Nerve decompression case volumes were similar between specialties
- There is an overarching trend towards decreasing case volume variability in either specialty
- This information could help inform fellowship directors regarding areas of training deficiency

REFERENCES:
Figure 2: Mean total case volume (A) and mean case volume for four comparable categories (B-E) between plastic surgery (PRS) and orthopaedic surgery (Ortho) residents during the entirety of residency training from academic years 2010-2011 to 2018-2019. (F) Mean volume of microsurgery cases completed by Ortho residents during their training. Standard deviations marked with vertical bars, when the data was available. Significant differences ($p<0.05$) noted in mean case volumes for the following categories over the entire study period: amputation, fracture/dislocation, and nerve repair. *denotes $p<0.05$ for analysis of variance of linear regression trend over time.
RF: Poster 85: Consenting Patients for Excision of Guyon's Canal Tumors

Category: Bone and Joint; Nerve; Other Clinical Topics

Evaluation/Diagnosis; Patient Education; Residents/Fellow/Educator Resources

Level of Evidence: 4

Amanda Spielman
Becher Alhalabi
Teanoosh Zadeh
Anne-Sophie Lessard

HYPOTHESIS
Limited literature reviewing the incidence of benign and malignant lesions of Guyon's canal interferes with pre-operative planning and consenting patients.

METHODS
A systematic search of the literature was done related to lesions causing ulnar nerve compression at the wrist.

RESULTS
48 articles involving 78 tumors were found. Motor deficits were present in 31 (37.3%) patients; 39 cases (57.4%) involved the right hand. Swelling was present in 29 (48.3%) and 17 (44.7%) had a positive Tinel's sign. Most cases were treated by complete surgical excision (n=71, 85.5%). The most common lesions described included ganglion cysts (n=36, 43%), lipomas (n=12, 14.5%), giant cell tumors of the tendon sheet (GCTTS) (n=9, 10.8%), and schwannomas (n=4, 4.8%).

SUMMARY
- Population data of incidence of Guyon's canal tumors is lacking.
- Tumors of Guyon's canal are similar to tumors of the hand. Schwannomas are the exception, as they are the fourth most common tumor of Guyon's canal but a rare cause of hand tumors.
- Awareness of such differences allows appropriate planning and consenting for Guyon's canal release to improve decision-making

REFERENCES:
HYPOTHESIS
The purpose of this study was to compare scaphoid and lunate kinematics after scapholunate interosseous ligament (SLIL) repair with traditional Kirschner wire (K-wire) fixation or two-tine staple fixation. We hypothesized two-tine staple fixation would more closely approximate physiologic motion of the scaphoid and lunate compared to K-wire fixation.

METHODS
Eight fresh cadaver arms with normal scapholunate (SL) intervals were included and infrared motion capture was used to assess three dimensional kinematics between the scaphoid and lunate as the wrists were moved through a simulated dart throwers motion. Kinematic data was recorded for overall wrist flexion and extension, scaphoid and lunate flexion/extension, and scaphoid and lunate pronation/supination. Kinematic data was recorded for each wrist in four states: SLIL intact, SLIL sectioned, K-wire fixation across SL interval and scaphocapitate joint, and with two-tine Nitinol staple fixation across SL interval. The range of motion in each of the conditions of interest were compared to the normal wrist with SLIL intact using a paired t-test. Strength of the SL staple fixation was evaluated using an axial load machine to assess load to failure of the staple construct at a force simulating a ground level fall.

RESULTS
Range of motion of the scaphoid and lunate with the SLIL intact and SLIL sectioned were similar. K-wire fixation across the SL interval significantly decreased overall wrist range of motion as well as scaphoid and lunate motion in all planes except for scaphoid flexion. Conversely, scaphoid and lunate motion after staple fixation was similar to normal wrists except for a significant decrease in scaphoid extension. Under axial load simulating a ground level fall, three of eight arms demonstrated no failure and none of the failures were due to primary failure of the two-tine staple.
SUMMARY

Two-tine staple fixation across the scapholunate interval provides adequate fixation strength following injury to the scapholunate interosseous ligament as no primary failures of the staple were demonstrated at forces simulating a ground level fall. Staple fixation across the scapholunate interval more closely maintains physiologic motion of the scaphoid and lunate compared to K-wire fixation. Staple fixation of SL interval potentially allows for earlier wrist motion after SLIL repair as it maintains integrity of repair without compromising the majority of physiologic scaphoid and lunation motion.

REFERENCES:


Figure 3- Position of scaphoid and lunate through wrist range of motion in normal, after sectioning of SLIL, with K-wire placement and SLIL sectioned, and with Nitinol staple placement and SLIL sectioned.
RF: Poster 93: The Functional Range of Motion in the Elite Professional Musician

Category: Bone and Joint; Tendon; Other Clinical Topics

Evaluation/Diagnosis; Patient Education; Outreach/Volunteerism
Level of Evidence: 4

Michael J Moses
Devin Ganesh
O. Alton Barron

HYPOTHESIS
Musicians are better known as “micro motor athletes.” Their profession requires fine motor coordination, digit independence, great stamina, and flexibility. Instruments vary widely in their requirements for unique hand, wrist and elbow positioning but also vary for the right and left upper extremities. We hypothesize that elite, professional musicians will have a wide, instrument-specific functional range of motion needed. This is the first such report in the current literature.

METHODS
Thirteen members of the New York Philharmonic were examined. The instruments included were the: bassoon, French horn, oboe, tuba, standard violin, viola, cello, clarinet, and trombone. Goniometric analysis was performed on the musicians. Attention was paid to the extreme positions of the shoulder, elbow, wrist and hand required during playing. In addition, photographic and video documentation was obtained for retrospective analysis of the various joint positions.

RESULTS
The range of shoulder motion varied greatly depending on the instrument. Ninety degrees of abduction was required for the trombone and tuba, where the dominant shoulder was often held statically in this position during playing. The smaller and standard hand-held string instruments (violin, viola) required dynamic shoulder abduction and flexion at a maximum of 90 and 45 degrees, respectively. The relatively narrow dynamic motion arcs, however, are maintained for extended periods of time. The cello similarly requires 90 degrees of abduction for both upper extremities. The French horn and oboe required less than 40 degrees of abduction. The maximum arc of right elbow motion was required by the trombone, with motion from up to full extension to 120 degrees of right elbow flexion required to maneuver the slide. The most extreme wrist position was observed to be in the left arms of the violinist and violist, especially during tremolo and pizzicato, both of which required 100 degrees of forearm hypersupination and 70 degrees of wrist flexion at high position. Maximum elbow flexion of 150 degrees was required at the low position on the cello.
SUMMARY
• Elite musicians represent a unique patient population that is often treated by upper extremity surgeons, though there is a paucity in the literature regarding their functional range of motion across instruments • This is the first study documenting the functional range of motion of elite musicians • This data is important for surgeons treating this patient population in order to better understand pathology, injury, recovery, and eventual return to play
HYPOTHESIS
Despite near equal representation of women in medical schools since 2008, the percentage of women in surgical subspecialties has remained low. Hand surgery accounts for one of the highest percentages of women at 19%, with a steady growth entering the specialty. Ascension to leadership positions has not yet been fully elucidated among this group. Using membership data obtained through the American Society for Surgery of the Hand (ASSH), our study examines whether increased female representation translated to representation at different levels within the organization.

METHODS
The 2014-2018 membership rosters were obtained from ASSH and compared by sex. Leadership and volunteer committee positions were evaluated as published in the annual ASSH Committee Reference Book. Leadership positions were defined as appointment to committee chair, Council or acceptance to the young leader’s program, a development program for Candidate and Active members.

RESULTS
Between 2014 and 2018, the percentage of female ASSH members steadily increased from 14% to 17%. The average percent of female members who applied for committee positions was 22% with an average of 18% of applicants occupying a committee position. The average number of committee applications submitted per female applicant was similar to that of their male counterparts (1.31-2.00 vs 1.55-1.97, respectively). Ascension of female members to council ranged from 8%-31% with the highest percentage during 2015 to 2016.

SUMMARY
• There is a steady increase in the percentage of women at every level of ASSH. Female ASSH members are applying for leadership positions at a higher rate than their male peers and are advancing through the leadership ladder more quickly. • This may indicate that future women leaders are appropriately supported in the organization • Low representation at the highest levels may be due to a predictable time lag as younger women ascend in the organization.
REFERENCES:
RF: Poster 95: The Use of Cadaveric Meniscus for Joint Resurfacing of the Wrist and Hand

Category: Bone and Joint

Surgical Technique; Prognosis/Outcomes
Level of Evidence: 4

Dr. Meghan Claire McCullough
David Kulber
Michael Sun

HYPOTHESIS
Osteochondral defects of the carpometacarpal (CMC), metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints often necessitate joint arthrodesis or mechanical arthroplasty. Cadaveric meniscus has long been used for large joint resurfacing, but its application to smaller joints of the hand is less well understood. In severely arthritic thumb and finger joints, we propose the use of cadaveric meniscus for joint resurfacing as an off-the-shelf alternative to address osteochondral defects and restore articular function.

METHODS
Thirty-six patients with osteoarthritis of the CMC, MCP or PIP joints underwent joint resurfacing with cadaveric meniscus. Patient demographics and operative information were recorded. Postoperative DASH (Disability of the Shoulder, Arm and Hand) scores, Wong-Baker pain scale score, grip strength and pinch strength were compared to preoperative scores at 6 weeks and 6 months.

RESULTS
Twenty-one females and 15 males, with mean age of 56.7 years (42-73), underwent a total 43 joint reconstructions. Reconstructive sites included thumb carpometacarpal joint (n=21), thumb metacarpal joint (n=2), thumb interphalangeal joint (n=2), digit metacarpal joint (n=3) and digit proximal interphalangeal joint (n=2). Mean DASH score decreased from an average of 39.2 (16-91) to 22.7 (3-55) at 6 months and pain scale scores decreased from an average of 6.5 (4-10) to 1.6 (0-4). Grip strength increased from 38.7 (3-84) to 44.5 (8-94) and pinch increased from 10.3 (1-19) to 10.7 (2-20). There were no complications related to the meniscus and no patients required revision surgery.

SUMMARY
• We demonstrate the successful use of cadaver meniscus in hand joint arthroplasty to reduce subjective pain and disability scores, as well as to improve objective strength measures, including grip and pinch strength. • Results suggest that cadaveric meniscus for small joint arthroplasty represents a viable joint salvage option or adjunct to preserve pain-free motion and avoid total joint arthrodesis
REFERENCES:
RF: Poster 96: Machine Learning-Aided Diagnosis Enhances Human Detection of Perilunate Dislocations

Category: Bone and Joint; Miscellaneous Nonclinical Topics

Evaluation/Diagnosis; Residents/Fellow/Educator Resources
Level of Evidence: 3

Anna Luan, MD, MS
Lisa von Rabenau, MS
Bao H. Do, MD
James Chang, MD
Brian C. Pridgen, MD

HYPOTHESIS
We hypothesize that utilization of a machine learning algorithm can improve human detection of perilunate dislocations.

METHODS
A machine learning algorithm was previously developed for evaluation of wrist radiographs. In order to validate its performance, a questionnaire study was performed asking human participants from emergency medicine, hand surgery, and radiology to evaluate for presence of a perilunate dislocation on 30 distinct lateral wrist radiographs with and without the use of the tool, which labeled the lunate as identified by the algorithm (Figure 1). Human performance with and without the machine learning tool was evaluated using accuracy, sensitivity, specificity, and total response time. A two-tailed paired student’s t-test was conducted to compare results.

RESULTS
Of 241 potential participants, a 16.6% response rate was achieved. There were 24 respondents from Emergency Medicine, 6 from Radiology, and 10 from Hand Surgery. Nine were attending physicians, 3 were fellows, and 28 were residents. Use of the machine learning tool improved accuracy from 89.3% to 92.7% (p < 0.01), specificity from 87.5% to 94.0% (p < 0.01), and resulted in a 28.3% reduction in total diagnosis time (p < 0.000001); sensitivity remained unchanged at 91.2 vs 91.5%. When stratified by training level, attending physicians and fellows had no statistical change in performance, but they did have a 32.2% reduction in time to diagnosis (p < 0.05). For residents of all levels, use of the machine learning tool resulted in improved accuracy from 86.8% to 91.1% (p < 0.01), specificity from 84.8% to 91.8% (p < 0.01), and a 26.6% reduction in diagnosis time (p < 0.00001) (Figure 2). Finally, while surgery and radiology residents lagged behind attendings in accuracy (90.6% vs. 99.2%, p < 0.001), sensitivity (96.4% vs. 100%, p < 0.05), and specificity (84.8% vs. 98.3%, p < 0.001) at baseline, use of the machine learning tool improved their diagnostic abilities to eliminate any statistical difference from attendings across all measures.
SUMMARY
· Use of a machine learning tool improves resident accuracy and specificity for radiographic
detection of perilunate dislocations and time to diagnosis for all training levels. · For surgery
and radiology residents, the machine learning tool improves accuracy, sensitivity, and
specificity of detection of perilunate dislocations to match that of attending physicians. · This
machine learning tool may help to 1) decrease misdiagnosis of perilunate dislocations,
particularly when attending evaluation is delayed and 2) decrease the time required for
diagnosis at all training levels.

Figure 1. Sample of lateral wrist radiographs presented to participant for
diagnosis of presence or absence of perilunate dislocation, in which they were
presented with either A) an unlabeled radiograph, or B) a radiograph labeled with
a box around the lunate generated by a machine learning algorithm to predict the
lunate position.
Figure 2. Sensitivity, specificity, accuracy, and total time to diagnosis of perilunate dislocation by attendings, fellows, and residents at baseline and with utilization of machine learning algorithm. Data represent mean and 95% CI. * p < 0.05, ** p < 0.01, *** p < 0.001.
RF: Poster 99: Prospective Analysis Comparing Arthroplasty with Cadaveric Meniscus versus Trapezial Resection Alone in Basilar Joint Arthritis

Category: Bone and Joint

Treatment; Surgical Technique; Prognosis/Outcomes
Level of Evidence: 4

Dr. Meghan Claire McCullough
David Kulber
Michael Sun

HYPOTHESIS
Advanced thumb carpometacarpal (CMC) joint arthritis is widely treated with trapeziectomy. To obviate the need for autologous tissue, maintain thumb length and reduce the risk of scaphoid impingement, the senior author developed an interposition arthroplasty technique using cadaveric meniscus. We hypothesize that the use of meniscus improves the subject’s outcome and subsequent functionality of the basilar joint arthroplasty procedure when compared with trapeziectomy alone.

METHODS
Twenty-one patients with Eaton stage III-IV CMC osteoarthritis underwent arthroplasty with cadaveric meniscus and seven patients underwent trapeziectomy alone. Postoperative DASH (Disability of the Shoulder, Arm and Hand) scores, Wong-Baker pain scale score, grip strength and pinch strength were compared to preoperative scores at 6 weeks and 6 months for each patient.

RESULTS
The study group with cadaveric meniscus consisted of fourteen females and seven males, and the control group of five females and two males. Mean age was similar between the groups at 61.4 (48-72) years for the study group and 65.7 years (56-78) for the control group. Reduction in mean DASH score from preoperatively to six months postoperatively was statistically significant only in the study group (p<0.05), compared to the control (p=0.148). Reduction in Wong Baker scores was statistically significant in both groups (p<0.05), although there was a more rapid decrease in the study arm. Strength measures similarly improved in both groups, although did not reach significance in either group. There were no surgical complications in either group.

SUMMARY
• Joint resurfacing with cadaveric meniscus represents a viable joint salvage option in severe cases of CMC arthritis. • Early results suggest that when compared to trapeziectomy alone, interposition arthroplasty with cadaveric meniscus results in a greater reduction in subjective pain and disability scores and similar improvement in strength measures.
REFERENCES:
HYPOTHESIS
Traumatic injuries of the hand and upper extremity are common but risk being overlooked due to other distracting injuries and can contribute to morbidity if left unaddressed. We hypothesize that there may be differences in injuries associated with upper extremity trauma based on demographic and incident related variables.

METHODS
Data was collected using the National Trauma Data Bank (NTDB). Patients greater than 18 years of age who presented as a trauma consult to participating hospitals and underwent intervention for their hand or upper extremity injury were selected. These patients were identified based on CPT codes indicating upper extremity interventions. Univariate analysis was performed to identify the five most common ICD codes for non-upper extremity injuries as well as the five most common upper extremity CPT codes. Using the identified ICD codes, bivariate analysis (Chi-square tests for categorical variable and t-tests for continuous variable) was performed and p-values were reported as a measure of significance to evaluate non-upper extremity co-occurring conditions. Significance was tested at 0.05.

RESULTS
A total of 284,700 patients underwent hand and upper extremity intervention between 2011-2016. The mean age was 48.1 years old and the range was 18-97 years old. Of these, 62% were male and 38% female. The most common upper extremity procedures included open reduction and internal fixation (ORIF) of the radius and ulna, ORIF of the humerus, closed reduction without internal fixation of the radius and ulna, debridement of open radius or ulna fractures, and ORIF phalanges of the hand. The most common non-upper extremity conditions associated with operative upper extremity trauma included lung contusion, lumbar vertebra fractures, and traumatic pneumothorax, along with various other contusions and abrasions.

SUMMARY
• Lung contusion, lumbar vertebra fractures, traumatic pneumothorax, and head and neck contusions are the injuries most commonly associated with operative upper extremity trauma.
• Understanding the most common upper extremity interventions performed and the associated non-upper extremity injuries may help streamline consultation to the hand surgeon.
for definitive care. • Knowledge of the demographics of those commonly affected by upper extremity trauma is important in providing optimal care.

REFERENCES:
Committee on Trauma, American College of Surgeons. NTDB. Chicago, IL, revised 2018. The content reproduced from the NTDB remains the full and exclusive copyrighted property of the American College of Surgeons. The American College of Surgeons is not respo
RF: Poster 103: Adjunct Modalities in Trauma and Burn Hand Surgery

Category: Skin and Soft Tissue

Treatment
Level of Evidence: 4

Dr. Danielle Thornburg
Scott Swanson
Areta Kowal-Vern
Arpana Jain
Kevin Foster
Marc Matthews

HYPOTHESIS
autologous flap coverage and native soft tissue coverage remain the mainstay of hand and plastic surgery reconstruction, therapies traditionally used in advanced wound care, cosmetic dermatology, aesthetic plastic surgery, and burn surgery have permeated into hand reconstruction and serve as valuable adjuncts that can be added to one’s armamentarium.

METHODS
A retrospective chart review was performed for three patients treated at the Arizona Burn Center and Valleywise Health Medical Center in Phoenix, Arizona by the trauma, burn and hand surgery teams.

