HYPOTHESIS
Risk factors for congenital upper limb differences (CoULDs) are often studied at the general population level. The Congenital Upper Limb Differences (CoULD) registry provides a unique opportunity to study the impact of prenatal risk factors within the population of patients with a CoULD. Our central hypothesis is that most patients will not have an identified self-reported risk factor.

METHODS
All patients with malformations enrolled between June 2014 and March 2020 in the prospective CoULD registry, a national multicenter database of patients diagnosed with a CoULD, were included in this cross-sectional, observational analysis. We analyzed self-reported, prenatal risk factors including: maternal smoking, alcohol use, recreational drug use, prescription drug use, gestational diabetes (GDM), and gestational hypertension. Outcome measures included comorbid medical conditions, proximal involvement of the limb difference, bilateral involvement, and additional orthopaedic conditions. Multivariable logistic regression was used to analyze the effect of risk factors, controlling for sex and presence of named syndrome.

RESULTS
2410 patients were analyzed. 72% (1734) did not have a self-reported risk factor. Of the 28% (676) that did have at least one risk factor, prenatal maternal prescription drug use was the most frequent (376/2410; 16%). Maternal prescription drug use was associated with increased odds for patient medical comorbidities (OR 1.43, p=0.02). Gestational diabetes was associated with increased odds for comorbid medical conditions (OR 1.58, p=0.04), additional orthopaedic conditions (OR 1.51, p=0.04), and proximal involvement (OR 1.52, p=0.04). Overall, reporting one or more risk factor increased the odds of patient comorbid medical conditions (OR 1.42, p<0.001) and additional orthopaedic conditions (1.25, p=0.03).
SUMMARY

- Most caregivers (72%) did not report a risk factor during enrollment which speaks to the ill-defined etiologies of CoULDs.
- Reporting a risk factor in general and gestational diabetes alone were associated with a more medical and orthopaedic comorbidities in patients along with having more proximal upper limb anomalies.
- These findings suggest that risk factors may correlate with increased burden of disease and that further investigation is needed into the interaction of gestational diabetes and the development of CoULDs.
Annual Meeting Live Paper 28: Fracture fixation strength in metacarpal plating versus intramedullary nailing using a 3-point bending model: a cadaveric, biomechanical study

SPP0154
Hand

Christopher Beaumont
David Beason
Kathleen McKeon

HYPOTHESIS
The purpose of our study was to evaluate the ultimate load to failure for two metacarpal fracture fixation strategies, plating versus intramedullary nailing and then compare them to the native metacarpal. Our hypothesis is that the intramedullary nail after fracture fixation would more closely restore the native strength of the metacarpal when compared to plate fixation.

METHODS
11 matched pair cadaveric hands (age range 19-49, 5 males / 6 females) were dissected to produce 88 intact and equally-distributed metacarpals (small, ring, long and index). The metacarpals were then randomly selected to undergo either plate fixation (Synthes) or intramedullary nail fixation (Exsomed Innate). A 3-point bending model was used to test the native metacarpal strength to the point of fracture creation and subsequently the plate and nail fixation constructs after fracture fixation. The data was then collected and compared against the native metacarpal strength to create a normalized ultimate load to failure.

RESULTS
Normalized maximum force (ratio of fixation:native) for the nail specimens returned significantly closer to normal than the plated specimens for the small (p=0.00002), long (p=0.00007), and index (p=0.02) fingers, as well as when combining all metacarpals (p=0.00001, Table 1). We did not detect a difference in maximum force for the ring finger (p=0.7).

SUMMARY
• When compared to plate fixation, metacarpal intramedullary nailing more closely restores the ultimate load to failure of the native metacarpal.

REFERENCES
Figure 1: Normalized Ultimate Load (means ± SD). Intermedullary nails increased (i.e., returned fractured metacarpals significantly closer to native) ultimate loads compared to plate fixation for the index, long, and small fingers, as well as when all metacarpals were combined. A ratio of native:native is shown for reference.

Table 1. Overall (i.e., all four metacarpals combined) data for the plate and nail groups, normalized to their respective native values. Note that a value of 1.0 represents a complete return to normal.