RESULTS
A thirty-two-year-old male sustained a third-degree contact burn to his right palmar surface and underwent treatment with tangential excision and debridement followed by placement of a split-thickness skin graft (STSG). He developed a hypertrophic scar, limiting motion. Fractionated CO2 laser scar ablation with intralesional steroid injection provided significant functional improvement. A forty-year-old female presented with segmental bone and muscle damage in a mangled and crushed left hand. She required multi-digit revision amputations with fillet flap wound coverage and bilayer wound matrix application followed by STSG placement. She is doing well post-operatively without need for further surgical intervention. A forty-two-year-old male in a motor vehicle collision with approximately 31% total body surface partial to full thickness thermal burns, including bilateral hand burns, underwent tangential excision and debridement with skin grafting. He developed a persistent, non-healing wound over his right index proximal interphalangeal joint. Dehydrated human amniochorionic membrane (dHACM) was applied and the wound healed without further interventions.

SUMMARY
- Treatment modalities utilized in other specialties, have been successfully implemented in patients with burns and traumatic injuries. These modalities remain valuable tools in hand reconstruction especially when tissue flaps are not an option due to severity, location, patient...
condition or when a less complex reconstruction is more desirable. ● CO2 laser therapy commonly employed in dermatology and aesthetic plastic surgery has decreased scar tissue formation with improved range of motion and soft tissue compliance. ● The bilayer wound matrix is comprised of collagen and glycosaminoglycan and employed as an artificial matrix for temporary coverage instituting earlier motion and reducing secondary contraction with definitive skin grafting. ● With more than 285 regulatory proteins that reduce inflammation and promote neo-epithelialization, dHACM is an extracellular matrix that is used to promote soft tissue and wound healing.

REFERENCES:
HYPOTHESIS
The purpose of this study was to determine if workers compensation (WC) status influences Press Ganey (PG) patient satisfaction survey results in an outpatient orthopedic population of patients with upper extremity complaints. Specifically, we wanted to know: 1) is there a lower satisfaction rate in patients with WC status compared to those without WC status, 2) is there a difference in satisfaction rate in patients with private, Medicaid, or Medicare payors, and 3) does distance traveled to appointment influence satisfaction rates of patients?

METHODS
Patients seen in an outpatient academic orthopedic upper extremity (UE) clinic from January 5, 2015 to April 10, 2018 were included in this retrospective cohort study. Patients were seen by fellowship trained Shoulder and Elbow and Hand/Upper Extremity surgeons at a Level I trauma and tertiary referral center. Demographic data including age, race, gender, marital status, primary payer, workers compensation (WC) status, and native language were obtained. All patient surveys were administered by Press Ganey (PG) Associates, the largest provider of tools for patient satisfaction measurement and analysis. Administration of the surveys was per internal protocols adhering to the institutional contract with PG Associates. Patients were categorized as satisfied if they provided a “top-box”, or highest rating, when asked if they would recommend the practice to others.

RESULTS
During the study period, 753 consecutive patients generated 950 surveys of outpatient encounters generated PG survey data. 117 patients were WC patients, who generated 148 surveys. Overall, 581 patients (77.1%) were considered satisfied. WC patients were less likely to be satisfied when compared to privately insured patients (OR 2.87 [95% CI 1.80-4.59], p<0.0001), Medicare patients (OR 3.79 [95% CI 2.22-6.45] p<0.0001), or Medicaid patients (OR 2.41 [95% CI 1.21-4.80], p=0.013). There was no difference between the privately insured, Medicare patients, or Medicaid patient payor groups (p>0.05).
SUMMARY
WC status is a non-modifiable risk factor for dissatisfaction with health care as compared to other primary payer groups, measured by standard patient satisfaction surveys. Payor type, in particular WC status, significantly influences PG patient satisfaction survey results in an outpatient orthopedic population of patients with upper extremity complaints.

Table 1: Payor Type Comparison

<table>
<thead>
<tr>
<th>Payor</th>
<th>OR</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WC vs Private</td>
<td>2.87</td>
<td>1.80-4.59</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>WC vs MedC</td>
<td>3.79</td>
<td>2.22-6.45</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>WC vs MedD</td>
<td>2.41</td>
<td>1.21-4.80</td>
<td>0.013*</td>
</tr>
<tr>
<td>MedC vs Private</td>
<td>0.76</td>
<td>0.48-1.20</td>
<td>0.24</td>
</tr>
<tr>
<td>MedD vs Private</td>
<td>1.19</td>
<td>0.63-2.25</td>
<td>0.59</td>
</tr>
<tr>
<td>MedD vs MedC</td>
<td>1.57</td>
<td>0.79-3.11</td>
<td>0.19</td>
</tr>
</tbody>
</table>

WC: workers compensation patients; MedC: Medicare patients; MedD: Medicaid patients; Private: privately insured patients; OR: odds ratio; CI: confidence interval; * indicates significance

Table 2: Comparison Based on Various Patient Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>OR</th>
<th>95% CI</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender: Male vs. Female</td>
<td>0.85</td>
<td>0.60 - 1.22</td>
<td>0.38</td>
</tr>
<tr>
<td>Surgical order: Yes vs No</td>
<td>1.56</td>
<td>0.92 - 2.64</td>
<td>0.1</td>
</tr>
<tr>
<td>Lives within 30 miles: Yes vs No</td>
<td>1.03</td>
<td>0.70 - 1.51</td>
<td>0.87</td>
</tr>
<tr>
<td>Lives within 60 miles: Yes vs No</td>
<td>0.96</td>
<td>0.67 - 1.37</td>
<td>0.82</td>
</tr>
<tr>
<td>Lives within 120 miles: Yes vs No</td>
<td>1.77</td>
<td>0.81 - 3.90</td>
<td>0.15</td>
</tr>
<tr>
<td>Method of Administration: Paper vs Internet</td>
<td>1.15</td>
<td>0.85 - 1.56</td>
<td>0.37</td>
</tr>
</tbody>
</table>

OR: odds ratio; CI: confidence interval; * indicates significance (p < 0.05)
RF: Poster 107: An Analysis of Carpal Fractures in the National Trauma Data Bank: Incidence and Characteristics

Category: Bone and Joint; Other Clinical Topics

Evaluation/Diagnosis
Level of Evidence: 2

Juston Fan
Ryne Jenkins
Roy Caputo

HYPOTHESIS
Carpal fractures are rare fractures making up 18% of hand fractures. Scaphoid fractures are well known as the most common type among carpal fractures however reported rates in current literature range from 50% to 70%. Few studies exist investigating the overall incidence of carpal fractures. The purpose of our study was to identify the incidence and characteristics of carpal fractures among trauma patients. We also hypothesize that multiple carpal fractures are seen in younger patients with higher injury severity scores (ISS) among trauma patients.

METHODS
A retrospective analysis of patients with carpal fractures from the National Trauma Data Bank (NTDB) from years 2007 to 2016 was completed. ICD-9 codes were used to identify patients with carpal fractures. ICD-9 codes included fractures of the scaphoid, lunate, triquetral, pisiform, hamate, capitate, trapezium, trapezoid, unspecified carpal bones and multiple carpal bones. Basic patient demographics were collected. Incidence of carpal fractures was assessed with associated injury severity score (ISS), age and drug use. Cases with unspecified fractures were excluded from analysis of overall incidence among carpal fractures.

RESULTS
7,741,756 trauma cases were present in the NTDB from years 2007 to 2016. There were 41,323 reported cases of carpal fractures with a relative incidence of 0.005%. Average age was 41.9 years old and ISS was 11.6. Carpal fracture incidence is displayed in Table 1. The highest relative incidence among all carpal fractures was scaphoid fractures (46%) and then triquetrum fractures (23%). 11% of both open and closed fractures were positive for illegal drug use. 17% of open lunate fractures and 15.4% of open pisiform fractures were positive for illegal drug use. Compared to patients with isolated fractures, patients with multiple fractures were younger (mean 34.8, 37.9) for both open and closed fractures respectively. Interestingly, patients with multiple carpal fractures did not have higher injury severity scores than those with one isolated fracture (12.3 vs 11.9).

SUMMARY
· In the National Trauma Data Bank, from 2007 to 2016, carpal bone fractures were rare, with an incidence of 0.005% and the most common being scaphoid fractures with a relative
incidence of 46% among all carpal fractures. Current literature overestimates the relative incidence of scaphoid fractures among carpal fractures. Patients who sustained multiple carpal fractures were younger overall but were not associated with higher ISS.

REFERENCES:

<table>
<thead>
<tr>
<th>Table 1. Carpal Fracture Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scaphoid</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Total count</td>
</tr>
<tr>
<td>Incidence among trauma population*</td>
</tr>
<tr>
<td>Incidence among all carpal fractures*</td>
</tr>
</tbody>
</table>

*Incidence expressed as percentages

*Unspecified fractures were excluded from analysis
RF: Poster 112: Higher than Expected Rates of Distal Radio-Ulnar Joint Fixation in Radial Shaft Fractures: Location of Fracture Matters  
*Category: Bone and Joint; Skin and Soft Tissue; Tendon*

Evaluation/Diagnosis; Prognosis/Outcomes  
Level of Evidence: 2

Joanne Zhang  
Aneesh Samineni  
David Sing  
Alyssa Rothman  
Andrew Stein

**HYPOTHESIS**  
The prevalence of associated distal radio-ulnar joint (DRUJ) injury in the setting of isolated radial shaft fracture has been previously described to be around 11%. The purpose of this study was to evaluate rates of DRUJ fixation based on location of the radial shaft fracture and risk factors associated with postoperative complications following radial shaft open reduction internal fixation (ORIF). We hypothesize that the rate of DRUJ fixation increases with more distal fractures.

**METHODS**  
Adult patients who underwent isolated radial shaft ORIF from 2014 to 2018 were identified from American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database and stratified by location of fracture as well as by presence or absence of DRUJ fixation. Preoperative patient characteristics and postoperative complications were compared to determine risk factors associated with DRUJ fixation.

**RESULTS**  
We identified 1,517 patients who underwent radial shaft ORIF, of which 396 (26.1%) underwent DRUJ fixation. Preoperative patient characteristics and postoperative complications were similar between cohorts. Mean operative time for DRUJ fixation was greater than without DRUJ fixation for radial shaft ORIF (86.5 vs 77.5 min, *p*<0.001). Radial shaft fracture location was available via ICD coding for 1,061 patients: DRUJ fixation was performed in 50 of 163 (30.7%) distal radial shaft fractures, 191 of 875 (21.8%) midshaft fractures, and 3 out of 23 (13.0%) proximal shaft fractures (*p*=0.025). Risk factors for patients readmitted include being male (OR: 12.76, 95% CI 1.88-86.93, *p*=0.009) and older age (≥70 vs <50) (OR: 4.99, 95% CI 1.12-22.31, *p*=0.035). Risk factors for patients with any postoperative complication include dependent functional status (OR: 6.78, 95% CI 1.35-34.16, *p*=0.02), older age (50-69 vs <50) (OR: 2.73, 95% CI 1.01-5.91, *p*=0.047).
SUMMARY
• In this large national multicenter analysis, the rate of DRUJ fixation in isolated radial shaft ORIFs exceeded previously reported rates of concomitant DRUJ injury, especially among distal radial shaft fractures. • More distally-located radial shaft fractures are significantly associated with higher rates of DRUJ fixation; male sex and older age are risk factors for readmission while dependent functional status, older age, and ASA≥3 are risk factors for postoperative complications. • Fixation of the DRUJ was not associated with a difference in perioperative outcomes, other than increasing operating time by an average of 9 minutes. • Establishing uniform guidelines on how to best assess DRUJ instability may help in clarifying indications for DRUJ fixation.

REFERENCES:

| Table 1. Preoperative Patient Characteristics, Radial Shaft ORIF |
|---------------------------------|------------------|------------------|-----------------|
|                                | Total            | Distal Radioulnar Joint Fixation, n (%) | No Distal Radioulnar Joint Fixation, n (%) | P-value |
| Total                          | 1517             | 396 (26.1)       | 1121 (73.9)     |         |
| Age                            |                  |                  |                 |         |
| ≤50                            | 812 (54)         | 222 (56.1)       | 590 (53.3)      | 0.362   |
| 50-69                          | 510 (33.9)       | 123 (31.1)       | 387 (35)        |         |
| ≥70                            | 181 (12)         | 51 (12.9)        | 130 (11.7)      |         |
| Sex                            |                  |                  |                 |         |
| Female                         | 710 (46.8)       | 182 (46)         | 528 (47.1)      | 0.739   |
| Male                           | 807 (53.2)       | 214 (54)         | 593 (52.9)      |         |
| Distal Radio-ulnar Joint Fixation|                |                  |                 |         |
| No DRUJ Fixation               | 1121 (73.9)      | 0 (0)            | 1121 (100)      | <0.001  |
| Perc DRUJ Fixation             | 233 (15.4)       | 233 (58.8)       | 0 (0)           |         |
| Open DRUJ Fixation             | 163 (10.7)       | 163 (41.2)       | 0 (0)           |         |
| Obesity class (kg/m^2)         |                  |                  |                 |         |
| Non-obese (18.5-30)            | 941 (70.1)       | 228 (67.9)       | 713 (70.9)      | 0.481   |
| Underweight (<18.5)            | 19 (1.4)         | 4 (1.2)          | 15 (1.5)        |         |
| Obese (≥30)                    | 382 (28.5)       | 104 (31)         | 278 (27.6)      |         |
| ASA Class                      |                  |                  |                 |         |
| 1-2                            | 1219 (80.9)      | 310 (79.9)       | 909 (81.2)      | 0.616   |
| ≥3                             | 288 (19.1)       | 78 (20.1)        | 210 (18.8)      |         |
| Hypertension                   | 310 (20.4)       | 79 (19.9)        | 231 (20.6)      | 0.837   |
| History of diabetes            | 104 (6.9)        | 34 (8.6)         | 70 (6.2)        | 0.142   |
| History of pulmonary disease   | 42 (2.8)         | 5 (1.3)          | 37 (3.3)        | 0.052   |
| History of cardiac disease     | 6 (0.4)          | 2 (0.5)          | 4 (0.4)         | 1       |
| History of smoking             | 350 (23.1)       | 89 (22.5)        | 261 (23.3)      | 0.796   |
| Chronic steroid use            | 29 (1.9)         | 6 (1.5)          | 23 (2.1)        | 0.648   |
| Non-independent functional status | 12 (0.8)    | 4 (1.5)          | 8 (0.7)         | 0.8     |

ASA: American Society of Anesthesiologists; ORIF: Open Reduction Internal Fixation; Percentages reported in parentheses.
<table>
<thead>
<tr>
<th>Outcome/Risk Factor</th>
<th>Odds Ratio (95% Confidence Interval)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Readmission</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional status: Dependent vs. Independent</td>
<td>13.7 (0.92,204.35)</td>
<td>0.058</td>
</tr>
<tr>
<td>Male vs. female</td>
<td>12.76 (1.88,86.39)</td>
<td>0.009</td>
</tr>
<tr>
<td>History of COPD vs. none</td>
<td>6.03 (0.81,44.93)</td>
<td>0.079</td>
</tr>
<tr>
<td>Age: ≥70 vs. &lt;50</td>
<td>4.99 (1.12,22.31)</td>
<td>0.035</td>
</tr>
<tr>
<td>Smoking vs. not smoking</td>
<td>2.95 (0.89,9.73)</td>
<td>0.076</td>
</tr>
<tr>
<td>Distal Radioulnar Joint Fixation vs No Fixation</td>
<td>2.52 (0.82,7.76)</td>
<td>0.107</td>
</tr>
<tr>
<td><strong>Any Complication</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional status: Dependent vs. Independent</td>
<td>6.78 (1.35,34.16)</td>
<td>0.02</td>
</tr>
<tr>
<td>Age: ≥70 vs. &lt;50</td>
<td>3.13 (0.88,11.14)</td>
<td>0.077</td>
</tr>
<tr>
<td>History of COPD vs. none</td>
<td>2.96 (0.97,9.04)</td>
<td>0.056</td>
</tr>
<tr>
<td>Smoking vs. not smoking</td>
<td>2.95 (0.89,9.73)</td>
<td>0.076</td>
</tr>
<tr>
<td>Age: 50-69 vs. &lt;50</td>
<td>2.73 (1.74,44)</td>
<td>0.05</td>
</tr>
<tr>
<td>ASA: ≥3 vs 1-2</td>
<td>2.45 (1.01,5.91)</td>
<td>0.047</td>
</tr>
<tr>
<td>Distal Radioulnar Joint Fixation vs No Fixation</td>
<td>1.22 (0.55,2.7)</td>
<td>0.624</td>
</tr>
</tbody>
</table>

ASA: American Society of Anesthesiology score; BMI: Body Mass Index;
Other risk factors with p value >0.10 not shown
HYPOTHESIS
The INNate intramedullary screw (ExsoMed, Aliso Viejo, CA) will have a higher load to failure (LTF) in both three-point bend (3PB) and axial loading (AX) than crossed Kirschner wire (K-wire) fixation of metacarpal neck fractures.

METHODS
32 fresh frozen ring finger and small finger matched pairs were randomized to either IM screw or .045 Kirschner wire fixation. A standardized neck osteotomy was created in each specimen prior to fixation with either the IMS or crossed K-wires. Proper implant placement was confirmed with plain radiographs. Metacarpals were further randomized to either an axial load or 3-point bending stress (3PB). Load to failure (LTF), stiffness, and fracture displacement was recorded. Failure was defined by either an audible or visual failure of the construct or deflection in the load displacement curve. DEXA scan data was available for each cadaveric specimen. t-tests were performed to identify significant differences between the groups.

RESULTS
The average specimen age was 67 years. Age, gender, sidedness, and digit used was evenly distributed between groups. There was no significant difference in bone density between the two groups. Pin fixation demonstrated plastic deformation in 3PB between 75-150 N. The intramedullary screw (IMS) had a significantly higher LTF than pins in 3PB (546 vs 154 N, p<0.001), however it had a lower LTF in axial loading (405 vs 634 N, p = 0.012).

SUMMARY
Retrograde intramedullary screw fixation has emerged as a popular alternative to K-wire fixation for metacarpal neck fractures with good early clinical outcomes while allowing earlier weight bearing and return to activity. When surgical fixation is indicated for metacarpal neck and shaft fractures, the INNate IM screw (ExsoMed, Aliso Viejo, CA) provides a biomechanically superior option to crossed K-wires to maintain length and alignment with application of both three-point bend and axial load for axially stable fractures.
REFERENCES:

Figure 1: Load to failure of k-wires and intermediullary (IM) nails in 3-point bending (3-PB) and metacarpal long axis compression (Axial). There was a significant difference in 3-PB (*, p<0.001) and Axial compression (**, p=0.012).
HYPOTHESIS
We hypothesized that passive thumb MP hyperextension has no correlation with dynamic MP position during pinch and grasp functional activities in patients with concurrent first CMC joint arthritis. Secondarily, we believed that pinch strength would not be correlated to passive MP joint position but instead to active MP joint position.

METHODS
Cross-sectional analysis of patients with thumb CMC arthritis was performed. Measurements of passive thumb MP hyperextension and dynamic thumb MP position during lateral key pinch, jar grasp, and cap grasp were collected. Additionally, pinch strength and level of pain at rest and during pinch activity using a VAS scale were recorded. Subgroup analysis was performed for patients with passive MP hyperextension <30 and ≥30 degrees.

RESULTS
Thirty-three patients were enrolled in our observational study. Average passive MP hyperextension was 28 degrees (range 55 flexion – 88 hyperextension). A poor correlation was appreciated between passive MP hyperextension and MP position during dynamic activities. No difference was seen between the two subgroups (<30 and ≥30 degrees passive hyperextension) when comparing average MP joint position during dynamic key pinch and dynamic jar grasp. However, there was a significant difference between the two subgroups when comparing average MP joint position during dynamic cap grasp, though both positions were in flexion (m=24° and m=9°). Poor correlation was also seen between MP position during dynamic pinch activity and pinch strength. Furthermore, no difference in pinch strength was seen between patients with and without dynamic control (dynamic MP position £0). Finally, there was no difference seen in pinch strength between patients with passive MP joint hyperextension <30 vs ≥30 degrees.
SUMMARY

- Passive MP hyperextension had little correlation with both dynamic MP position and pinch strength.
- Majority of patients in our study functionally position their thumb MP in position of flexion, despite an average passive hyperextension of 28 degrees.
- Passive MP hyperextension may not be the optimal parameter to indicate the need for MP stabilization in patients undergoing treatment for CMC arthritis.
HYPOTHESIS
Injury to the TFCC is a frequent cause of pain and disability in the collegiate athlete. The purpose of this study was to evaluate time of return to play in college athletes undergoing arthroscopic repair of peripheral TFCC tears.

METHODS
Using corresponding current procedural terminology code 25107, a retrospective chart review was conducted from 2015-2019 at the author’s institution. Inclusion criteria included collegiate athletes with peripheral TFCC tears undergoing arthroscopic repair after a failure of nonsurgical interventions. Charts were reviewed to ascertain the mechanism of injury, repair technique, time to return to play, and complications.

RESULTS
A total of 7 college athletes with peripheral TFCC arthroscopic repairs were identified. 5 were female, and the most common sport was softball (3/7). Age range was 19-22 years. 5 injuries were on the nondominant hand. 4/7 (57%) were repaired with suture anchors, 3/7 (42%) with either 3-0 prolene or PDS sutures. On average, athletes returned to their previous level of play at 7.8 weeks (range 6-10) after routine postoperative immobilization and rehabilitation. One patient developed a dorsal wrist ganglion cyst requiring re-operation.

SUMMARY
• All subjects successfully underwent arthroscopic repair of peripheral TFCC lesions • All patients returned to their level of previous level of play • Return to play was achieved 7-8 weeks postoperatively

REFERENCES:

<table>
<thead>
<tr>
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<th>Sex</th>
<th>Age</th>
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<th>Repair technique</th>
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<tr>
<td>1</td>
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<td>Softball</td>
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<td>Tennis</td>
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<td>M</td>
<td>20</td>
<td>Basketball</td>
<td>2.9 Pushlock Anchor</td>
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RF: Poster 125: Dynamic MRI for ECU Instability

Category: Tendon

Level of Evidence: 3

Mohamed Salar
Marc Kaye

HYPOTHESIS
The primary purpose of this study is to demonstrate that adding a supination view to the standard MRI wrist series increases the diagnostic potential of MRI in regard to identifying Extensor carpi ulnaris (ECU) instability. The secondary purpose is to investigate if ulnar head edema, ECU tendinosis and ECU tenosynovitis are associated with ECU instability.

METHODS
An internal retrospective review of wrist MRI examinations were reviewed over two phases. The first period entailed evaluation of static wrist MRIs. The second period included the same wrist MRIs but with inclusion of a dynamic supinated series. We compared the two phases’ ECU subluxation/dislocation incidence. We also investigated any potential association of ulnar head edema, ECU tendinosis or ECU tenosynovitis with ECU instability incidence.

RESULTS
The addition of the supination series to the standard MRI demonstrated a statistically significant increase in the likelihood of the radiologists reporting ECU instability. The radiologist were 26 times more likely to read ECU dislocation with the supination series. Ulnar head edema, ECU tendinosis and ECU tenosynovitis were not associated with ECU instability.

SUMMARY
• ECU subluxation/dislocation presents an especially challenging diagnosis as it is frequently missed on standard MRI imaging • MRI supination series should be added to wrist MRI examination for evaluation of ulnar sided wrist pain with suspected ECU instability • The addition of the supination series allowed the radiologist to be 26 times more likely to read ECU dislocation than without it

REFERENCES:

RF: Poster 126: Retrograde Intramedullary Screw Fixation for Metacarpal Fractures: A Systematic Review

Category: Bone and Joint

Treatment; Surgical Technique; Prognosis/Outcomes
Level of Evidence: 4

Genoveffa R. Morway
Taylor RIder
Christopher M. Jones

HYPOTHESIS
Common forms of fixation of metacarpal fractures have historically included percutaneous Kirschner (K) wire fixation, plates-and-screws, and more recently, intramedullary screw fixation. Retrograde intramedullary screws (RIS) are a novel modality first described 10 years ago. The purpose of this review is to critically evaluate the published literature assessing outcomes of RIS fixation for metacarpal fractures and create a complication profile for this novel technique. We hypothesize that with the correct indications, RIS is a technically simple operation that demonstrates satisfactory outcomes.

METHODS
A comprehensive literature search was performed using electronic databases for both clinical and biomechanical studies in relation to RIS fixation published from 2000-2020. Clinical studies were assessed for use of RIS in metacarpal fractures, evaluation of clinical outcomes including grip strength, DASH score, total active motion, etc., and level of evidence 4 or better. Biomechanical studies were assessed for use of RIS, evaluation of biomechanical parameters including load-to-failure, and level of evidence 5 or better.

RESULTS
A total of 19 studies (13 clinical and 6 biomechanical) met the inclusion criteria. The clinical studies examined 603 metacarpal fractures and demonstrated adequate functional outcomes in terms of grip strength, total active motion, and time to return to work. The biomechanical studies examined 80 metacarpal fractures, finding that load-to-failure in RIS was often equal to or higher than K wires but less than plate and screws. The complication rate in reviewed studies was 2.8%, with the most prevalent complications being stiffness and extension lag.

SUMMARY
The use of retrograde intramedullary screws for fixation of metacarpal shaft or neck fractures is a novel technique that has shown satisfactory clinical outcomes. Biomechanical data is varied for RIS, though demonstrates adequate stability that is at least equal to K wires but less than plate and screws. The complication rate in reviewed studies was 2.8%, with the most prevalent complications being stiffness and extension lag. Most current articles consist of retrospective...
reviews, additional prospective and high power studies are needed to compare the efficacy of RIS to traditional methods of fixation.

REFERENCES:
RF: Poster 214: Dynamic Measurements of Thumb Circumduction in Patients with First Carpometacarpal Joint Arthritis Using a Wearable Motion Sensor

Category: Bone and Joint

Evaluation/Diagnosis
Level of Evidence: 3

Viviana M. Serra Lopez
Rikesh A. Gandhi
David P. Falk
Josh Baxter
John Lien
Benjamin L. Gray

HYPOTHESIS
Wearable motion sensors can be used to characterize thumb circumduction in patients with first carpometacarpal (CMC) joint arthritis.

METHODS
This is a prospective study performed in an outpatient clinic setting at an urban academic center. After Institutional Board Review approval was obtained, patients with radiographic and clinical evidence of first CMC joint arthritis were enrolled after written informed consent was obtained. Baseline data were obtained from all subjects, including age, hand dominance and previous treatments for thumb CMC arthritis. Subjects with bilateral hand involvement were included in the study population with both hands recorded. Exclusion criteria included any surgical management for first CMC joint arthritis. An experimental setup was designed that allowed subjects to rest their elbow in neutral pronosupination and immobilized the second through fifth carpometacarpal joints. An electromagnetic motion sensor (Patriot, Polhemus, Colchester, VT) was embedded into a thumb interphalangeal joint immobilizer. The motion sensor and thumb were aligned at 0° of abduction and 0° of extension at the beginning of each trial. Patients were then asked to complete five continuous thumb circumduction movements, starting from the previously described position (Figure 1). These were performed in a clockwise direction for the right hand, and a counterclockwise for the left. Data were recorded continuously using a custom developed interface (LabVIEW, National Instruments, Austin TX). From these data, circumduction curves based on degrees of motion and measurements regarding peak thumb abduction and extension angles were extracted.

RESULTS
A total of 19 subjects participated, for a total of 28 affected extremities. Bilateral disease was present in 64% of patients, and 68% percent of patients were female. Mean patient age was 67, with the majority of affected extremities (39%) having an Eaton stage 3 classification. Average maximum thumb abduction was 41.7° (95% CI 36.7° to 48.4°) and average maximum extension
was 32.1° (95% CI 24.1° to 41.8°). Figure 2 plots the circumduction of the thumb by plotting degrees of extension versus degrees of abduction for our patient population, with the black borders corresponding to a 95% bootstrap confidence interval.

**SUMMARY**
- Using a single motion sensor, dynamic thumb circumduction was described in patients with first carpometacarpal (CMC) joint arthritis
- This study provides an innovative platform to quantify joint mobility in patients with CMC joint arthritis, compared to standard goniometry
- Possible future studies using this motion sensor include quantification of thumb circumduction loss in patients with CMC joint arthritis when compared to asymptomatic controls
Figure 2.
Circumduction curves for patients with first CMC joint arthritis, showing extension vs. abduction. Borders correspond to 95% bootstrap confidence intervals.
HYPOTHESIS
Radial tunnel syndrome is believed to be a clinical diagnosis. Currently limited information exits in the literature regarding specific MRI and ultrasound (US) findings of radial tunnel syndrome. We hypothesized that evaluation of patients with suspected radial tunnel syndrome would yield specific MRI and US findings.

METHODS
A single institution musculoskeletal radiology department identified all patients with the associated diagnosis code of radial tunnel syndrome who underwent MRI or US from September 2013 through September 2019. 137 patients were identified. Patients were excluded if there was incomplete chart information regarding symptoms and imaging findings, if they had a radial nerve palsy, acute trauma or mass within the radial tunnel. Imaging reports were reviewed for the most common characteristics identified by radiologist that lead to a diagnosis of radial tunnel syndrome.

RESULTS
113 patients met inclusion criteria and all patients had symptoms of radial tunnel syndrome. 68 patients had finding suggestive of radial tunnel syndrome on imaging. 34 patients underwent MRI, 31 patients underwent US and 3 patients had both. 39 patients demonstrated atrophy or edema in the supinator muscle. 48 had focal thickening with signal changes in the nerve in the distribution of the radial tunnel. 8 patients had a prominent leash of henry in addition to focal thickening or signal changes of the nerve. MRI identified 34 of the 39 patients with signal changes in the supinator muscle. Ultrasound identified 32 of the 49 patients with signal changes in the radial nerve. All 3 patients who underwent MRI and US were found to have fatty atrophy and thickening of the nerve. Of the 45 patients without imaging findings of radial tunnel syndrome 34 underwent MRI and only 11 underwent US.

SUMMARY
• Radial tunnel syndrome is mainly a clinical diagnosis but focal signal changes within the radial nerve and supinator muscle indicate objective finding to confirm the diagnosis and guide treatment. • Further investigation into whether MRI or ultrasound is more sensitive at diagnosing radial tunnel syndrome is warranted.
REFERENCES:
RF: Poster 136: Madelung Deformity: Insights Into a Rare Congenital Difference Utilizing Social Media

Category: Bone and Joint; Pediatric Trauma and Congenital Conditions; Other Clinical Topics

Evaluation/Diagnosis; Prognosis/Outcomes; Patient Education
Level of Evidence: 4

Dr. Abbas Peymani
Max Lokhorst
Austin Chen
Bernard Lee
Samuel Lin
Simon Strackee

HYPOTHESIS
Madelung deformity is extremely rare, the literature is scarce, and the published small-powered studies inadequately describe functional status, let alone consider the patients’ perspective [1,2]. In this study we answer the following question: what is the impact of Madelung deformity on the physical, mental, and social aspects of patients’ lives?

METHODS
Using an universal patient-reported outcome tool entitled Patient-Reported Outcomes Measure Information System (PROMIS), we collaborated with several social media communities to conduct a survey. PROMIS Short Form scores were calculated and compared between unoperated and operated patients. Correlations between the scores were calculated using the Spearman’s Rank correlation coefficient; correlation strength was interpreted as low (<0.3), moderate (0.3-0.5), or high (>0.5).

RESULTS
Of the 207 persons that opened the survey, a total of 133 participants (64%) completed the survey. A total of 55 participants (49%) had undergone previous surgical correction of the wrist with a mean age of 20.5±9.5 at first surgery, and 2.4±2.7 surgeries in total. Calculated PROMIS scores for adults were as follows: Pain Intensity 4.9±2.8, Pain Interference 57.6±10.0, Upper Extremity 35.2±8.1, Depression 53.8±11.1, Anxiety 55.4±11.4, and Ability to Participate in Social Roles and Activities 42.5±7.7. No significant differences were seen between operated and unoperated patients. Calculated scores for children were: Pain Intensity 5.0±2.8, Pain Interference 55.7±11.3, Upper Extremity Function 24.6±10.4, Depressive Symptoms 57.7±11.3, Anxiety 57.3±11.9, and Peer Relationships 42.2±10.3. Compared to unoperated pediatric patients, a significant decrease of Pain Interference was seen in operated pediatric patients (51.0±12.0 versus 62.3±5.2; P=0.045).
SUMMARY
• Madelung deformity has significant effects on one's physical, mental, and social health. • Even after surgical treatment, the health burden of this congenital hand difference remains. • Utilizing social media, we were able to compensate for the rarity of Madelung deformity by engaging an international audience.

REFERENCES:
Figure 2. Interpreting PROMIS T-Scores for Adult and Pediatric Domains
HYPOTHESIS
Our anatomical knowledge of Madelung deformity is limited due to the rarity of the congenital hand difference. The purpose of this study was to: (1) develop a 3D statistical shape model [1] of patients’ distal radius bones to visualize and understand the spectrum of shape variations; (2) determine if classifications are possible based on shape; (3) investigate the efficacy of shape information in a diagnostic predictive model.

METHODS
CT scans of 26 Madelung deformity, and 26 healthy wrists were processed and brought into correspondence using a parametric, non-rigid registration algorithm. Next, a SSM of these models was obtained through principal component analysis, after which shape variations could be represented as ‘modes of variation’ ordered by the amount of explained variance. Three different SSMs were developed: a Madelung deformity model (n=26), a healthy model (n=26), and a mixed model (n=52) containing shapes of both Madelung deformity and healthy wrists. The Kolmogorov-Smirnov statistic was used to determine whether shape parameters (coefficients of the modes of variation) were normally distributed. A binary logistic regression model was developed using the modes of variation as continuous covariates and a shape’s origin as binary outcome (0 = healthy, 1 = Madelung deformity). To assess the predictive ability of the regression model, 70% of our dataset (n=36) was used as a training set and 30% (n=16) as a testing set.

RESULTS
In a SSM of the distal radius in Madelung deformity, the first 5 modes of variation (37%, 18%, 13%, 9%, and 5%) can cumulatively explain 82% of the observed shape variation (Figure 1). The histograms of shape variations (Figure 2) do not show multimodal distributions for any of the main modes of variation, thus there is no evidence to classify Madelung deformity based on distal radius shape. Our predictive model, containing only the first 2 modes, shows high efficiency in classifying unseen shapes (Accuracy 0.938, Sensitivity 0.857, Specificity 1.000, Precision 0.944, and F1 Score 0.937).
SUMMARY
• In this study we statistically determined and visualized the five most important modes of shape variation for Madelung deformity in 3D. • This mathematical deduction of shape highlights the spectrum of presentation in which the distal radius in Madelung deformity can present. • No classification can be made based on the shape of the distal radius. • Shape differences are both visibly and quantitatively different in comparison to healthy distal radius bones, and show added value in predictive regression models.

REFERENCES:

Figure 1. Shape variations of the distal radius in Madelung deformity. The -2SD, mean, and +2SD coefficients of the first mode are visualized.
Figure 2. Distribution of shape parameters for the first five modes in a Madelung deformity model.
RF: Poster 138: Mind the Gap: a Comparison of Scheduled and Realized Hand Surgery Case Duration

HYPOTHESIS
We suspect that a substantial portion of outpatient hand surgery cases are poorly estimated in terms of their duration, and that a majority of these case times are underestimated, potentially leading to costly operating room delays. The reasons for poor case estimation are likely multifactorial.

METHODS
All outpatient hand surgery cases from 2018 at a major academic medical center (including both an outpatient surgery center and a dedicated orthopedic hospital) were reviewed. Delta case time was calculated as the difference between the scheduled and realized case duration (i.e., the scheduled and realized time that a surgical patient spent in the operating room). Delta case time proportion was defined as the delta case time divided by the scheduled case duration. Poorly estimated cases were defined as those with delta case time proportion > 0.5. Preoperative time (time in room until incision), surgical time (incision to close), and out time (incision closed until departure from room) were also recorded.

RESULTS
3,714 cases were identified. 709 (19.1%) cases had poorly estimated case durations. Of poorly estimated cases, 77.7% were under-estimated (meaning cases took longer than expected). First start cases were less likely to be poorly estimated (16.1% vs. 20.0%, p=0.01). There was significant surgeon variability, with the percentage of poorly estimated cases ranging from 10.5% to 48.6% across surgeons (p<0.001). There was also significant variability based on facility, with 15.6% of cases poorly estimated at the outpatient surgery center vs. 21.8% at the orthopedic specialty hospital (p<0.001). In comparisons between well-estimated and poorly estimated cases, well-estimated cases tended to have longer scheduled case duration (76.8 vs. 65.0 mins, p<0.001), but shorter realized case duration (73.0 vs. 102.2 mins, p<0.001) and surgical time (42.0 vs 67.4 mins, p<0.001). Well-estimated cases also had shorter preop time (24.7 vs. 27.4 mins, p<0.001) and shorter out time (6.3 vs. 7.3 mins, p<0.001), but these differences were smaller in magnitude.