<table>
<thead>
<tr>
<th></th>
<th>Normalized Max Load</th>
<th>Normalized Displacement at Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plate</td>
<td>0.38 ± 0.18</td>
<td>1.39 ± 0.65</td>
</tr>
<tr>
<td>Nail</td>
<td>0.69 ± 0.28</td>
<td>2.39 ± 0.89</td>
</tr>
<tr>
<td>p-value</td>
<td><strong>0.00001</strong></td>
<td><strong>0.00001</strong></td>
</tr>
</tbody>
</table>
HYPOTHESIS
Different cell delivery methods have been described to supplement biological scaffolds, such as acellular nerve allografts (ANA). Obtaining a satisfactory cell transplantation efficiency remains a challenge. We sought to investigate the functional motor recovery of ANAs after dynamic seeding versus microinjection of adipose-derived mesenchymal stem cells (MSC). We hypothesized that both cell delivery methods would result in equivalent functional motor outcomes.

METHODS
Forty Lewis rats underwent reconstruction of a 10 mm sciatic nerve defect. Animals were divided into four experimental groups (n = 10/group): I) autograft, II) ANA, III) ANA dynamically seeded with MSCs, and IV) ANA injected with MSCs. In group III, ANAs were dynamically seeded with 1x106 MSCs on a bioreactor for 12-24 hours prior to surgery. ANAs in group IV were longitudinally injected with 1x106 MSCs in 10 L of culture medium over the entire course of the nerve graft. Functional motor recovery was evaluated using various outcome measurements. During the survival period, the tibialis anterior (TA) muscle cross-sectional area was measured using ultrasound imaging. In non-survival procedures at 12 weeks, measurements of ankle contracture, compound muscle action potential (CMAP), isometric tetanic force (ITF), and wet muscle weight (MW) were determined. All results are expressed as a percentage of the contralateral non-operated side. Two-way and one-way ANOVA with post hoc Bonferroni correction for multiple comparisons were carried out for comparisons between groups.

RESULTS
TA cross-sectional area recovery was significantly higher in groups III and IV compared to groups I and II at week 8. Group IV also showed significantly higher recovery rates than group I and II at week 4. The ankle contracture and CMAP amplitude were inferior in ANAs alone compared to all other groups. Group IV demonstrated significantly higher ITF and MW compared to ANAs alone. No significant differences were observed between ANAs dynamically seeded with MSCs and ANAs injected with MSCs.
SUMMARY

- Addition of MSCs to ANAs demonstrated earlier regeneration compared to ANAs alone and autografts and were demonstrated as early as post-operative week 4.
- Therapeutic efficacy of MSC injection in ANAs appears to be higher compared to dynamic seeding and may be a function of retained MSC that may be lost in handling of the seeded allograft.
- Injection of MSCs in ANAs is a technically challenging and may not be applicable for clinical translation requiring long nerve grafts.
- Both methods of seeding improved functional outcomes.
- The method chosen for human translation must be technically feasible, reproducible and timely. Future studies are required to improve the dynamic cell seeding efficiency.

Figure 1. Tibialis anterior muscle cross-sectional area expressed as percentage recovery compared to contralateral non-operated side. Results are expressed as mean ± standard error of the mean (SEM). N = 10/group/time point. ANA = acellular nerve allograft, MSC = mesenchymal stem cells, DS = dynamic cell seeding, MI = microinjection. *Compared to autografts, #Compared to ANAs. *P<0.05, **P<0.01, ***P<0.001, ****P<0.0001.
Figure 2. Assessment of functional motor recovery using (A) ankle angle, (B) compound muscle action potential (CMAP), (C) isometric tetanic force (ITF), and (D) wet muscle weight compared to contralateral non-operated side at 12 weeks. Results are expressed as mean ± SEM. N = 10/group. ANA = acellular nerve allograft, MSC = mesenchymal stem cells, DS = dynamic cell seeding, MI = microinjection. */P<0.05, **P<0.01, ***P<0.001, ****P<0.0001.
HYPOTHESIS
The purpose of this study is to evaluate the association between timing of nerve repair and nerve retraction requiring the use of allograft, autograft, or a conduit. We hypothesized that a delay in timing to nerve repair would result in higher utilization of a bridge repair which includes allograft, autograft, or a conduit when compared to primary repair.