SUMMARY
• Nearly one-fifth of outpatient hand surgery cases are poorly estimated in terms of case duration, and the vast majority of these are under-estimated. This can lead to costly operating
room delay. • The likelihood of poor case estimation was dependent on time of day, surgeon, and facility. • It seems that poor case estimation was related to a combination of both scheduling cases for durations that were too short and surgeries taking longer than they typically do. Nonsurgical time spent in the room seems less influential in dictating whether cases were well-estimated.

Figure 1: Explanation of relative perioperative times. Total Case Duration is defined as the time the patient spends in the operating room. Delta Case Proportion = Delta Case Time/Scheduled Total Case Duration. Poorly estimated cases are those for which Delta Case Time > 0.5.
RF: Poster 142: Carpal Tunnel Surgery: Can Patients Read, Understand, and Act on Online Educational Resources?

Category: Skin and Soft Tissue; Other Clinical Topics; Miscellaneous Nonclinical Topics

Surgical Technique; Patient Education; Residents/Fellow/Educator Resources
Level of Evidence: N/A

Trevor R Gulbrandsen, MD
Burke Gao, MD
Alan Shamrock, MD
Joseph Buckwalter V, MD
Ericka Lawler, MD
Timothy P. Fowler, MD

HYPOTHESIS
Patients utilize online resources to educate themselves prior to undergoing elective surgery such as carpal tunnel surgery (CTS). Online health information must be written at the elementary school level to maximize public comprehension. We hypothesized that currently available online resources regarding CTS would score poorly on objective measures of readability (syntax reading grade-level), understandability (ability to process key messages), and actionability (providing actions the reader may take). Additionally, we hypothesized that the previously mentioned outcomes measured would not correlate with the resources’ ranked order that is listed when searched (Google search rank order).

METHODS
Patient education materials were identified using two independent online searches (Google.com) using the term “Carpal Tunnel Surgery”. From the top 50 search results, articles regarding patient information were included if directed at educating patients regarding CTS. News articles, non-text material (video), research manuscripts, industry websites, and articles not related to CTS were excluded. The readability of included articles was quantified using the Flesch-Kincaid Grade Level Index (Table 1). The Patient Education Materials Assessment Tool (PEMAT) was used to assess actionability and understandability using a 0-100% scale for both measures of interest (Figure 1). Spearman’s correlation coefficient was utilized to examine the relationship between a website’s average Google search rank (from first to last) and its readability, understandability, and actionability. Statistical significance was defined as p<0.05.

RESULTS
Thirty-nine websites met study inclusion criteria. The mean Flesch-Kincaid reading ease converted grade level was 9.84±2.54, with no websites ≤6th grade reading level (Table 1). Readability was not associated with Google search rank order (lowest p=0.25). Mean understandability and actionability scores were 58.57%±14.88 and 25.64%±24.31, respectively. Among understandability scoring criteria, no articles included information summaries and only 11 (28.2%) utilized visual aids. Among actionability categories, 22 websites (56.4%) identified at
least one action to be taken for readers, but only 8 (36.4%) provided explicit, easy to understand steps. Neither understandability scores (rho: -0.215; p=0.189) or actionability scores (rho: -0.088; p=0.596) were associated with Google search rank.

SUMMARY
· CTS online education materials scored poorly with respect to readability, understandability, and actionability. · There was no association between readability, understandability, and actionability with Google search rank order. · In the era of shared decision-making, future efforts should be made by hand specialists to improve the readability of online patient resources.

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<th>School Level</th>
<th>Interpretation</th>
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<td>100-90</td>
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<td>Easy to read and understand</td>
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<td>6th Grade</td>
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<td>7. The material does not expect the user to perform calculations.</td>
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<td>15. The material uses visual aids whenever they could make content more easily understood (e.g., illustrations or动力 partition views).</td>
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<td><strong>ACTIONABILITY</strong></td>
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<td>21. The material addresses the user directly when describing actions.</td>
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</tr>
<tr>
<td>22. The material breaks down any action into manageable, explicit steps.</td>
<td>Disagree = 0  Agree = 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. The material provides a tangible tool (e.g., worst-case, checklist) whenever it could help the user take action.</td>
<td>Disagree = 0  Agree = 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. The material provides simple instructions or examples of how to perform calculations.</td>
<td>Disagree = 0  Agree = 1  No calculations = NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. The material explains how to use the charts, graphs, tables, or diagrams to take actions.</td>
<td>Disagree = 0  Agree = 1  No charts, graphs, tables, diagrams = NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. The material uses visual aids whenever they could make it easier to act on the instructions.</td>
<td>Disagree = 0  Agree = 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* A very short print material is defined as a material with two or fewer paragraphs, and no more than 1 page in length.
RF: Poster 145: Systematic Review of the Use of Power Doppler Ultrasound in the Imaging of Peripheral Nerve Compression Neuropathy

Category: Nerve; Other Clinical Topics

Evaluation/Diagnosis; Anatomy

Level of Evidence: 4

Dr. Andrew J. Landau, MD
Laura Simon, MLIS
Priyanka Parameswaran, BS
Rabiah Fresco, BS
Dr. Christopher J. Dy, MD MPH FACS
Dr. David M. Brogan, MD MSc

HYPOTHESIS
Power Doppler ultrasonography (PDUS) has been used as an adjunct in the diagnosis of peripheral nerve compression neuropathy. To better characterize its sensitivity and specificity, we performed a systematic review of clinical articles describing its use in carpal and cubital tunnel syndrome diagnosis.

METHODS
We systematically reviewed published literature discussing use of PDUS to diagnose carpal tunnel syndrome, cubital tunnel syndrome, or peripheral compression neuropathy using a combination of keywords and controlled vocabulary in Ovid Medline, Embase.com, Scopus, Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials, Database of Abstracts of Reviews of Effects, Health Technology Assessment Database, NHS Economic Evaluation Database, World Health Organization International Clinical Trial Repository Platform, and Clinicaltrials.gov. No filters for language, date, or publication type were used. Two author groups initially screened and systematically reviewed relevant reports. Disagreements were settled by the senior author. Efforts were made to identify and consider the impact of potential biases.

RESULTS
Twenty one studies were included, involving 1,459 participants with suspected or confirmed compression neuropathy (1279 median neuropathy, 180 ulnar neuropathy). All but 2 studies examined patients with carpal tunnel syndrome exclusively. One study evaluated cubital tunnel syndrome only and the other included both. There were distinct differences in study design and methodology across studies. Several studies had inadequacies and/or insufficient detail to critically assess the methodology.
SUMMARY

• PDUS is unreliable as a screening test, but appears to increase diagnostic accuracy of ultrasonography in compression neuropathies • Seems to be most beneficial in detecting flow in moderate-severe disease, and may be valuable in detecting hypervascularization in early cases of compression neuropathy • Appears to be sensitive method for determining recovery in early post-treatment period and may have benefit in surveillance of disease progression and/or resolution • More information is needed to determine the value of detecting intraneural vascularity in cubital tunnel syndrome
HYPOTHESIS
Targeted Muscle Reinnervation (TMR) has been shown to play an important role in the prevention and treatment of painful postoperative neuromas. Additionally, some studies have anecdotally note decreased opioid consumption following TMR; however, to date, no study has evaluated the impact of the timing of TMR on patient opioid use or pain visual analogue scores (VAS). We hypothesize that TMR performed acutely would lead to lower VAS and decreased opioid intake in patients with major limb amputation as compared to those with TMR performed in a delayed fashion.

METHODS
In this retrospective review, a query of the OrthoCarolina Amputation Registry was performed to identify patients who underwent a TMR procedure between August 2016 and February 2020. Clinic and hospital medical records were reviewed to confirm TMR was performed. Acute TMR was defined as TMR within 3 months of the major limb amputation and delayed TMR was defined as TMR >3 months after the major limb amputation. Patient-reported opioid use was documented at the preoperative clinic visit as well as at each subsequent postoperative visit. Primary outcomes included VAS and patient-reported opioid consumption following TMR. Secondary outcome variables included use of non-narcotic pain medication and preoperative opioid use.

RESULTS
A total of 52 limbs were identified that underwent TMR, with 35 in the acute group and 17 in the delayed group. Average age at time of amputation was 43 years of age in both groups. Preoperative opioid use was identified in 61% of patients in the acute group and 56% in the delayed group. A higher percentage of patients were on non-narcotic medication (e.g. Gabapentin, Lyrica) in the delayed (69%) versus acute group (40%) (p=0.06). At final follow-up, the average VAS in the delayed TMR group was significantly higher than that in the acute group (6.23 vs. 1.69, p<0.001). There were no statistically significant differences in opioid consumption between the acute and delayed group at 6 month follow up (p=0.13) or at final follow-up (p>0.99). At the time of final follow up, 85% of patients were not consuming opioid medications, with 84% and 87% in the acute and delayed TMR groups, respectively.
SUMMARY
• TMR is an effective procedure to reduce opioid consumption following major limb amputation, with 85% of our cohort not consuming opioid medication at final follow up. • Patients with TMR performed in an acute setting had significantly lower VAS scores than patients with TMR performed in a delayed setting.
RF: Poster 155: Hand-Specific External Fixation for Complex Proximal Interphalangeal Joint Injuries

Category: Bone and Joint

Treatment; Surgical Technique; Prognosis/Outcomes

Level of Evidence: 4

Naji Madi
Richard McEntee
Pedro Beredjiklian

HYPOTHESIS

Proximal interphalangeal (PIP) joint fracture and fracture-dislocation remain some of the more challenging injuries to treat. Different treatments have been described, with early motion as key in achieving improved outcome. We report the outcome of treatment of PIP joint fractures and fracture-dislocations using a hand-specific external fixator.

METHODS

Twenty-five patients were included in this retrospective review. All were treated with a hand specific external fixator (DigiFix®, Virak Orthopedics LLC). There were 15 men and 10 women, average age 40 years (4-75 years). Active range of motion, radiographs, duration of therapy and DASH score were used to assess outcome.

RESULTS

There were 18 fracture-dislocations and 7 pilon fractures of the PIP. The ring finger was injured in 13 patients. The duration of external fixation was 5.8 weeks (range, 3.7 – 8.8 weeks). The external fixator was applied initially in the dynamic mode in 21 patients; and in the static mode in 5 patients, which were dynamized later. The average follow-up period was 28 weeks (range, 12-105 weeks). The final active range of motion was flexion of 81° (range, 30°-105°) and extension lag of 12° (range, 0° to -40°). The DASH score was 25 (range, 0-66). The average duration of therapy postoperatively was 12.4 weeks (range, 0-28 weeks). At final follow up, radiographic criteria was excellent in 11 patients, good in 11, fair in 2, poor in 1. No major complications were reported. Minor complications included superficial cellulitis that responded to oral antibiotics in 4 patients and stiffness in 2 patients, requiring manipulation under anesthesia in one and extensor tenolysis in the other.

SUMMARY

• Hand-specific external fixation for the treatment of complex PIP joint injuries leads to a favorable outcome. • No major complications were reported with the usage of Hand-specific external fixation. • Our study reports on one of the largest samples of PIP joint injuries. • Our results are comparable to previous reports with functional range of motion and patient satisfaction.
REFERENCES:
Radiographic data vs DASH vs Arc of motion

- DASH
- Arc of motion

excellent  good  poor
HYPOTHESIS
The primary aim of this study was to determine if any difference existed in the interval from time of arrival in the operating room (OR) to time to incision for patients with a standard preoperative preparation and preparation outside of the OR. As a secondary aim, this study sought to determine if any difference existed in the interval from anesthesia start time to anesthesia end time between the standard preoperative preparation and preparation outside of the OR.

METHODS
A single institution retrospective cohort study compared 2 groups of patients undergoing 1 of 3 ambulatory hand surgeries (carpal tunnel release, trigger finger release, or first dorsal compartment release) between 1/1/2019 – 5/1/2019. One group of patients (N1 = 64) had a tourniquet placed on the operative extremity and local anesthetic agent injected in the preoperative holding area (PHA) by a single hand surgeon. A second group of patients (N2 = 137, treated by 4 other hand surgeons) had the same tourniquet application and local anesthetic administered as needed, but with both given after the patient’s arrival in the OR. Data gathered included demographics, type of procedure performed, laterality of procedure, whether preparation was done inside or outside the OR, time interval from patient arrival in the OR to incision, and duration of anesthesia. In addition to appropriate descriptive statistics, the Wilcoxon-Mann-Whitney test was used to compared medians of time intervals. The significance level was 0.05.

RESULTS
The median time interval to incision was 10 minutes (interquartile range: 8 – 12.5) for the PHA group versus 15 minutes (interquartile range: 12 – 19) for those prepared in the OR (P < 0.0001). Moreover, the median anesthesia time was 28.5 minutes (interquartile range: 25 – 34) for the PHA group versus 47 minutes (39 – 59) for those prepared in the OR (P < 0.0001). No complications were encountered with preoperative preparation in either group.
SUMMARY

- Applying tourniquet and local anesthetic prior to patient arrival in the OR significantly decreases the time to incision in ambulatory hand surgeries.
- Preparation prior to the OR can also significantly decrease anesthetic time.
- Future studies may prospectively evaluate other interventions to reduce OR time and provide a more detailed cost analysis based on equipment used and surgical location.

REFERENCES:
Comparison of (A) median time interval from arrival in the OR to incision across the 3 procedure groups, further stratified by the location of preoperative preparation of the extremity and (B) median anesthetic time across the 3 procedure groups, further stratified by the location of preoperative preparation of the extremity. The label “Pre-OR” indicates that the tourniquet and local anesthetic were applied to the operative extremity prior to the patient’s arrival in the OR. Similarly, the label “In OR” indicates that the tourniquet and local anesthetic were applied to the operative extremity after the patient’s arrival in the OR.
HYPOTHESIS
There has been a decrease in the amount of opioids prescribed for pediatric upper extremity trauma procedures after the emergence of a 2017 law mandating pre-operative parental consent for opioid prescription in Pennsylvania.

METHODS
This was a retrospective review of pediatric patients surgically managed for isolated trauma of the upper extremity at a single institution between 01/01/2016 - 12/31/18. Patients undergoing one of four common pediatric upper extremity procedures (Table 1) were identified and divided into two cohorts: those with pre-operative opioid informed consent obtained, and those without. Variables collected include patient demographics, surgical and hospital data, type of discharge prescriber, and the volume and type of pain medications prescribed post-operatively. Univariate analyses were performed to examine differences in patient, prescriber and medication characteristics between cohorts. Mann-Whitney U tests were used to analyse differences in prescription volume.

RESULTS
Inclusion criteria for this investigation were met by 1,417 patients. Opioid consent was obtained from 55.6% of parents/guardians. There were no differences in patient demographics or procedural distribution between cohorts. There were differences in the prescribing provider, with a greater proportion of prescriptions completed by Advanced Practice Providers in the opioid consented cohort (p<0.005). The prescription volume of opioids in both solution and tablet form was lower in patients with preoperative informed consent (p<0.001) (Table 1). The frequency of opioid refill showed no difference between groups despite a lower prescription volume in the consented cohort. Prescribing of NSAIDs was higher in the cohort with informed consent (p=.001).

SUMMARY
Patients prescribed opioids after the initiation of the pre-operative consent mandate were prescribed 27.1% fewer total doses There was no difference in need for opioid refills requested.
despite decreased overall prescribed doses The prescription of NSAIDs and acetaminophen increased after the initiation of the consent form.

### Table 1: Cohort demographics and opioid prescribing before and after preoperative opioid consenting was implemented. Categorical variables reported as frequency (%). Continuous variables reported at mean +/- standard deviation.

<table>
<thead>
<tr>
<th>Variable</th>
<th>No Opioid Consent (n=629)</th>
<th>Opioid Consent (n=788)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>10.9 +/- 4.0</td>
<td>11.7 +/- 3.4</td>
<td>.710</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>358 (56.9)</td>
<td>469 (59.5)</td>
<td>.175</td>
</tr>
<tr>
<td>Female</td>
<td>271 (43.1)</td>
<td>319 (40.5)</td>
<td></td>
</tr>
<tr>
<td>Procedure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRPP/ORPP of Supracondylar Humerus Fracture</td>
<td>314 (49.9)</td>
<td>381 (48.4)</td>
<td>.370</td>
</tr>
<tr>
<td>CRPP/ORPP of Humeral Condylar/Epicondylar Fracture</td>
<td>138 (21.9)</td>
<td>152 (19.3)</td>
<td></td>
</tr>
<tr>
<td>Flexible Nailing of Forearm Fracture</td>
<td>71 (11.3)</td>
<td>94 (11.9)</td>
<td></td>
</tr>
<tr>
<td>CRPP of Finger Fracture</td>
<td>96 (16.9)</td>
<td>161 (20.4)</td>
<td></td>
</tr>
<tr>
<td>Discharge Prescriber</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced Practice Provider (NP/PA)</td>
<td>246 (39.1)</td>
<td>440 (55.8)</td>
<td>&lt;.005</td>
</tr>
<tr>
<td>Resident (MD/DO)</td>
<td>250 (39.7)</td>
<td>254 (32.2)</td>
<td></td>
</tr>
<tr>
<td>Fellow (MD/DO)</td>
<td>99 (15.7)</td>
<td>62 (7.9)</td>
<td></td>
</tr>
<tr>
<td>Attending (MD/DO)</td>
<td>34 (5.4)</td>
<td>32 (4.1)</td>
<td></td>
</tr>
<tr>
<td>NSAIDs Prescribed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>198 (31.5)</td>
<td>570 (72.3)</td>
<td>.001</td>
</tr>
<tr>
<td>No</td>
<td>431 (68.5)</td>
<td>218 (27.7)</td>
<td></td>
</tr>
<tr>
<td>Acetaminophen Prescribed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>524 (83.3)</td>
<td>679 (86.2)</td>
<td>.137</td>
</tr>
<tr>
<td>No</td>
<td>105 (16.7)</td>
<td>109 (13.8)</td>
<td></td>
</tr>
<tr>
<td>Opioids Prescribed</td>
<td></td>
<td></td>
<td>.276</td>
</tr>
<tr>
<td>Yes</td>
<td>552 (87.8)</td>
<td>682 (86.5)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>77 (12.2)</td>
<td>106 (13.5)</td>
<td></td>
</tr>
<tr>
<td>Number of Opioid Doses Prescribed</td>
<td></td>
<td></td>
<td>&lt;.005</td>
</tr>
<tr>
<td>Liquid Oxycodone (Total mL/Dose mL) (n=435)</td>
<td>28.12 +/- 21.4</td>
<td>17.9 +/- 10.7</td>
<td></td>
</tr>
<tr>
<td>vs n = 544</td>
<td>6.01 +/- 16.0</td>
<td>5.94 +/- 15.9</td>
<td>&lt;.005</td>
</tr>
<tr>
<td>Oxycodone Tablets (n = 117 vs n = 135)</td>
<td></td>
<td></td>
<td>&lt;.005</td>
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<tr>
<td>Opioid Refill</td>
<td></td>
<td></td>
<td>.087</td>
</tr>
<tr>
<td>Yes</td>
<td>4 (0.6)</td>
<td>9 (1.1)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>625 (99.4)</td>
<td>857 (98.9)</td>
<td></td>
</tr>
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</table>
HYPOTHESIS
The Boston Carpal Tunnel Questionnaire (BCTQ) is a validated measurement tool for the severity of Carpal Tunnel Syndrome (CTS) and improvements in BCTQ following carpal tunnel release (CTR) have been demonstrated to influence patient satisfaction. We hypothesize that patient related factors influence response in BCTQ subscales including the symptom severity scale (SSS) and the functional status scale (FSS) following CTR.

METHODS
A prospectively maintained database of patients presenting with possible CTS was reviewed and patients undergoing surgery with measurement of follow-up BCTQ scores were included in the analysis. Baseline demographic data were obtained and paired t-tests were utilized in order to compare BCTQ sub-scales at each follow-up time point (2 weeks, 6 weeks, 6 months, and 1 year). Based off of previously published data, minimal clinically important differences (MICD) in BCTQ, SSS, and FSS were set at 0.74, 1.6, and 1.0, respectively. Patients below these MICD thresholds were deemed as failures to improve following CTR. Univariate analysis using chi-square tests/Fisher exact tests for categorical variables and student’s t-tests were used to identify risk factors for failure to improve following CTR. Multi-variate logistic regression was used to identify independent predictors for failure to improve following CTR.

RESULTS
106 patients met inclusion criteria and were included in the study (Table 1). Patients demonstrated significant improvements in BCTQ, SSS, and FSS compared to baseline at all follow-up time points. Improvement in BCTQ and FSS stabilized at 6-week follow-up, while SSS stabilized at 2-week follow-up. Independent predictors for failure to improve beyond the MICD in BCTQ included African-American ethnicity, sensory nerve action potential (SNAP) < 6.0, concomitant cubital tunnel release, and lower BMI. Factors significantly associated with failure to improve in SSS included male gender, African-American ethnicity, median nerve CSA < 10.0 mm2, and lower baseline SSS. Predictors for failure of FSS to improve included older age, higher BMI, African-American ethnicity, and lower baseline FSS (Table 2).
SUMMARY

• Surgeons use a variety of techniques (history, CTS-6, ultrasound, EMG) to diagnose CTS. • CTR results in significant improvements in BCTQ and its sub-scales with improvements stabilizing after six weeks suggesting no need for follow-up after this time point in routine cases. • A select cohort of patients fail to improve following CTR with factors independently associated with a lower degree of improvement. Identification of patients with these risk factors will provide a basis for counseling and increased monitoring of patients at risk for a guarded prognosis following CTR.

REFERENCES:

<table>
<thead>
<tr>
<th>Table 1. Baseline Demographic, Pre-Operative, and Operative Characteristics of the Study Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Hands</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Ethnicity</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Asian</td>
</tr>
<tr>
<td>Diabetes</td>
</tr>
<tr>
<td>Right</td>
</tr>
<tr>
<td>Median CSA</td>
</tr>
<tr>
<td>CTS-6</td>
</tr>
<tr>
<td>Baseline Boston Carpal Tunnel</td>
</tr>
<tr>
<td>Baseline Functional Status Scale</td>
</tr>
<tr>
<td>DPN Sensory Latency</td>
</tr>
<tr>
<td>DSL NR</td>
</tr>
<tr>
<td>SNAP &lt; 6.0</td>
</tr>
<tr>
<td>Distal Motor Latency</td>
</tr>
<tr>
<td>DML NR</td>
</tr>
<tr>
<td>CMAP &lt; 10.0</td>
</tr>
<tr>
<td>Surgical Approach</td>
</tr>
<tr>
<td>Open</td>
</tr>
<tr>
<td>Concomitant Cubital Tunnel Release</td>
</tr>
<tr>
<td>Surgeon 1</td>
</tr>
</tbody>
</table>
Table 2. Multivariate Logistic Regressions of Factors Independently Predictive of Failure to Improve following Carpal Tunnel Release

<table>
<thead>
<tr>
<th></th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boston Carpal Tunnel Questionnaire</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>1.00</td>
<td>0.94-1.07</td>
<td>0.924</td>
</tr>
<tr>
<td>BMI</td>
<td>0.82</td>
<td>0.69-0.98</td>
<td>0.030*</td>
</tr>
<tr>
<td>African-American Ethnicity</td>
<td>21.48</td>
<td>2.79-165.10</td>
<td>0.003*</td>
</tr>
<tr>
<td>Median Nerve CSA ( \geq 10.0 )</td>
<td>0.64</td>
<td>0.11-3.67</td>
<td>0.612</td>
</tr>
<tr>
<td>SNAP &lt; 6.0</td>
<td>12.16</td>
<td>1.32-112.26</td>
<td>0.028*</td>
</tr>
<tr>
<td>DML NR</td>
<td>2.40</td>
<td>0.07-80.90</td>
<td>0.626</td>
</tr>
<tr>
<td>Concomitant CuTR</td>
<td>10.20</td>
<td>1.03-100.86</td>
<td>0.047*</td>
</tr>
<tr>
<td>Baseline BCTQ</td>
<td>0.45</td>
<td>0.12-1.70</td>
<td>0.240</td>
</tr>
<tr>
<td><strong>Symptom Severity Scale (SSS)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Gender</td>
<td>28.29</td>
<td>4.74-168.70</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>African-American Ethnicity</td>
<td>12.87</td>
<td>2.34-70.91</td>
<td>0.003*</td>
</tr>
<tr>
<td>Median Nerve CSA ( \geq 10.0 )</td>
<td>0.16</td>
<td>0.03-0.72</td>
<td>0.017*</td>
</tr>
<tr>
<td>Normal Nerve Studies</td>
<td>0.38</td>
<td>0.05-2.84</td>
<td>0.344</td>
</tr>
<tr>
<td>Baseline SSS</td>
<td>0.10</td>
<td>0.03-0.41</td>
<td>0.001*</td>
</tr>
<tr>
<td><strong>Functional Status Scale (FSS)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>1.08</td>
<td>1.01-1.16</td>
<td>0.033*</td>
</tr>
<tr>
<td>Male Gender</td>
<td>2.81</td>
<td>0.71-11.08</td>
<td>0.140</td>
</tr>
<tr>
<td>BMI</td>
<td>1.10</td>
<td>1.01-1.19</td>
<td>0.030*</td>
</tr>
<tr>
<td>African-American Ethnicity</td>
<td>7.93</td>
<td>1.59-39.57</td>
<td>0.012*</td>
</tr>
<tr>
<td>SNAP &lt; 6.0</td>
<td>1.37</td>
<td>0.36-5.17</td>
<td>0.647</td>
</tr>
<tr>
<td>Surgeon 1</td>
<td>2.29</td>
<td>0.63-8.30</td>
<td>0.208</td>
</tr>
<tr>
<td>Baseline FSS</td>
<td>0.18</td>
<td>0.06-0.51</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

*p-value < 0.05

Variables were selected for inclusion in multivariate regression analysis using a \( p \)-value cut-off of 0.2 on univariate regression analysis.
RF: Poster 164: Identifying the Location of the Flexor Digitorum Superficialis Tendon Insertion: a cadaveric study

*Category:* Bone and Joint; Tendon  
Surgical Technique; Anatomy; Basic Science  
Level of Evidence: N/A

Rex Saito  
Daniel Lara  
Brenden Cutter  
Eric G. Huish, Jr.  
Marc A Trzeciak

**HYPOTHESIS**
We hypothesize that both the proximal and distal interphalangeal skin creases can be used as reliable anatomic landmark to estimate the distal insertion of the FDS.

**INTRODUCTION**
The flexor digitorum superficialis (FDS) is the largest extrinsic flexor of the forearm that serves as the primary flexor of the proximal interphalangeal (PIP) joints of the middle phalanges. It’s insertion point serves an important landmark and is part of the injury-site factors when considering replantation vs revision amputations in single-finger amputation injuries. Single-finger reimplantations at the level of zone II (proximal to the insertion of the FDS) are rarely indicated and are considered to be a relative contraindication due to its poor prognosis secondary to limited PIP joint motion.

**METHODS**
Five fresh frozen cadaver upper extremities were dissected using a linear incision over the volar aspect of each digit. Prior to incision, 0.7mm Kirschner wires were inserted on the ulnar and radial aspect at the level of the proximal interphalangeal crease and distal interphalangeal crease of each digit to serve as landmarks for measuring. After the superficial incision, the A3-A5 and C2-C3 pulleys were then released and the fibroosseous digital sheath was incised to visualize the FDS and FDP tendon. The FDP tendon was then released distal to the insertion point of the FDS and reflected distally to help visualize the footprint of the FDS insertion site on the middle phalanx. Dissection was then performed so that the distal aspect of the FDS insertion site could be visualized. Measurements were then acquired from the K wires placed in the proximal interphalangeal crease and distal interphalangeal crease to the most distal aspect of the insertion point of the FDS using a digital caliper.

**RESULTS**
The mean distance from the proximal interphalangeal crease to the distal aspect of the FDS insertion was 9.05 mm (±2.34 mm). The minimum and maximum measurements were 5.60 mm and 13.39 mm.
SUMMARY
In total, the mean PIP to FDS distance in all fingers was 9.12mm and the DIP to FDS was 9.02mm. Although the location of injury is only part of the consideration of replantation vs revision amputation in single finger amputation injuries, we believe that the measurements found in this study can help aid hand surgeons to estimate FDS involvement in zone 2 injuries and guide their treatment decisions.

REFERENCES:

Table 1: Average distance from PIP to DIP, Average distances from the PIP and DIP to the distal insertion point of the FDS tendon. n=5

<table>
<thead>
<tr>
<th>Finger</th>
<th>PIP-DIP (cm)</th>
<th>PIP-FDS(mm)</th>
<th>DIP-FDS(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index</td>
<td>2.20</td>
<td>8.02</td>
<td>9.23</td>
</tr>
<tr>
<td>Long</td>
<td>2.33</td>
<td>11.41</td>
<td>9.43</td>
</tr>
<tr>
<td>Ring</td>
<td>2.20</td>
<td>9.12</td>
<td>10.89</td>
</tr>
<tr>
<td>Small</td>
<td>1.5</td>
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RF: Poster 165: Location and course of the Neurovascular bundle of the finger in relation to a mid-axial incision line: A cadaveric study

Category: Nerve; Skin and Soft Tissue

Surgical Technique; Anatomy; Basic Science
Level of Evidence: N/A

Brenden Cutter
Daniel Lara
Eric G. Huish, Jr.
Marc A Trzeciak

HYPOTHESIS
We hypothesize that when making a mid-axial incision of the finger and thumb, the neurovascular bundle will be protected within the volar skin flap.

INTRODUCTION
The digital mid-axial incision is a commonly used approach in hand surgery. The incision is made by first flexing the digit and marking the point at each joint where the flexion crease ends. These points are then connected to identify the mid-axial incision line. The palmar digital neurovascular structures are potentially at risk with this approach; however, Green’s Operative Hand Surgery states that when the incision is correctly placed, the proper digital nerves should lie protected in the volar skin flap. The purpose of our study is to better evaluate the location of the proper palmar digital neurovascular bundle of the fingers and thumb in relation to a mid-axial incision line.

METHODS
A standardized mid-axial incision along both radial and ulnar sides of each digit was made on five fresh frozen cadaver hands. The neurovascular (NV) bundle was then dissected and exposed, with care not to disturb its connective tissue attachments. The distance from the margin of the incision to the NV bundle (specifically the proper palmar digital nerve) was then measured using digital calipers at the proximal interphalangeal joint (PIP) and the distal interphalangeal joint (DIP) on the radial and ulnar sides of each digit. The same protocol was performed at the interphalangeal joint (IP) of each thumb.

RESULTS
A total of 80 measurements were taken on the 20 included index, long, ring, and small fingers. The measured distance in these digits was non-parametrically distributed with a median (IQR) distance of 3.96mm. There was no difference between values taken at the PIP and DIP levels. An additional 10 measurements were taken on the included thumbs with a median distance of 6.58mm. On the radial side of the fingers, distances were significantly higher than those taken on the ulnar side. The thumb also displayed a difference, with ulnar sided distance being higher than the radial sided measurements.
SUMMARY
Our study confirmed that the NV bundle is safely volar during a mid-axial incision of the finger and thumb. Interestingly, the NV bundle was found to be closer to the mid-axial incision along the ulnar side of the fingers (3.77mm) versus the radial side (4.23mm). This distance was found to be smaller at the level of the DIP joint (3.89mm) versus the PIP joint (4.11mm). To our knowledge, this is the first study to measure the distance from the margin of the mid-axial incision line to the NV bundle. With an increased understanding of anatomy and the potential dangers of surgical approaches, surgeons can better provide treatment for their patients.

REFERENCES:

Table 1: Mean distance of the NV bundle to the margin of the mid-axial incision. n=5

<table>
<thead>
<tr>
<th>Finger</th>
<th>PIP Radial (mm)</th>
<th>DIP Radial (mm)</th>
<th>PIP Ulnar (mm)</th>
<th>DIP Ulnar (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index</td>
<td>5.14</td>
<td>4.28</td>
<td>4.81</td>
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<tr>
<td>Long</td>
<td>4.55</td>
<td>5.07</td>
<td>3.74</td>
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<td>Ring</td>
<td>3.50</td>
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<td>Small</td>
<td>3.62</td>
<td>4.14</td>
<td>4.39</td>
<td>3.52</td>
</tr>
<tr>
<td>Thumb</td>
<td>6.05 (IP)</td>
<td>7.18 (IP)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig 1. Dissection pins placed in the nerve at the level of the PIP and DIP joint creases
HYPOTHESIS
The goal of this study is to quantify loading on the carpometacarpal joint (CMC) before and after metacarpophalangeal joint (MP) fusion. Prior anatomic modeling studies have estimated that a key-pinch of 10 newton’s (N) is equivalent to approximately 120N of contact force at the CMC. (1) We hypothesized that fusion of the MP alters the load characteristics of the CMC.

METHODS
Nine cadaver hand, wrist, and forearm specimens were dissected to expose the flexor pollicis longus (FPL), adductor pollicis (ADD), flexor pollicis brevis (FPB), abductor pollicis longus (APL), extensor pollicis longus (EPL), and extensor pollicis brevis (EPB). Specimens were mounted to a custom built test fixture. To simulate key pinch and fingertip pinch, weights (FPL 1500/1500gm, ADD 2000/1000gm, FPB 1500/2000gm, APL 500/500gm, EPL 500/500gm, EPB 500/500gm, respectively) were attached to the tendons with suture and hung over pulleys. Tekscan pressure sensors were inserted into the thumb CMC joint, and between the thumb and index finger to measure the force, contact area, and contact pressure. The MP joint was then fused at 30° with a K-wire and the tests repeated. Fused and intact specimens were compared with a paired t-test.

RESULTS
Nine specimens were tested with an average age of 65 years, BMI of 26.2, and 5:4 male to female ratio. Thumb-finger (pinch) contact force, contact area, and contact pressure were similar between all fused and intact specimens. In tip pinch, joint contact force, contact area, and contact pressure were similar between fused and intact groups. In key pinch, joint contact force trended to be greater in fused specimens by 3.9 N but was not significant (P=0.0667), while contact area and contact pressure were similar. The number of maxed out cells was greater in key pinch fused and unfused specimens. The pinch-joint ratio for contact forces in key pinch was 3.06 for intact specimens and 4.13 for fused specimens (P=0.1411).
SUMMARY
• In a biomechanical analysis of CMC forces in both tip and key pinch, there were no significant differences in contact force, contact area, or contact pressure with MP fusion.
• CMC mechanics were observed to be affected with MP fusion, but did not result in increased joint pressures.
• We found that the ratio of pinch strength to joint contact force was less than the 12-fold increase identified by Cooney & Chao in 1977.
• Contact area was similar between fused and unfused specimens but pressure maxed out in key pinch specimens.

REFERENCES:

Figure 2: Specimens were loaded with weights and Tekscan pressure sensors were inserted into thumb CMC joint and between thumb and index finger to measure force, contact area, and contact pressure.
Figure 1 Bird's eye view of a loaded specimen without pressure sensors.
**HYPOTHESIS**

The treatment of metacarpal fractures with intramedullary screws (retrograde or antegrade) is gaining widespread acceptance though little biomechanical data is available to guide implant choice. We hypothesize that larger diameter screws provide improved resistance to 3-point bending loads as well as resistance to torsional forces.

**METHODS**

Transverse osteotomies were performed over the proximal shaft, 22mm from the base of the metacarpal, in 18 middle finger metacarpal 4th-generation composite Sawbones® with canal diameter of 3.2 mm. Sawbones were fixated with antegrade intramedullary screw fixation with 6 each of 4.7mm Acutrak 2, Standard Acutrak 2 (4.0mm), and Mini Acutrak 2 (3.5mm). Each screw was 30mm in length and countersunk 2mm to allow for screw threads to cross the osteotomy by 10mm. The Sawbones were mounted in a robotic test jig with torsional loading at a rate of 1° per second until 15° of external rotation was reached, and the torsion loads recorded. In a second test jig, 3-point dorsal loading was applied with the central pin positioned at the site of the osteotomy, with loading applied at 10mm per minute until 3mm of bone displacement was reached or the construct failed.

**RESULTS**

For torsional testing, there were significant differences with maximum torsional loads of 55 Ncm seen for the 4.7mm Acutrak 2, 40 Ncm for the Standard Acutrak 2, and 26 Ncm for the Mini Acutrak 2 screws (p < 0.05) (Figure 1). Similarly, the 3-point dorsal bending strengths were found to be significantly different, with bending resistance of 915N for the 4.7mm Acutrak 2, 739N for the Standard Acutrak2, and 280N for the Mini Acutrak2 screws (p< 0.05) (Figure 2).

**SUMMARY**

Intramedullary screw placement with interference fit is a safe and reliable option for treatment of metacarpal shaft fractures. • Larger screw diameters are associated with significant increase in both torsional strength and resistance to 3-point bending in our metacarpal model. • When considering IM screw fixation of metacarpals with canal diameter of 3.0 to 3.5 mm, we
recommend use of 4.0mm or larger diameter screws to achieve adequate interference fit for rotational and bending stability.

REFERENCES:
Figure 2: Metacarpal 3pt-bending Test

- Force (N) vs. Displacement (mm)
- Screw types: Mini, Standard, 4.7mm
**HYPOTHESIS**
Pisiform excision and Guyon tunnel release is an efficient treatment for Pisotriquetral pathologies in terms of Patient Rated outcomes Scores (PROS), range of motion (ROM), and grip strength.