METHODS
This is a retrospective (case-control) study of patients who underwent upper extremity nerve repair identified by CPT codes at a large academic institution and its affiliated surgical centers. Timing of injury and surgery were recorded, as well as demographic information, mechanism of injury, site of injury, and type of nerve repair. The difference in the number of days from injury to surgery between the Primary Repair group and the Bridge Repair group was assessed using unpaired t-tests. The odds of a patient requiring bridge repair based on the duration between injury and surgery were evaluated using logistic regression.

RESULTS
A total of 403 nerves in 335 patients (mean age 35.87 +/- 15.33 years) were included. 241 nerves were primarily repaired and 162 required bridge repair. Patients requiring bridge repair had a greater duration between injury and surgery compared to patients who underwent primary repair (45.09 +/- 62.85 days versus 14.12 +/- 14.33 days, p < 0.001; Figure 1). Furthermore, the nerves requiring bridge repair were associated with a greater gap compared to the nerves repaired primarily (15.66 +/- 15.67 mm versus 0.26 +/- 1.58 mm, p < 0.001).

Based on logistic regression, each 1 day increase in duration between injury and surgery was associated with a 3% increase in the odds of requiring bridge repair (OR 1.03, 95% CI [1.02, 1.05], p < 0.001; Figure 2).

SUMMARY
• There is currently a lack of evidence regarding whether time to nerve repair influences the type of repair that occurs.
• This study demonstrated that nerve injuries requiring bridge repair were associated with a significantly greater delay from the time of injury to the time of surgery.
• We demonstrated that each 1 day increase in the duration between injury and surgery was associated with a 3% increase in the odds of requiring bridge repair.
• We therefore advocate for an expedited nerve repair in patients with nerve laceration.

Figure 1. Density plot demonstrating the duration between injury and surgery in nerves that were repaired primarily and nerves that required bridge repair.

Figure 2. Probability of an injured nerve requiring bridge repair based on the number of days between injury and surgery.
Annual Meeting Live Paper 24: Epidemiology of Acute Surgical Upper Extremity Infections at a Tertiary Care Center: Risk Factors, Prognostic Indicators and Clinical Outcomes

SPP0816
Hand

Level 4

Jordan G Bruce
Ketan Sharma, MD, MPH
Ida K. Fox, MD

HYPOTHESIS
Upper extremity (UE) infections are common and can be managed by all hand surgeons irrespective of specialty, practice setting, or geography. The purpose of our prospective, epidemiological analysis is to elucidate the pre-determining risk factors, prognostic indicators, and clinical outcomes in this important population.

METHODS
We prospectively enrolled patients with UE surgical infections presenting to a level-one, tertiary care trauma center over a five-year period (2014 to 2019). Surgical was defined as requiring initial debridement. Data were collected and analyzed. These included information on 1) demographics, 2) infection (mechanisms, location, and type), 3) microbiology, 4) leukocytosis at presentation, and 5) outcomes (need for repeat debridement and inpatient length-of-stay (LOS)). Infection type was subcategorized as superficial (paronychia, felon, superficial abscess) versus deep (deep space abscess, osteomyelitis, septic arthritis, flexor tenosynovitis, necrotizing fasciitis). The student’s t-test and chi-squared analyses were used to compare continuous and categorical sample distributions, respectively.