**INTRODUCTION**
Pisotriquetral pathology is an uncommon cause of ulnar sided wrist pain. Patients present with volar ulnar wrist pain with a positive shuck test. Pain may be from instability or arthritis. Pain unresponsive to non-operative measures may be treated with surgical excision of the pisiform. Outcomes of pisiform excision have been described through retrospective analysis of small case series. We illustrate the improvement in Patient Rated outcomes Scores (PROS), range of motion (ROM), and grip strength in a prospective manner from the collected cohort of patients treated with pisiform excision.

**OBJECTIVES**
To assess change PROS and ROM for a series of patients with pisotriquetral pathology treated with surgical excision of the pisiform. Patients were entered into a surgical database at the time of decision for surgery. Prospective data collection will allow assessment of improvement secondary to surgery, any change in range of motion. Follow up evaluations at three and twelve months will allow an analysis of improvement with time.

**METHODS**
Between 2015 and 2019, a consecutive prospective series of nine cases of pisiform excision were performed by the senior surgeon on nine patients (age 58.889 ± 9.103). All procedures were done through a palmar approach. Guyon’s canal was released, and the ulnar nerve identified and protected. Data was collected as part of a surgical wrist pain database. Patients were evaluated pre-operatively with the PRWE and QDASH questionnaires, wrist ROM, and grip strength. These evaluations were conducted at three and twelve months postoperatively. A paired student T-test was used to determine differences in the means. Data are presented as mean ± SD unless stated otherwise. Differences with p<0.05 were considered significant.

**RESULTS**
Compared to the pre-operative assessment, at three months, the means of PRWE pain score and PRWE functional score improved significantly (29.778±15.385 vs.16.125± 9.463 and 22.222 ± 15.575 vs. 9.000±11.814, respectively, n=9, p<0.05). Furthermore, Mean PRWE total
decreased from 52.000± 27.830 to 22.333 ± 20.727 (n=9, p<0.05). Between three to twelve months, no significant difference could be seen in the mean values of these tests. The Mean Clinically Important Difference (MCID) at twelve months was exceeded in 66% of the patients. Grip strength showed significant improvement at three months (21.067±10.010 vs. 14.000±7.329, n=9, p<0.05) but did not change significantly at twelve months. The range of motion did not show a significant difference when evaluated at three and twelve months.

**SUMMARY**

Pisiform excision with Guyon tunnel release significantly alleviates pain and improves functionality and grip strength when performed on patients that suffer from ulnar sided wrist pain as a result of Pisotriquetral pathology.
HYPOTHESIS

The position of the median nerve at the carpal tunnel inlet and its relationship to the flexor pollicis longus (FPL) may be a predictor of carpal tunnel syndrome (CTS). The purpose of this study is to determine the locations of the median nerve and FPL using ultrasound (US), and to test the hypothesis that the position of the median nerve is affected by CTS.

METHODS

Patients with and without a clinical diagnosis of CTS underwent US examination of the wrist. With the forearm in a supinated position and wrist in neutral position, the US probe was placed at the level of the pisiform, perpendicular to the long axis of the forearm. The US image saved was analyzed using Microsoft PowerPoint. A 4 x 10 grid was placed on the carpal tunnel, with pisiform (Pis) and scaphoid (Sca) as the lateral margins. The center points of the median nerve and FPL tendon were identified. The horizontal x and vertical y positions of these center points were taken as a ratio of the position in relation to the grid box, taking the bottom right corner as the origin. Descriptive and student’s t-tests were used for statistical analyses.

RESULTS

US of the carpal tunnel were obtained from 51 male and 64 female wrists (mean age = 49.1). The median nerve was identified in 115 wrists (yellow, average x = 0.70, y = 0.82), and FPL was identified in 90 wrists (pink, average x = 0.86, y = 0.59, Figure-1). There were 97 wrists without CTS (No CTS) and 17 wrists with CTS (Table-1). There were significantly more females in the CTS group (p = 0.016). There was a significant difference in the vertical position of median nerve between No CTS and CTS wrists (p = 0.0006), but no differences in the horizontal position of median nerve or vertical and horizontal positions of FPL. A gender difference in the median nerve position for the No CTS group was analyzed to see if the above difference were due to gender effect. However, there were no statistically significant differences between males and females in both mean x and y positions (p = 0.19 and 0.53, respectively).
SUMMARY
- Common locations of the median nerve and FPL within the carpal tunnel were determined using ultrasound of 115 wrists. 
- The median nerve position in the CTS wrists was more superficial than that in the No CTS wrists.

<table>
<thead>
<tr>
<th></th>
<th>No CTS (97)</th>
<th>CTS (17)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age</td>
<td>48</td>
<td>56</td>
<td>0.07</td>
</tr>
<tr>
<td>% Female</td>
<td>51%</td>
<td>82%</td>
<td>0.016</td>
</tr>
<tr>
<td>Median nerve mean x</td>
<td>0.7</td>
<td>0.7</td>
<td>0.99</td>
</tr>
<tr>
<td>Mean y</td>
<td>0.81</td>
<td>0.85</td>
<td>0.0006</td>
</tr>
<tr>
<td>FPL mean x</td>
<td>0.86</td>
<td>0.86</td>
<td>0.7</td>
</tr>
<tr>
<td>Mean y</td>
<td>0.59</td>
<td>0.59</td>
<td>0.94</td>
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</tbody>
</table>
BACKGROUND
A comprehensive understanding of trends for financial reimbursement of shoulder arthroplasty is important as progress is made toward achieving sustainable payment models in orthopaedics. This study analyzes Medicare reimbursement trends for primary and revision shoulder arthroplasty.

HYPOTHESIS
We hypothesize that Medicare reimbursement has decreased for shoulder arthroplasty procedures from 2000 to 2020, and that revision procedures have experienced the greatest decreases in reimbursement.

METHODS
The Physician Fee Schedule Look-Up Tool from the Centers for Medicare & Medicaid Services was queried for each Current Procedural Terminology (CPT) code utilized in shoulder arthroplasty and hemiarthroplasty, and physician reimbursement data was extracted. All monetary data was adjusted for inflation to 2020 US dollars (USD) utilizing changes to the United States consumer price index (CPI). Both the average annual and the total percentage change in surgeon reimbursement were calculated based on these adjusted trends for all included procedures. Mean percentage change in adjusted reimbursement among primary procedures in comparison to revision procedures was performed.

RESULTS
After adjusting for inflation, the average reimbursement for all shoulder arthroplasty procedures decreased by 35.5% from 2000 to 2020. Revision total shoulder arthroplasty experienced the greatest mean decrease (-44.6%), while primary total shoulder arthroplasty (-23.9%) experienced the smallest mean decrease. The adjusted reimbursement rate for all included procedures decreased by an average of 1.8% each year. The mean reimbursement for
revision procedures decreased more than the mean reimbursement decreased for primary procedures (-41.1% for revision, -29.9% for primary; P<0.001).

SUMMARY
- When adjusted for inflation, Medicare reimbursement for shoulder arthroplasty has steadily decreased from 2000 to 2020
- The average reimbursement for revision procedures decreased by more than the average reimbursement for primary procedures
- Increased awareness and consideration of these trends will be important for all stakeholders in the healthcare system in order to assure continued access to surgical orthopaedic care in the United States
HYPOTHESIS
A link between distal radius fractures and carpal tunnel has been established in the literature, however the etiology of this link is still unclear. We hypothesize that increasing dorsal displacement in distal radius fractures increases the strain on the median nerve, increasing the risk of median nerve pathology such as carpal tunnel syndrome.

METHODS
We began with validation of our methods using ex-vivo measurement of median nerve strain in 4 cadaveric forearms placed in a custom designed jig with the nerve fixed at each end. The nerves were stretched in increments of 0.635 cm, as measured with a digital caliper. Strain was measured using a camera with optical markers glued to the epineurium. Custom MATLAB software was then used to perform segmentation analysis of the images taken by the camera to calculate the absolute distance between optical markers, and compare this to the known change in nerve length. After validation of the system, we then used it to measure the strain in 10 cadaver arms with a simulated distal radius fracture (DRF) and increasing dorsal angulation. The median nerve of each arm was exposed and optical markers applied. A custom designed jig rigidly fixed each cadaver arm to ensure reproducible measurements. Increasing dorsal angulation was applied to the epiphyseal fragment, and the resultant strain in the median nerve calculated. The measured strain at each angle was then analyzed using a linear regression model.

RESULTS
The linear regression model in the validation experiment demonstrated a regression coefficient of 1.00067 (p<0.0001) of change in nerve length on measured nerve strain with r²=0.899, suggesting a high correlation between the known applied strain and the measured strain. This validates our methodology measuring these changes with optical tracking. Linear regression analysis of the effect of increasing dorsal angulation on strain in the osteotomy model yielded a regression coefficient of -0.000048 (p=0.714), r²=0.00129 (Figure 2).

SUMMARY
• Increases in median nerve strain at the wrist are negligible with increasing dorsal tilt in a distal radius fracture model, suggesting that increased pressure within the carpal tunnel is the
primary cause of median neuropathy in distal radius malunion • Prior work has demonstrated 19 mm excursion of the median nerve with wrist motion2, which likely accommodates for increased dorsal angulation • The results validate our clinical experience that transverse carpal ligament release can effectively resolve carpal tunnel syndrome even in the setting of significant malunion

REFERENCES:
Figure 2
HYPOTHESIS
Although most metacarpal fractures can be treated nonoperatively, intramedullary fixation when indicated allows early return of function. In designing a better intramedullary (IM) device for fixation, this study aims to define the size ranges of the fifth metacarpal required for optimal intramedullary device based on the full parametrization of the cortical structure of the fifth metacarpal. We hypothesize that individual morphometric parameters of the fifth metacarpal (e.g. length, location of the isthmus, IM canal width, etc.) can be statistically sorted into a finite number of groups. Averages within each of the groups will further determine an optimal size and shape for the IM device.

METHODS
In this imaging study, we used a computed tomography (CT) scans of the cadaveric hands and basic demographics of the donor. A total of 45 CT scans of individual hands were reviewed for imaging quality, underlying pathology or prior fractures. Thirty-eight CT scans met inclusion criteria and were segmented into 3D computer models (MIMICS) and the data points were exported to MATLAB for further analysis. Fully automatic algorithms were developed to measure spatial dimensions of the fifth metacarpal length and cross-sectional radii at both cortical and trabecular level (Figure 1).

RESULTS
The length of bone was calculated as a function of the height of the donor specimen and averaged to 54.8±4.4 mm. The average minimum diameter of the inscribed circle for canal model was 3.3±0.8 mm at 49.5% of the length, which signifies the location of isthmus. The length of the bone was parameterized in distinct size ranges and the scribed circles of the bone in 6 size ranges for male and female population (sample data in Table 1).

SUMMARY
The results indicated gender variation and a statistically significant relation between the different parameters (p≤ 0.05). Sexual dimorphism was observed with all measurements, suggesting requirement for different sizes of implant devices. A total of 6 statistically distinct
size groups of the fifth metacarpal can be ascertained. The derived parameters from the analysis could be used to optimize the dimensions of fracture fixation devices and its position of implant in the future.

REFERENCES:

<table>
<thead>
<tr>
<th>Length of Bone</th>
<th>Average Female</th>
<th>Average of Male</th>
<th>Average</th>
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<tbody>
<tr>
<td>45-48</td>
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<td>48-51</td>
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<td>54-57</td>
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<td>57-60</td>
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<tr>
<td>60-63</td>
<td>3.2</td>
<td></td>
<td>3.2</td>
</tr>
</tbody>
</table>

**Figure 1:** (top) The bone model fitted within best fit rectangle, with the circumscribed circle around solid cortex model, and circumscribed circle around the canal model. (bottom) The example of inscribed and superscribed circles to the cortex cross-section and canal cross-section models.
HYPOTHESIS
We hypothesize that two-dimensional computed tomography (2D-CT) will improve the inter-observer reliability of distal humerus fracture classification and identification of key fracture characteristics compared to traction radiographs.

METHODS
Radiographs and 2D-CT scans of 18 distal humerus fractures treated at an academic level 1 trauma center were used to create two image sets, one with injury and traction radiographs and the other with injury films and 2D-CT. These were then randomly assigned to two PowerPoint presentations in random patient order. Eleven orthopaedic surgeons of various subdisciplines and training levels reviewed each PowerPoint two weeks apart and answered questions regarding classification, identification of coronal fractures, metaphyseal and articular comminution, and treatment options. Statistical analysis was performed to determine the inter-observer reliability for each variable using kappa-statistic.

RESULTS
2D-CT improved the inter-observer reliability of fracture classification by the AO/ASIF classification scheme \([k=0.28 \ (CI=0.23-0.33) \ to \ 0.41 \ (CI=0.37-0.46)]\), as well as the identification of articular comminution \([k=0.48 \ (CI=0.41-0.56) \ to \ k=0.64 \ (CI=0.59-0.70)]\). There was not a statistically significant difference in inter-observer reliability of identification of metaphyseal comminution, coronal fractures, or treatment decisions.

SUMMARY
• 2D-CT improved the inter-observer reliability of AO/ASIF classification and identification of articular comminution in distal humerus fractures compared with traction radiographs. • We showed non-inferiority of distal humerus traction radiographs compared with 2D-CT in the identification of metaphyseal comminution, coronal fractures, and determination of treatment options. • The inter-observer reliability for AO/ASIF and Jupiter and Mehne classification of
distal humerus fractures, as well as for the identification of key fracture elements is fair to moderate.

REFERENCES:

Table 1: Inter-observer reliability for each parameter as represented by Kappa statistic with (95% confidence intervals). Kappa values have been assigned to subdivisions, with values 0.00 to 0.20 indicating slight agreement; 0.21 to 0.40, fair agreement; 0.41 to 0.60, moderate agreement; 0.61 to 0.80, substantial agreement; and > 0.81, almost perfect agreement.

<table>
<thead>
<tr>
<th>Question</th>
<th>Standard Radiograph + Traction Radiograph</th>
<th>Standard Radiograph + 2D-CT</th>
</tr>
</thead>
</table>
| **AO Classification**             | **0.28052 (0.2313-0.3297)**              | **0.4138 (0.3699-0.4576)** **
| Jupiter Mehne Classification      | 0.3253 (0.2795-0.3712)                    | 0.3108 (0.2660-0.3557)      |
| Presence of Coronal Fracture      | 0.1733 (0.1048-0.2419)                    | 0.3038 (0.2090-0.3986)      |
| **Presence of Articular Commination** | **0.4842 (0.4094-0.5590)**              | **0.6425 (0.5923-0.6974)** **
| Presence of Metaphyseal Commination | 0.17259 (0.0992-0.2460)                    | 0.2376 (0.1568-0.3184)      |
| Presence of Separate Articular Fragment | 0.2498 (0.1728-0.3267)                    | 0.3885 (0.3048-0.4722)      |
| Presence of Impacted Stable Articular Fragment | 0.1438 (0.0323-0.2554)                    | 0.1524 (0.0608-0.2440)      |
| Do you need an Olecranon Osteotomy | 0.3039 (0.2570-0.3509)                    | 0.3664 (0.2900-0.4429)      |
| Decision of treatment type        | 0.0927 (0.0342-0.1512)                    | 0.0174 (-0.0294-0.0642)     |

(*) Values provided as the kappa coefficient with 95% confidence interval in parentheses. (**) Statistically Significant increase (p <0.05)
HYPOTHESIS
Isolated ulna fractures are rare and therefore management strategies are overall not well characterized. Post-operative complications in isolated fractures are also less well defined than in both bone forearm fractures. We sought to analyze and compare management trends of operative isolated ulnar fractures and ulnar fractures occurring in the setting of radius fractures at our institution, as well as incidence of complications with different forms of treatment.

METHODS
A retrospective chart review of patients treated for ulna fractures at the University of Virginia between 2017 and 2019 was performed. Patient groups were isolated ulna fractures and ulna fractures occurring with radius fracture. Records were reviewed to determine patient demographics, comorbidities, mechanism of injury, fracture characteristics, time to initial evaluation by a hand surgeon, type of intervention, and incidence of malunion or nonunion, change in range of motion, and any ulnar neuropathy noted. Descriptive statistics were used to analyze these groups.

RESULTS
20 patients underwent operative management of ulna fractures were identified. There was no significant difference in average age between patients with isolated ulna fractures and those with both bone fractures (p=0.03). 81% of isolated ulna fractures were in female patients, versus only 56% of both bone forearm fractures. 55% of isolated ulna fractures involved the distal third. 91% of isolated ulna fractures were closed injuries, versus 70% of both bone forearm fractures. Ulna fractures in isolation were more frequently comminuted (73%) than both bone ulna fractures (50%), but less likely to be displaced >50% or angulated >10 degrees relative to both bone fractures. 91% of isolated ulna fractures were managed with ORIF (55% plate fixation alone, 36% plate plus lag screws), versus 70% of ulna fractures occurring with radius fracture (60% plate fixation; 10% plate plus lag screws). One patient treated with ORIF required reoperation for hardware removal for implant-related pain.
**SUMMARY**
Ulna fractures are more likely to occur in isolation in female patients and are most common in the distal third. Isolated ulna fractures are more likely to be closed injuries with less displacement and angulation relative to ulna fractures occurring with a radius fracture, but are more commonly comminuted. Isolated ulna fractures were more frequently managed with ORIF than if a radius fracture was also present. ORIF resulted in limited pronation/supination in both isolated ulna fractures and ulna fractures occurring with a radius fracture; CRPP also resulted in limited pronation supination in 1 isolated ulna fracture.