RESULTS
A total of 602 consecutive patients were enrolled. Average age was 43 years; 69% were male; 21% had diabetes; 25% were obese; 52 % were active smokers; and 31% had a prior history of IV drug abuse. 65% had either Medicaid coverage or no insurance. 29% were employed full-time, and 23% presented with an established psychiatric illness (prevalence higher than the general population). 46% exhibited leukocytosis at presentation. Cultures grew MSSA (21%), MRSA (21%), other gram-positive organisms (31%), and gram-negative organisms (14%). Overall, 31% of patients required a repeat debridement, and the average inpatient LOS was 4 days. Diabetics were more likely to grow fungal or polymicrobial organisms, present with deep infections, require a repeat debridement, and have longer LOS (all p<0.001). Infection mechanism or pathogenic microbiology did not affect outcomes; infection type did influence increased need for repeat debridement and LOS (p<0.001). Patients presenting with leukocytosis also exhibited significantly higher need for repeat debridement (p<0.001) and longer LOS (p=0.010).
SUMMARY

- UE infection patients are more likely to be underinsured and unemployed
- Psychiatric illness is a novel risk factor for these infections. Leukocytosis and pre-existing diabetes predict more severe infections that require additional debridement and longer duration of inpatient stay.
Annual Meeting Live Paper 02: The Role of Amputation and Myoelectric Prosthetic Fitting in Patients with Traumatic Brachial Plexus Injury

SPP0804
Nerve/Soft Tissue

Level 4

Sean R. Cantwell
Andrew W. Nelson
Nicholas A. Pulos
Robert J. Spinner
Allen T. Bishop
Alexander Y. Shin

HYPOTHESIS
Advancements over the past 20 years have led surgeons to consider amputation a failure of treatment for patients with traumatic brachial plexus injuries (BPIs). Despite this, a cohort of patients exists who have either failed surgical reconstruction or are unsatisfied with their outcomes, are burdened by paralyzed and insensate limbs, and have sought elective amputation. With lighter weight myoelectric prosthetics (MEPs) using nonintuitive control mechanisms, some of these patients have demonstrated great improvement of their function. We sought to determine the role and outcome of amputation in this patient population, as well as determine if prosthetic fitting with nonintuitive myoelectric control mechanisms was feasible and functionally useful.

METHODS
A retrospective review of patients with BPIs who underwent elective upper extremity amputation at a single BPI clinic between 2001 and 2020 was performed. Medical records were reviewed for demographics, injury details, reconstruction attempts, amputation characteristics, outcomes, and complications. Patients’ use of MEPs was determined, as well as their functional benefit from the device. Primary outcomes included post-amputation visual analog scale (VAS) pain scores and Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire scores.

RESULTS
Thirty-two patients with BPIs underwent elective amputation. Seventeen patients (53%) underwent prosthetic fitting and 10 patients (31%) were fit for MEP devices. Transradial amputees were more likely to undergo prosthetic fitting and MEP fitting. Patients who experienced spontaneous nonfunctional recovery or improvements after surgery tended to undergo MEP fitting. Post-amputation VAS scores decreased for all patients regardless of amputation level or prosthetic fitting. DASH scores were not significantly different before and after amputation, reflecting the severity of the BPI disability. Patients were more likely to be employed following amputation regardless of prosthetic fitting. No patient expressed regret about undergoing amputation. All patients fit for MEPs reported regular use of their prosthetic
compared to 29% of patients fit for traditional prosthetics. 100% of patients fit with MEPs demonstrated functional terminal grasp/release. No major complications occurred as a result of amputation.

SUMMARY
• Amputation is a safe, effective treatment for patients with severe BPIs who fail attempts at surgical reconstruction or are ineligible for reconstruction due to the severity of their injuries.
• In amputees with sufficient nonintuitive myoelectric signals, MEP fitting allows for dramatically increased function, resulting in high rates of prosthetic use with grasp and release.
• Amputation is associated with decreased mechanical pain, increased rates of employment, and high levels of patient satisfaction.

REFERENCES
Annual Meeting Live Paper 08: Accuracy of Electrodiagnostic Testing and Clinical Exam for Carpal Tunnel Syndrome: Analysis from a Multicenter Quality Collaborative

SPP0237
Nerve/Soft Tissue

Level 3

Jessica I. Billig, MD, MS
Sandra V. Kotsis, MPH
Zhongzhe Ouyang, MS
Lu Wang, PhD
Kevin C. Chung, MD, MS
M-CHIQS group

HYPOTHESIS
Electrodiagnostic studies (EDS) are commonly used to diagnose carpal tunnel syndrome (CTS). However, EDS should not be used as a screening tool because of the false positive and negative values, thus questioning their use as a reference standard[1]. We aimed to evaluate the accuracy of EDS severity and clinical examination and to determine patient-level and practice-level predictors for accuracy.

METHODS
We analyzed data from 609 patients (941 hands) with CTS at nine practices (July 1, 2019-December 31, 2019) by 41 surgeons in the Michigan Collaborative Hand Initiative for Quality in Surgery (M-CHIQS). M-CHIQS is a quality initiative that collects data in a prospective manner from electronic medical records. Patient demographic and clinical characteristics including CTS-6 scores and clinical assessment scores (CAS) were gathered[2]. CTS-6 scores were grouped into validated categories: low (0-5), moderate (6-12), and high (13-26). CAS were categorized as mild, moderate, and severe. The Goodman and Kruskal’s gamma statistics measured the agreement between EDS and CTS-6 and between EDS and CAS. We performed cumulative logistic regression models with mixed effects to evaluate the association among EDS severity, clinical assessments (CTS-6 and CAS), and patient characteristics to account for clustering of patients within sites.

RESULTS
The distribution of CTS-6 scores and CAS is shown in Figure 1. The EDS severity grade was 23% normal/mild, 45% moderate, and 32% severe. Among all sites, the correlation between EDS severity and CTS-6 scores was $\gamma=0.32$ ($P<0.001$) with an accuracy of 44%. The correlation between EDS severity and CAS was $\gamma=0.66$ ($P<0.001$) with an accuracy of 58%. Moreover, wide site-level variation in the gamma coefficient between EDS and CTS-6 and between EDS and CAS was seen (Figure 2). For women, there was a lower correlation between EDS severity and CTS-6
(women: $\hat{\rho}=0.25$, men: $\hat{\rho}=0.44$) but higher correlation between EDS severity and CAS compared to men (women: $\hat{\rho}=0.69$, men: $\hat{\rho}=0.64$).

**SUMMARY**

- The accuracy between EDS severity and clinical examination is low, highlighting the importance of incorporating pre-test probabilities and disease prevalence when choosing the optimal test or clinical examination assessment for diagnosing CTS.
- Wide practice-level variation in the correlation between EDS severity and clinical examination underscores the variability in diagnostic testing accuracy.
- Differences in accuracy between EDS and clinical exam scores should prompt hand surgeons to consider specific characteristics (i.e., sex) when determining the optimal diagnostic modality.

**REFERENCES**


Figure 2. Concordance Between EDS and Clinical Assessment Across Different Sites

Variation of concordance among the sites between EDS and clinical assessment had P<0.05 using cumulative link mixed models with the dependent variable being EDS severity adjusting for the different clinical assessment scores (CTS-6 and CAS), age, sex, ethnicity, and BMI.

**HYPOTHESIS**
A ligament-sparing volar wrist arthrotomy with subsequent capsular repair used as a novel approach for treatment of distal radius fractures will (1) not cause biomechanical radiocarpal instability, and (2) provide adequate direct visualization to assess distal radial articular surface reduction.

**METHODS**
Ten upper extremity match-paired specimens were tested. For each pair, one side underwent trans-flexor carpi radials volar approach with arthrotomy to visualize the distal radius articular surface (Group 1; Figure 1), and the other underwent standard trans-flexor carpi radials volar approach without arthrotomy (Group 2). In Group 1, the articular surface was systematically photographed to quantify the surface area directly visualized via volar arthrotomy. Following biomechanical testing, the wrist was disarticulated to expose and to photograph the entire articular surface facilitating calculation of the percentage of articular surface visualized from the volar arthrotomy. Following capsular repair (Group 1), all specimens underwent axial loading to evaluate for carpal instability non-dissociative, defined as ulnar carpal translation visualized with fluoroscopy. Incremental loads (0lb, 5lb, 10lb, 20lb, 40lb) were applied through a 2mm Steinmann pin placed into the intramedullary canal of the third metacarpal. Lunate overhang was measured to allow calculation of ulnar translation using the Gilula method: (a) the width of the lunate was measured, and (b) a bisecting vertical line was drawn along the ulnar border of the radius parallel to the diaphysis. Statistical comparisons between groups for each loading increment were performed with paired two-tailed t-tests on matched specimens to control for differences in bone density, specimen age, and ligamentous laxity.