**REFERENCES:**

<table>
<thead>
<tr>
<th></th>
<th>Ulna/radius fractures (n=10)</th>
<th>Isolated ulna fractures (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average age (years)</strong></td>
<td>48.2</td>
<td>47</td>
</tr>
<tr>
<td><strong>Gender % (male/female)</strong></td>
<td>44/56</td>
<td>19/81</td>
</tr>
<tr>
<td><strong>Dominant hand involvement (%)</strong></td>
<td>33</td>
<td>45</td>
</tr>
<tr>
<td><strong>Average time to presentation (days)</strong></td>
<td>18.7</td>
<td>4.3</td>
</tr>
<tr>
<td><strong>Mechanism of injury (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MVC</td>
<td>70</td>
<td>46</td>
</tr>
<tr>
<td>Fall</td>
<td>20</td>
<td>27</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(proximal/middle/distal)%</td>
<td>30/10/60</td>
<td>9/36/55</td>
</tr>
<tr>
<td><strong>Closed/open (%)</strong></td>
<td>70/30</td>
<td>91/9</td>
</tr>
<tr>
<td><strong>Simple/comminuted (%)</strong></td>
<td>50/50</td>
<td>73/27</td>
</tr>
<tr>
<td><strong>Displacement &lt;50%/&gt;50% (%)</strong></td>
<td>30/70</td>
<td>45/55</td>
</tr>
<tr>
<td><strong>Average angulation (degrees)</strong></td>
<td>23</td>
<td>8.6/36</td>
</tr>
<tr>
<td><strong>Angulation &gt;10 degrees (%)</strong></td>
<td>89</td>
<td>45/55</td>
</tr>
<tr>
<td><strong>Smoking status</strong></td>
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<td>(smoking/nonsmoking, %)</td>
<td>12.5/87.5</td>
<td>45/55</td>
</tr>
<tr>
<td><strong>Management (# ulna fractures)</strong></td>
<td>Plate fixation</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Lag screw</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Plate + lag screw</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>CRPP</td>
<td>3</td>
</tr>
<tr>
<td><strong>Limitation of pronation/supination (% per operative technique)</strong></td>
<td>Plate fixation</td>
<td>50/67</td>
</tr>
<tr>
<td></td>
<td>Lag screw</td>
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</tr>
<tr>
<td></td>
<td>Plate + lag screw</td>
<td>0/0</td>
</tr>
<tr>
<td></td>
<td>CRPP</td>
<td>0/0</td>
</tr>
<tr>
<td><strong>Average length of follow up (months)</strong></td>
<td>3.6</td>
<td>5.1</td>
</tr>
</tbody>
</table>

Table 1. Summary of demographic, mechanism of injury, fracture characteristics/morphology, operative management techniques, and post-operative limitation in range of motion with pronation and supination for the 21 total ulna fractures that underwent operative intervention at the University of Virginia between July 2017 and October 2019.
RF: Poster 194: Efficacy of a second corticosteroid injection for trigger fingers: Analyzing the likelihood of success based on co-morbid conditions and timing to predict failure.

Category: Bone and Joint; Tendon

Evaluation/Diagnosis; Treatment; Prognosis/Outcomes
Level of Evidence: 2

Christine Bub MD
Shaya Shahsavarani BS
Mark Cote DPT, MS,
Charles Ekstein MD
Kate Nellans MD, MPH,
Lewis Lane MD

HYPOTHESIS
Stenosing tenosynovitis, or trigger finger, is usually treated by an initial corticosteroid injection, but there is little data regarding factors that influence the efficacy of a second injection. We hypothesize that patient and timing factors help predict the likelihood of success of a second injection or predict whether surgical release would be necessary.

METHODS
This is a prospective case series of all patients presenting to the offices of two board certified hand surgeons between the years of 2007 to 2014 and followed for a minimum of 5 years. Patients were included if they were 18 or older and presented with a trigger finger as their active problem for their visit. Patient demographics, comorbidities, and previous trigger finger injections or surgery in a different finger were included in the analysis. A univariate and multivariate analysis was performed with statistical significance defined as <0.05.

RESULTS
Five hundred and fifty patients were identified, of which 266 had two or more injections in at least one finger (48%). In 428 fingers, 32.9% went on to require surgical release to relieve symptoms. The average age of subjects was 68.2 year and 41% percent were female. Patients who had a second injection to relieve trigger symptoms within 3 months of the first injection were at greater than twice the odds to undergo surgery for release of trigger symptoms. In practice, 52% of patients who had two injections within 3 months required surgery, while only 30% of patients required surgery if the two injections were more than 3 months between injections (p=0.007).

SUMMARY
• Steroid injections for any trigger finger within 3 months increase the risk of failure almost two-and-a-half-fold. • Hand surgeons may specifically counsel patients who require an early second injection about proceeding directly to surgery.
REFERENCES:

<table>
<thead>
<tr>
<th>Table 1 - Patient Demographics</th>
<th>Resolved with second injection</th>
<th>Require surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=287</td>
<td>n=141</td>
</tr>
<tr>
<td><strong>Gender, Female, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>127 (44.25)</td>
<td>60 (42.55)</td>
</tr>
<tr>
<td><strong>Affected digit, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thumb</td>
<td>41 (14.29)</td>
<td>26 (18.44)</td>
</tr>
<tr>
<td>Index</td>
<td>34 (11.85)</td>
<td>14 (9.93)</td>
</tr>
<tr>
<td>Middle</td>
<td>96 (33.45)</td>
<td>55 (39.01)</td>
</tr>
<tr>
<td>Ring</td>
<td>92 (32.06)</td>
<td>41 (29.08)</td>
</tr>
<tr>
<td>Small</td>
<td>24 (8.36)</td>
<td>5 (3.55)</td>
</tr>
<tr>
<td><strong>Diabetes Status at First Injection, n (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>239 (83.28)</td>
<td>114 (80.85)</td>
</tr>
<tr>
<td>Type 1</td>
<td>2 (0.70)</td>
<td>1 (0.71)</td>
</tr>
<tr>
<td>Type 2</td>
<td>42 (16.03)</td>
<td>26 (18.44)</td>
</tr>
<tr>
<td><strong>Rheumatoid Arthritis, n (%)</strong></td>
<td>6 (2.09)</td>
<td>1 (0.71)</td>
</tr>
<tr>
<td>DeQuervain’s Tenosynovitis, n (%)</td>
<td>28 (8.36)</td>
<td>17 (12.06)</td>
</tr>
<tr>
<td>Carpal Tunnel Syndrome, n (%)</td>
<td>119 (41.46)</td>
<td>74 (52.48)</td>
</tr>
<tr>
<td>Breast Cancer on Aromatase Inhibitors, n (%)</td>
<td>4 (1.39)</td>
<td>3 (2.13)</td>
</tr>
<tr>
<td>History of Autoimmune Disease, n (%)</td>
<td>6 (2.09)</td>
<td>8 (5.67)</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Table 2 - Days between primary and secondary injection, grouped</th>
<th>Resolved with second injection</th>
<th>Require surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=287</td>
<td>n=141</td>
</tr>
<tr>
<td><strong>Reinjection time frame</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;3 Months, n (%)</td>
<td>24 (48)</td>
<td>26 (52)</td>
</tr>
<tr>
<td>3-6 Months, n (%)</td>
<td>112 (65.5)</td>
<td>59 (34.5)</td>
</tr>
<tr>
<td>6-12 Months, n (%)</td>
<td>95 (74.8)</td>
<td>32 (25.2)</td>
</tr>
<tr>
<td>12+ Months, n (%)</td>
<td>56 (70)</td>
<td>24 (30)</td>
</tr>
</tbody>
</table>
HYPOTHESIS
Vascularized denervated muscle targets (VDMTs) represent a novel surgical approach that can more effectively treat and prevent painful neuromas and provide signal amplification for intuitive control of prostheses following amputation than currently available approaches.

METHODS
In Sprague-Dawley rats, the common peroneal (CP) nerve was transected and implanted into the lateral gastrocnemius muscle that was either 1) vascularized and innervated (representing burying nerve into unmodified muscle; BIM); 2) devascularized and denervated (representing regenerative peripheral nerve interface, RPNI), or 3) vascularized and denervated (VDMT; experimental ). 4) In untreated controls, the CP nerve was transected and without implantation into muscle. In aim 1, the efficacy of signal amplification was assessed by characterizing compound motor action potentials (CMAPs) within the lateral gastrocnemius following CP stimulation at 100 days post-operatively. In aim 2, the efficacy of neuroma prevention by histologically evaluating regenerating sensory axons within the lateral gastrocnemius, and expression of regeneration- and pain- associated genes within the dorsal root ganglia.

RESULTS
At sacrifice, the VDMTs demonstrated maintenance of muscle bulk while the RPNI s were resorbed and replaced with scar tissue (Fig.1). CMAP peak amplitude of the lateral gastrocnemius stimulated by the common peroneal was 0.19 µV in the BIM group; RPNI 0.080 ± 0.073 µV; VDMT 3.27 ± 0.93 µV (P<0.01, Fig.2). CMAP peak amplitude of a naïve gastrocnemius with intact tibial innervation (naïve) stimulated from the same distance was 4.0 µV. There was also a significant difference in waveform signal-to-noise ratio quality between the RPNI and VDMT groups (Fig.2). Aim 2 results are pending.
SUMMARY
VDMTs are more receptive to reinnervation than already innervated muscle. VDMTs demonstrate less resorption than RPNIs. VDMTs demonstrate improved CMAP amplitude and quality than RPNIs. Data pertaining to neuroma prevention is pending.

REFERENCES:
Figure 2. CMAP peak amplitudes and representative CMAP waveforms, asterisk signifies P<0.01. BIM = bury in muscle; RPNI = regenerative peripheral nerve interface; VDMT = vascularized denervated muscle target.
HYPOTHESIS
Proximal row carpectomy (PRC) and limited wrist fusion (LRF) are two well established surgical treatments for post-traumatic wrist/carpal bone arthrosis. We hypothesize that the patient reported outcomes for physical function and pain scores, through PROMIS computer adaptive testing, would be similar during post-operative evaluations for limited wrist fusion and proximal row carpectomy.

METHODS
Patients who underwent limited wrist fusion or proximal row carpectomy by a fellowship trained hand surgeon within our institution were identified for analysis. Limited wrist fusion cases between 1/2016 and 11/2019 were queried utilizing CPT Codes 25820 and 25825, while proximal row carpectomy cases, during that same time period, were queried with CPT code 25215. PROMIS Physical Function (PF) and Pain Interference (PI) were collected at subsequent post-operative visits. PROMIS data for each procedure was divided based on time relative to surgery and placed into pre-op 1yr-1week, post-op 1wk-1mo, 1mo-3mo, 3mo-6mo, 6mo-1yr, and 1yr-2yr categories. The mean PF and PI outcomes for each time category was then compared between procedures, and student t-tests were performed for statistical comparison between means.

RESULTS
A total of 40 patients underwent limited wrist fusion while 38 patients underwent proximal row carpectomy, and all 78 patients completed pre- and post-operative PROMIS outcomes testing. There were more females for both procedures (22 limited wrist arthrodesis and 20 for PRC) with left side being more common in arthrodesis (25) and right more common in PRC (23). Overall there were nearly twice as many post-operative visits for limited wrist fusion (328) than carpectomy (174). Physical function was better for proximal row carpectomy than limited arthrodesis for all time categories, but only with statistical significance (p <0.01) for 3mo-6mo and 1yr-2yr (fig. 1). Pain interference was also better in the PRC group with statistical significance (p <0.01) only at the 3mo-6mo time category (fig. 2).
SUMMARY
· Physical function, as measured by PROMIS, was better following proximal row carpectomy. · PRC group had lower pain interference PROMIS scores. · While the number of patients undergoing each procedure was similar, the number of post-operative visits was significantly less for proximal row carpectomy. · CPT codes do not necessitate causation for a particular procedure. · Next steps include analyzing costs and establishing procedural relative value.

REFERENCES:


RF: Poster 199: Outcomes of Type I Open Distal Radius Fractures: A Comparison of Delayed and Urgent Open-reduction Internal Fixation

Category: Bone and Joint

Treatment
Level of Evidence: 4

Tyler W. Henry BS
Richard McEntee BS
Jonas L. Matzon MD
Kevin Lutsky MD

HYPOTHESIS
Type I open distal radius fractures treated with open-reduction internal fixation (ORIF) have demonstrated minimal risk for infection. For this reason, they may not require urgent surgical treatment. The purpose of this study was to evaluate the outcomes of patients with type I open distal radius fractures treated with delayed ORIF compared to urgent ORIF. We hypothesize that the overall outcomes and complication rates will not differ significantly between delayed and urgent ORIF.

METHODS
We identified all Gustilo-Anderson type I open distal radius fractures that had undergone ORIF using volar plating over a 5-year period. Patients were stratified into those treated urgently within 24 hours and those scheduled for delayed surgery. Outcomes including functional scores, complications, re-operations, and radiographic measures were compared.

RESULTS
Twenty-four patients with type I open distal radius fractures were treated with ORIF using volar plating (Table 1). Seven patients were treated with delayed ORIF at a mean time from injury to surgery of seven days (Range: 2 – 15 days) and a mean time from initial office visit to surgery of five days (Range: 1 – 8 days). Seventeen patients were treated with urgent ORIF within 24 hours of presentation to the emergency department. In the delayed treatment group, all seven patients were started on a course of oral antibiotics at the time of presentation that was continued through the time of surgery (5 Cephalexin, 1 Amoxicillin/Clavulanic acid, 1 Clindamycin). In the urgent treatment group, all seventeen patients received empiric intravenous antibiotics, and nine of those patients were continued on intravenous antibiotics for 48 hours. Following surgery, eight patients treated urgently were prescribed a course of oral antibiotics (6 Cephalexin, 2 Clindamycin). Two patients received both 48 hours of intravenous antibiotics and a course of oral antibiotics. There were no infections in either group and a single re-operation in each group. The mean post-operative Quick-DASH score was 29 (Range: 0 – 77), and did not differ significantly between delayed (mean = 19) and urgent (mean = 38) treatment. Rate of complications, and radiographic measures did not differ significantly between the groups (Table 2).
SUMMARY
- Open distal radius fractures are traditionally treated emergently.
- Type I open distal radius fractures appear amenable to delayed outpatient ORIF provided that the wound is clean at the time of initial presentation and that antibiotics are initiated appropriately.
- Prospective trials further evaluating the safety and efficacy of delayed ORIF appear warranted.

<table>
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<tr>
<th>Variable</th>
<th>Study Population (n = 24)</th>
<th>Delayed Treatment (n = 7)</th>
<th>Urgent Treatment (n = 17)</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>Mean Age (years)</td>
<td>63 (20 – 89)</td>
<td>63 (47 – 73)</td>
<td>63 (20 – 89)</td>
<td>.973</td>
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<tr>
<td>Dominant-sided Injuries</td>
<td>8 (-)</td>
<td>1 (-)</td>
<td>7 (-)</td>
<td>.174</td>
</tr>
<tr>
<td>AO Fracture Classification</td>
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<tr>
<td>Type A</td>
<td>7 (-)</td>
<td>1 (-)</td>
<td>5 (-)</td>
<td>.635</td>
</tr>
<tr>
<td>Type B</td>
<td>2 (-)</td>
<td>1 (-)</td>
<td>1 (-)</td>
<td></td>
</tr>
<tr>
<td>Type C</td>
<td>17 (-)</td>
<td>5 (-)</td>
<td>11 (-)</td>
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<tr>
<td>Mean BMI</td>
<td>28 (17 – 43)</td>
<td>30 (21 – 40)</td>
<td>27 (17 – 43)</td>
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<tr>
<td>Patients with Hypertension</td>
<td>8 (-)</td>
<td>2 (-)</td>
<td>6 (-)</td>
<td>1.00</td>
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<tr>
<td>Patients with Diabetes</td>
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<td>0 (-)</td>
<td>0 (-)</td>
<td></td>
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<tr>
<td>Current Tobacco Users</td>
<td>2 (-)</td>
<td>0 (-)</td>
<td>2 (-)</td>
<td>.577</td>
</tr>
<tr>
<td>Mean Time to Follow-up (weeks)</td>
<td>58 (11 – 276)</td>
<td>32 (11 – 123)</td>
<td>70 (11 – 276)</td>
<td>.318</td>
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Table 1. Demographic characteristics of the study cohort, stratified by treatment group.
<table>
<thead>
<tr>
<th></th>
<th>Study Population (n = 24)</th>
<th>Delayed Treatment (n = 7)</th>
<th>Urgent Treatment (n = 17)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Re-operations</strong></td>
<td></td>
<td></td>
<td></td>
<td>.507</td>
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<tr>
<td><strong>Total Complications</strong></td>
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<td>.134</td>
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<tr>
<td>Hardware failure</td>
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<td>1*</td>
<td>0</td>
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<tr>
<td>DRUJ arthritis</td>
<td>2</td>
<td>1</td>
<td>1</td>
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<td>Flexor tendon adhesions</td>
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<td>Radioulnar synostosis</td>
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<tr>
<td>CRPS</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Symptomatic hardware</td>
<td>1</td>
<td>0</td>
<td>1*</td>
<td></td>
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</table>

<table>
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<th>Radiographic Measure</th>
<th>Study Population (n = 24)</th>
<th>Delayed Treatment (n = 7)</th>
<th>Urgent Treatment (n = 17)</th>
<th>p-value</th>
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<tbody>
<tr>
<td>Volar Tilt</td>
<td>9°</td>
<td>10°</td>
<td>8°</td>
<td>.610</td>
</tr>
<tr>
<td>Radial Tilt</td>
<td>22°</td>
<td>23°</td>
<td>22°</td>
<td>.781</td>
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<tr>
<td>Radial Height</td>
<td>12 mm</td>
<td>13 mm</td>
<td>11 mm</td>
<td>.222</td>
</tr>
<tr>
<td>Ulnar Variance</td>
<td>0.7 mm</td>
<td>1 mm</td>
<td>0.6 mm</td>
<td>.676</td>
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</table>

Table 2. Re-operation and complication occurrences, and mean values of radiographic measurements at final follow-up within the study population, stratified by treatment group. CRPS = Complex regional pain syndrome. *Required re-operation
RF: Poster 202: Methamphetamine and Orthopaedic Procedures: A objective measurement of intraoperative and perioperative risk

Category: Other Clinical Topics

Treatment; Prognosis/Outcomes; Patient Education
Level of Evidence: 4

Erin Murray
Sean Bonanni
Anthony Oyekan
Amelia Sorensen

HYPOTHESIS
Methamphetamine positive patients undergoing surgical intervention within 24 hours of a positive drug screen will have increased blood pressure lability compared to those without positive drug screens. Additionally, methamphetamine positive patients are at higher risk for perioperative complications.

METHODS
A retrospective case control study was performed on 40 patients with a methamphetamine positive drug screen within 24 hours of surgery and 40 patients without a positive drug screen were reviewed from 2013-2018. Blood pressures from the anesthesia record, disposition, and perioperative complications were recorded. Intraoperative lability was determined by utilizing the blood pressure lability index (LI), a validated measurement which correlates with risk for perioperative complications.

RESULTS
The study group consisted of 14 females, 26 males. The control group consisted of 11 females and 29 males. The average LI for the control group was 0.505 +/-0.183 while the methamphetamine ground was 0.550 +/-0.189, p=0.286. Four patients in the control group required ICU admission, one of which was unplanned. Seven methamphetamine positive patients required ICU admission, none were unplanned prior to surgery. There were no death during the hospitalization for either group.