**RESULTS**
77% (range 71-80%) of the total distal radius surface area was visualized utilizing the volar arthrotomy. Following arthrotomy, ulnar translation of the lunate remained below previously established significance levels of 2 mm and 10% in both groups at all loads (Table 1). Mean translation in the arthrotomy group ranged from 0.4mm to 0.9mm corresponding to a
maximum of 4% translation. No significant differences in ulnar translation were identified with increasing loads between groups (P>0.05; Table 1).

SUMMARY
- Volar radiocarpal arthrotyom facilitates direct visualization of 77% of the distal radius articular surface.
- Arthrotyom did not cause radiographic ulnar translation with partial sectioning of the long radiolunate and short radiolunate ligaments in this cadaveric model.
- These findings suggest that volar radiocarpal arthrotyom provides enhanced visualization of both the scaphoid and lunate facets of the distal radius articular surface during surgical fracture repair and does not cause iatrogenic biomechanical radiocarpal instability.

REFERENCES

Figure 1. (A) Illustration (B) cadaveric representation and (C) experimental representation of the novel volar radiocarpal capsular arthrotyom. The arthrotyom longitudinally splits the long radiolunate ligament, elevates the capsule off of the volar rim of the distal radius, and is completed at the mid-portion of the short radiolunate ligament leaving the ulnar half of the ligament intact.
Table 1. Radiographic lunate displacement with varying axial loads.

<table>
<thead>
<tr>
<th>Axial load (lb)</th>
<th>Group 1 (arthotomy)</th>
<th>Group 2 (control)</th>
<th>Paired t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm lunate overhang</td>
<td>Ratio of lunate overhang</td>
<td>Lunate translation from baseline</td>
</tr>
<tr>
<td>0</td>
<td>5.13 ± 1.34</td>
<td>0.39 ± 0.06</td>
<td>0 ± 0</td>
</tr>
<tr>
<td>5</td>
<td>5.54 ± 1.14</td>
<td>0.40 ± 0.07</td>
<td>0.41 ± 1.0</td>
</tr>
<tr>
<td>10</td>
<td>5.65 ± 1.11</td>
<td>0.40 ± 0.06</td>
<td>0.52 ± 1.0</td>
</tr>
<tr>
<td>20</td>
<td>5.89 ± 1.11</td>
<td>0.41 ± 0.05</td>
<td>0.76 ± 2.0</td>
</tr>
<tr>
<td>40</td>
<td>6.01 ± 1.25</td>
<td>0.43 ± 0.05</td>
<td>0.88 ± 4.0</td>
</tr>
</tbody>
</table>
HYPOTHESIS
Value-based healthcare models seek to optimize outcomes while lowering costs. Understanding value for commonly-performed surgeries enables us to track and improve the “return on investment” of these procedures. Using carpal tunnel release (CTR) as an example, we developed and validated a value equation that integrates clinical outcomes and cost of care.

METHODS
We assembled a cohort of patients who underwent primary unilateral CTR between 06/2018 through 08/2020 within a single academic hand surgery division. We defined value as improvement in patient outcomes divided by direct cost. A composite clinical outcomes score was created based on a combination of symptom resolution, complications including reoperation, and infection, with items selected and weighted using a modified Delphi process with 7 participating surgeons. These outcome measures were combined to derive a clinical outcome score for CTR. Direct cost (the sum of labor costs, supply costs, and fees), clinical outcome score and value (outcomes divided by direct cost) were calculated for individual patients, and patient values were averaged by surgeon in order to calculate surgeon value. One-way ANOVA and Fisher’s exact test were used to assess for differences across surgeons.

RESULTS
Seven participating surgeons treated 134 patients with unilateral CTR. All patients experienced complete or partial relief of symptoms. There were 5 patients with recurrent symptoms, 3 patients with scar hypersensitivity, and 1 patient with a superficial infection. There was no significant difference across the 7 surgeons in the composite clinical outcomes score. However, there was statistically significant variation in cost across surgeons (p<0.0001) - when benchmarked against the average per-case cost for all patients, the range of median cost was 0.63 (Surgeon 2; lowest cost) to 1.43 (Surgeon 7; higher cost). When value was calculated (outcomes divided by cost), there was statistically significant variation among surgeons (p=0.0001). Benchmarked across the average value for all patients, the range of median value
was 0.69 (Surgeon 7; lowest value) to 1.61 (Surgeon 2; highest value). These results are graphically demonstrated in “dashboard” form for outcomes, cost, and value in Figure 1.

**SUMMARY**

- We propose a method for combining clinical outcomes and total cost to calculate the value of carpal tunnel release.
- Although there was no difference among surgeons in clinical outcomes, there were significant differences among surgeons for total cost and value for carpal tunnel release procedures.
- Creating value dashboards enables us to track and improve the value of these procedures.

![Figure 1: Outcomes, cost, and value per surgeon, compared to the institutional average (grey line represent average among all patients).](image-url)
Annual Meeting Live Paper 03: Digital Nerve Management and Neuroma Prevention in Hand Amputations

SPP0128

Hand

Level 4

Jed Maslow
Alexis LeMone
Gregory Scarola
Bryan Loeffler
R. Glenn Gaston

HYPOTHESIS
Hand and digit amputations represent a relatively common injury affecting a young and active patient population. Symptomatic neuroma formation following amputation at the level of the digital nerve can cause significant disability and lead to revision surgery. One method for managing digital nerves in primary and revision partial hand amputations is to perform interdigital end-to-end nerve coaptations to prevent neuroma formation. In this study, we review our series of partial hand amputations and evaluate the success of this surgical technique in preventing symptomatic neuromas.

METHODS
A review of a prospectively collected database was performed. All patients with an amputation at the level of the common or proper digital nerves that had appropriate follow-up at our institution from 2010 to 2020 were included. Common or proper digital nerves were managed with either traction neurectomy or digital end-to-end neurorrhaphy (Figure 1). The primary outcome identified was the development of a neuroma as confirmed by at least two independent physicians. Secondary outcomes included revision surgery, complications, and visual analog pain scores (VAS).

RESULTS
A total of 289 nerves were amputated in 54 patients who underwent hand or digital amputation in the study period. Thirteen hands with 78 nerves (27%) underwent direct end-to-end coaptation with a post-operative neuroma incidence of 12.8% compared to 22.7% in the 211 nerves that did not have a coaptation performed (p = 0.06). Significantly fewer patients reported persistent pain if an end-to-end coaptation was performed (0% vs. 11.8%, p<0.01). The prevalence of depression in patients with symptomatic neuromas was twice as high as those patients without symptomatic neuromas (69.3% vs. 27.3%, p<0.01).
SUMMARY

• Digital nerve end-to-end neurorrhaphy is a method for neuroma prevention in partial hand amputations, which results in decreased residual hand pain without increased complications.

• Depression was significantly associated with the presence of symptomatic neuromas. Level of Evidence: Level III

REFERENCES


HYPOTHESIS
The purpose of this study was to examine the impact of lidocaine on pain control in patients undergoing corticosteroid injection for the treatment of trigger finger. The primary objective was to compare pain levels in patients receiving injections with lidocaine to pain levels in injections without lidocaine. A secondary objective was to examine patient anxiety related to the trigger finger injection. We hypothesize that adding lidocaine to the injectant will have no effect on the patient-perceived pain level of trigger finger injection.

METHODS
This study investigated the difference in pain associated with corticosteroid trigger finger injection both with and without the addition of lidocaine. A total of 59 patients and 72 digits were enrolled. Of the 72 total digits, 31 were randomly assigned to receive a corticosteroid-only injection while the other 41 digits received a corticosteroid plus lidocaine injection. Randomization of digits was performed via double-blinded, computer-randomized folders. We assessed patients’ anticipated and actual pain before and after the injection and the effect of lidocaine on both.