SUMMARY
● This is the first study to provide an objective measurement of intraoperative lability in patients who tested positive for methamphetamine within 24 hours of surgery. ● There was no statistically significant difference between the groups LI, but larger studies will be needed in the future. ● The exact perioperative risk attributable to acute methamphetamine intoxication remains unclear, and additional research is needed before we can accurately counsel patients on the risks of surgery.
REFERENCES:
RF: Poster 209: Regional Anesthesia and Postoperative Resource Utilization in Wrist Fracture Surgery

Category: Bone and Joint; Nerve; Other Clinical Topics

Evaluation/Diagnosis; Prognosis/Outcomes
Level of Evidence: 4

Michael Sun
Kapil Anand
Eugene Tsai
David Kulber

HYPOTHESIS

In patients who undergo surgery for distal radius fractures and receive regional anesthesia compared to only general anesthesia, a "rebound pain" phenomenon has been observed. We hypothesize that despite this possible increase in pain when the regional anesthesia wears off postoperatively, this does not affect patients' usage of healthcare resources for postoperative pain.

METHODS

A retrospective review was performed of patients who underwent operative fixation of a distal radius fracture in one calendar year at our institution. Charts were reviewed to find any differences between the two anesthesia approaches (regional anesthesia with sedation versus general anesthesia) in regard to pain scores, unplanned encounters with the healthcare system (emergency department, office, or telephone) for pain in the first week after surgery, and persistent pain symptoms requiring referral to a pain management specialist. Follow up through one year post-surgery was included. For each outcome, the incidence was determined, and then relative risk with 95% confidence interval was determined to compare between the two anesthesia approaches.

RESULTS

91 patients met eligibility requirements, 73 (80%) of whom received regional anesthesia and 18 (20%) of whom received only general anesthesia. There was no significant difference in the incidence of patients seeking unplanned medical attention for pain in the first week after surgery. Patients who received regional anesthesia reported significantly better pain scores in the PACU compared to patients who received only general anesthesia. There was no significant difference in persistent pain symptoms requiring referral to pain management specialists by 1 year after surgery.

SUMMARY

• Regional anesthesia effectively reduced pain scores in the immediate postoperative period. • Compared to general anesthesia, regional anesthesia does not appear to affect the incidence of patients seeking additional care for pain in the first week after surgery. • It does not appear to
affects the incidence of persistent painful symptoms in the long term that would require referral to pain management specialists.

REFERENCES:
HYPOTHESIS
Releasing the A4 pulley will not create a significant amount of anatomic bowstringing. Further release of the C1, A3, and C2 pulleys will increase the amount of tendon bowstringing.

BACKGROUND
The A4 pulley aids in proper flexor tendon mechanics. Although its importance in preventing bowstringing has been well established, partial or complete release of the A4 pulley has gained attention in the setting of flexor tendon repair recently. If done properly, releasing these pulleys can improve functional recovery and is unlikely to cause clinical problems. The purpose of our cadaveric study was to examine bowstringing of the flexor tendon when the A4 pulley is released. We also examined bowstringing with additional release of C1, A3, and C2 pulleys.

METHODS
The index, long, ring and small finger flexor digitorum profundus (FDP) tendons were studied on 5 cadaveric hands. The FDP tendon was exposed on each of the digits from the MCP to DIP joints through a midline volar incision. Manual traction was applied to the FDP tendon in order to form a composite fist. Measurements of pulp to palm distance and flexor tendon bowstringing were measured with intact pulley and with subsequent release of the A4 pulley, followed by the release of the C1, A3, and C2 pulleys as a unit. Bowstringing was measured using the distance from the middle phalanx to the dorsal aspect of the FDP tendon, using digital calipers.

RESULTS
The measurement of bowstringing followed a normal distribution for the A4 released digits (p=0.097) and the C1-A4 released digits (p=0.071). ANOVA showed no difference in bowstringing between finger types with A4 released (p=0.119) or with C1-A4 released (p=0.467). The mean (± SD) bowstringing present as measured by the widest gap between the tendon and bone was 1.55 (± 1.00) mm in the A4 released group vs. 3.54 (± 1.30) mm in the C1-A4 released group. This difference was statistically significant (p=0.0002).
SUMMARY
Venting the A4 pulley was once considered to be aggressive, however in recent years release of
the A4 pulley has become a key step for many hand surgeons in specific situations. Recent
reports have noted no clinically dysfunctional tendon bowstringing. Our results support the
evidence that the loss of the A4 pulley alone may be mechanically well-tolerated. Complete
transection of A4-C1 results in significant anatomical bowstringing. Clinically, it is important for
the surgeon to decide which window to work in. They can use either C1, A3, C2 window or A4
window but not both.

REFERENCES:
2018;141(6):1427-1437.

Table 1: Mean Pulp to Palm intact and following pulley release n=5

<table>
<thead>
<tr>
<th>Finger</th>
<th>Intact Pulp to Palm (cm)</th>
<th>A4 Released Pulp to Palm (cm)</th>
<th>A4-C1 Released Pulp to Palm (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index</td>
<td>1.38</td>
<td>1.44</td>
<td>1.63</td>
</tr>
<tr>
<td>Long</td>
<td>1.45</td>
<td>1.46</td>
<td>1.84</td>
</tr>
<tr>
<td>Ring</td>
<td>0.94</td>
<td>0.95</td>
<td>1.62</td>
</tr>
<tr>
<td>Small</td>
<td>0.25</td>
<td>0.32</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Table 2: Mean Tendon Bowstringing following pulley release n=5

<table>
<thead>
<tr>
<th>Finger</th>
<th>Tendon Bowstringing A4 Released (cm)</th>
<th>Tendon Bowstringing A4-C1 Released (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index</td>
<td>0.24</td>
<td>0.40</td>
</tr>
<tr>
<td>Long</td>
<td>0.28</td>
<td>0.43</td>
</tr>
<tr>
<td>Ring</td>
<td>0.12</td>
<td>0.37</td>
</tr>
<tr>
<td>Small</td>
<td>0.12</td>
<td>0.51</td>
</tr>
</tbody>
</table>
RF: Poster 211: Location of the Flexor Carpi Radialis Myotendinous Junction: A Cadaveric Study

Category: Skin and Soft Tissue; Tendon

Surgical Technique; Anatomy; Basic Science
Level of Evidence: N/A

Kunal Panwar
Daniel Lara
Marc Trzeciak
Eric G. Huish, Jr.

HYPOTHESIS
The flexor carpi radialis myotendinous junction has a predictable anatomic relationship reproducible by cadaveric study. Background: The flexor carpi radialis (FCR) tendon is frequently selected for use as an interposition graft, for tendon transfers, and as a landmark for volar forearm approaches. Original surgical techniques of FCR harvest recommend incision placement 10cm proximal to wrist crease. To date no anatomic study has been conducted to precisely define the location of the FCR myotendinous junction.

METHODS
5 fresh frozen cadavers were dissected, exposing the full length of the FCR. The radial styloid (RS) was selected as a distal anatomic landmark, the medial epicondyle (ME) was chosen as a proximal landmark. All measurements were taken along the length of the FCR tendon. As the FCR myotendinous junction is chevron shaped, we marked both the proximal myotendinous junction (PMT) and distal myotendinous junction (DMT), with the DMT indicating the beginning of purely tendinous FCR. Four measurements were taken for each arm: 1) RS to DMT 2) RS to PMT 3) ME to PMT 4) ME to DMT.

RESULTS
Pearson correlation coefficient comparing tendinous length of the FCR to the overall forearm length was 0.896 indicating a strong positive correlation (p=0.040). The mean ratio of tendinous FCR length to forearm length was 0.42 ± 0.05, ranging from 0.38 to 0.50. This correlated to a distance 11.7 ± 2.3cm proximal from the radial styloid.

SUMMARY
Our results suggest incision placement 10cm from proximal wrist crease to be unreliable in forearms too short or too long. We recommend measuring 40% of the length from RS to ME as a more consistent marker for FCR harvest.
Figure 1: Demonstrating indication for radial styloid, distal MT junction (indicated with forceps), and proximal myotendinous junction.

**Measurements taken from each cadaveric specimen**

<table>
<thead>
<tr>
<th>Specimen</th>
<th>RS to DMT (CM)</th>
<th>DMT to ME (CM)</th>
<th>RS to PMT (CM)</th>
<th>PMT to ME (CM)</th>
<th>Total Length (CM)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>14.5</td>
<td>14.5</td>
<td>19.0</td>
<td>10.0</td>
<td>29.0</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>9.5</td>
<td>15.2</td>
<td>13.2</td>
<td>11.5</td>
<td>24.7</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>10.3</td>
<td>17.1</td>
<td>15.6</td>
<td>11.8</td>
<td>27.4</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>13.8</td>
<td>16.3</td>
<td>17.8</td>
<td>12.3</td>
<td>30.1</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>10.5</td>
<td>16.2</td>
<td>13.7</td>
<td>12.9</td>
<td>26.6</td>
</tr>
</tbody>
</table>

RS = radial styloid, ME = medial epicondyle, DMT = distal myotendinous junction, PMT = proximal myotendinous junction
RF: Poster 212: Validation of Smartphone-based Clinical Images as Substitute for Goniometer Measurements in Pediatric Thumb IP Joints

Category: Pediatric Trauma and Congenital Conditions; Other Clinical Topics; Miscellaneous Nonclinical Topics

Evaluation/Diagnosis; Patient Education; Residents/Fellow/Educator Resources
Level of Evidence: 3

Dr. Madelyn Lauer
Christine Cheng
Abdullah Said

HYPOTHESIS
We hypothesize there will be no clinically significant difference between photo and goniometer measurements of pediatric thumb intraphalangeal joints. We will also evaluate the inter- and intra-observer reliability of photo measurements. Many published studies have validated the use of clinical photographs as a substitute for goniometer ROM measurements. To our knowledge no studies have evaluated ROM in the thumb interphalangeal (IP) joint. By validating the accuracy of digital photography on ROM measurements, we hope this will allow us to complete follow-up studies of our pediatric trigger thumb population.

METHODS
Data was collected from 25 consecutive clinic patients, age 5-17. These patients did not have a history of thumb trauma or congenital deformity. An information sheet with instructions on how to obtain clinical images was provided to patients and family members for review after consent was obtained. Additionally, a YouTube video illustrating thumb range of motion and specific instructions describing how to frame the thumb in the photograph was shown. The parent/guardian or patient obtained two images of each thumb in maximal flexion and in maximal extension. Subsequently, the investigator used the same smartphone to obtain an additional two images of each thumb, in maximal flexion and in maximal extension. The investigator then manually measured the range of motion of each thumb IP joint using a traditional goniometer. Photoshop was used to measure angles of motion on the clinical images. The thumb intra-phalangeal (IP) and metacarpophalangeal (MCP) joint of the 179 images were analyzed independently by two of the investigators (CJC, MFL). After a minimum of two weeks, the images were randomized once again and each of the investigators (CJC, MFL) then repeated digital measurements on the obtained photographic images using the same methods. Pearson correlation coefficients were calculated.

RESULTS
In our 25 patients with a total of 179 images, Pearson coefficient of image measurements versus goniometer was 0.9518, suggesting excellent correlation. The inter-observer correlation was also excellent at 0.9773, and intra-observer measurements are 0.97. This suggests
smartphone clinical images are an appropriate alternative to traditional goniometer measurements.

SUMMARY

• Goniometers are not commonly available to the general patient population, and large catchment areas can limit patients from proper follow up. • This study validates the use of clinical images as an acceptable alternative to traditional goniometer measurements. • Using clinical images in place of goniometers allows for increased ease of patient care and collection of data for research purposes.

REFERENCES:
How to Measure Thumb Motion

1. Start by getting something medium to dark blue or black to use as a background, like a blanket or towel.

2. Palm to the sky, line your thumb up with the camera. You should be able to see $\frac{1}{2}$ fingernail and $\frac{1}{2}$ finger pad.

   ![Too much pad](image1.png)
   ![Just right](image2.png)
   ![Too much nail](image3.png)

3. Once your thumb is lined up, bend the knuckle closest to the nail as much you can. Take a picture. (Make sure to tap the screen to focus on your thumb)

4. Now, straighten the knuckle closest to the nail as much you can. Take a picture. (Make sure to tap the screen to focus on your thumb)

5. Repeat with the other thumb.

6. Send images to your doctor as directed.

Visit [https://tinyurl.com/thumbmeasurements](https://tinyurl.com/thumbmeasurements) for an instructional video.
**HYPOTHESIS**

With this study, we aim to identify any effect surgical delay has on post-operative complication rates after surgical fixation of distal radius fractures in diabetic patients. The authors hypothesize that delaying operative fixation of distal radius fractures in this population can lead to better wound healing and decreased complication rates.

**METHODS**

All patients who underwent surgical fixation of distal radius fractures between 2012 and 2019 were reviewed. Patients were divided into two groups: one with diabetes mellitus and one without. Any patient with open physes, open injuries, polytrauma to the injured wrist and hand, or missing chart information was excluded. For each patient, demographics, laboratory values, comorbidities, injury details, fixation method, and post-operative complications were noted. Our primary analysis explored whether delayed surgical fixation affected complication rate. We also looked to see whether other comorbidities served as risk factors for complications using univariate analysis and multi-variable regression analysis.

**RESULTS**

Overall, 124 diabetic and 371 non-diabetic distal radius fractures were included in our study. The diabetic group had a statistically higher rate of total complications (21.0%) compared to the non-diabetic group (13.5%) (p=0.045) but similar rates of major complications that required surgical intervention (9.7% versus 5.7%, p=0.12). There was no statistical difference in the surgical time between the diabetic and non-diabetic fractures that had complications overall (8.1 versus 10.2 days, p=0.31) or major complications (7.1 versus 8.3 days, p=0.69). Surgical timing was not a risk factor for total (p=0.50) or major complications (p=0.32) in diabetic fracture univariate analysis. This held true in multi-variable regression analyses as well. Only younger age was significantly associated with higher total complications in univariate (p=0.02) and multi-variable (p=0.031) analysis.

**SUMMARY**

Complication rates after surgically stabilized distal radius fractures in diabetic patients are not affected by surgical timing after injury. Surgeons should still consider the entire clinical picture,
including fracture pattern, functional status, and comorbidities (age and smoking) when determining what treatment will maximize outcomes and decrease complications.

**Figure 1.** Complication Rates in Diabetic and Non-Diabetic Distal Radius Fractures. Total Complications and Major Complications (Complications That Needed Repeat Surgery).

**Figure 2.** Total Complications Stratified by Surgical Delay from Time of Injuries in Days in Diabetic Distal Radius Fractures.
RF: Poster 214: Does the Addition of Other Procedures Increase Postoperative Complications After Carpometacarpal Arthroplasty?

Category: Bone and Joint; Tendon; Other Clinical Topics

Evaluation/Diagnosis; Patient Education; Residents/Fellow/Educator Resources
Level of Evidence: 3

Pavin Trinh
Clifford Shecket
Danielle Rochlin
Paige Fox
Catherine Curtin

HYPOTHESIS
We hypothesized that patients who underwent carpometacarpal (CMC) arthroplasty and a trigger finger or carpal tunnel release would have more postoperative pain complications than those undergoing only CMC arthroplasty.

METHODS
We queried the IBM® MarketScan® Research Databases from January 1st, 2012 to December 31st, 2016. We identified all patients who received a CMC arthroplasty by CPT code. Patients who only had one code for CMC arthroplasty were assigned to the “CMC only” group. Patients who had codes for an additional procedure(s) on the same day were assigned to the “multiple procedures” group. The additional procedures included carpal tunnel and trigger finger release. Descriptive statistics were performed to summarize patient characteristics. We had four outcomes: persistent opioid use, diagnosis of complex regional pain syndrome (CRPS), 30 day readmissions, and 30 day complications. Pearson’s chi-squared analysis evaluated significant differences in rates of outcomes. We created multiple logistic regression models to determine the odds of pain related outcomes based on the patient group.

RESULTS
We found 22,074 patients, where the mean age was 59 years (SD 9) and 76% were women. The CMC only group consisted of 18,010 patients. The multiple procedures group consisted of 4,064 patients. In addition to a CMC arthroplasty, these patients received either a carpal tunnel release (74%), a trigger finger release (20%), or both (6%). CMC only patients had lower rates of persistent opioid use compared to patients who underwent multiple procedures (16% vs 18%, respectively; p=0.041). Readmission rates were also lower for CMC only patients (3% vs 4%, respectively; p=0.017). CMC only patients had decreased odds of persistent opioid use (OR=0.85; 95% confidence interval (CI), 0.75-0.97, p=0.013) and readmissions (OR=0.80; 95% CI, 0.67-0.96, p=0.016). The most common reason for readmission was pain (16%). There were no differences in the odds of developing CRPS or
complications between the two groups.

**SUMMARY**
- We found that adding another procedure to a CMC arthroplasty increases the odds of adverse outcomes such as persistent opioid use and readmission.
- Thus the patient and provider should weigh the balances of efficiency to do these procedures concurrently versus the increased risks with multiple procedures.
- This study suggests that careful consideration should be given when adding procedures to CMC arthroplasty.

### Table 1. Rates of Outcomes vs. Procedure Count

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CMC Only (%)</th>
<th>Multiple Procedures (%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persistent Opioid Use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1,548 (15.71)</td>
<td>371 (17.51)</td>
<td>0.041</td>
</tr>
<tr>
<td>No</td>
<td>8,304 (84.29)</td>
<td>1,753 (82.49)</td>
<td></td>
</tr>
<tr>
<td>Readmissions (30d)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>587 (3.26)</td>
<td>163 (4.01)</td>
<td>0.017</td>
</tr>
<tr>
<td>No</td>
<td>17,423 (96.74)</td>
<td>3,901 (95.99)</td>
<td></td>
</tr>
<tr>
<td>CRPS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>138 (0.77)</td>
<td>24 (0.59)</td>
<td>0.236</td>
</tr>
<tr>
<td>No</td>
<td>17,872 (99.23)</td>
<td>4,040 (99.41)</td>
<td></td>
</tr>
<tr>
<td>Complications (30d)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>49 (0.27)</td>
<td>15 (0.37)</td>
<td>0.299</td>
</tr>
<tr>
<td>No</td>
<td>17,961 (99.71)</td>
<td>4,049 (99.63)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2. Odds of Outcomes by Procedure Count

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p</th>
</tr>
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<tbody>
<tr>
<td>Persistent Opioid Use</td>
<td>0.85</td>
<td>0.75-0.97</td>
<td>0.013</td>
</tr>
<tr>
<td>Readmissions (30d)</td>
<td>0.80</td>
<td>0.67-0.96</td>
<td>0.016</td>
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<tr>
<td>CRPS</td>
<td>1.28</td>
<td>0.82-2.00</td>
<td>0.275</td>
</tr>
<tr>
<td>Complications (30d)</td>
<td>0.77</td>
<td>0.41-1.43</td>
<td>0.405</td>
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</table>