RESULTS
Pre-injection anticipated pain scores were 5.4 and 5.9 for the corticosteroid-only and corticosteroid plus lidocaine groups, respectively (p=0.389). Both groups also had similar levels of anxiety preceding the injection, with a nervousness score of 3.4 for the corticosteroid group and 4.0 for the lidocaine group (p=0.418). The reported pain of the needle during injection was 4.3 for the corticosteroid-only group compared to 4.1 for the corticosteroid plus lidocaine group (p=0.700). Similarly, the pain scores for the medication injection portion were 4.3 and 4.6 for the corticosteroid and lidocaine groups, respectively (p=0.587). The difference between perceived and predicted pain and anxiety was calculated by subtracting the pre-injection scores from the post-injection scores. Both groups experienced less pain and anxiety from the procedure than predicted pre-injection. The corticosteroid-only pain difference was -1.1 as compared to -1.5 for the corticosteroid plus lidocaine group (p=0.499).
SUMMARY

- In this study we observed no analgesic benefit from the addition of lidocaine to corticosteroid injections for the treatment of trigger finger.
- We additionally identified that experienced pain is less than predicted pain for the injection.
- Based on this study, we recommend utilization of corticosteroids alone for trigger finger injection.
Annual Meeting Live Paper 05: The Effect of Flexor Digitorum Profundus Repair Position Relative to Camper's Chiasm on Tendon Biomechanics

SPP0351
Hand

N/A

Mohammad M Haddara
Eric C. Mitchell
Louis M. Ferreira
Joshua Gillis

HYPOTHESIS
We hypothesize that repairing a zone II flexor digitorum profundus (FDP) laceration inside Camper’s Chiasm versus an outside-chiasm repair will not significantly alter tendon biomechanics in comparison to a native intact state.

METHODS
Twenty digits from five cadaveric specimens were tested using an in-vitro active finger motion simulator under two FDP tendon repair conditions: inside-chiasm and outside-chiasm. Tensile loads in FDP and flexor digitorum superficialis (FDS), WOF, and total active finger range of motion (ROM) were measured using in-line load cells and electromagnetic tracking, respectively. Results were analyzed by two-way Repeated Measures ANOVA tests.

RESULTS
The inside-chiasm repair had no effect on tendon loads or WOF for either FDP or FDS. The outside-chiasm repairs increased FDP loads by 32% (p=0.014) and decreased FDS loads by 9% (p=0.015) compared to the intact condition. This trend was similar for WOF following outside-chiasm repairs, which increased FDP WOF by 31% (p<0.001) and decreased FDS WOF by 18% (p=0.042). Comparing the two repairs, FDP loads and WOF were 25% (p=0.014) and 22% (p<0.001) greater with outside-chiasm repairs compared to inside-chiasm, with no significant change in FDS. Total active ROM was not affected by either repair.

SUMMARY
• Outside-chiasm repair of FDP increased tendon loads and WOF compared to inside-chiasm repairs. FDP tendon repair within the chiasm did not alter flexor tendon loads in either the FDP or FDS tendons.
• FDS loads and WOF were significantly decreased which indicates that the outside-chiasm repair shifted the balance of shared tendon load from FDS to FDP, which is evidenced by their mirrored loading patterns. Reconstitution of the anatomic relationship of FDP and FDS by placing FDP within Camper’s Chiasm during the repair of zone II flexor tendon lacerations is recommended based on this study.
REFERENCES

Figure 1. Tendon Load vs. Finger Flexion. Flexor tendon loads experienced by a) FDP and b) FDS as a function of percent flexion range. Tendon loads increased with flexion angle for every condition (p<0.001). At full flexion, the outside-chiasm repairs significantly increased FDP loads by 3.6 ± 2.9 N (p=0.014) and reduced FDS loads by 1.5 ± 1.2 N (p=0.915) compared to the intact condition.
Figure 4. Work of Flexion: Work of flexion summed over the full range (WOF) as a function of repair type (n=20, Mean ± 1 SD; *p<0.05; ***<0.001). The outside-chiasm repair significantly increased FDP’s WOF by 115.3 ± 56.3 N.mm (p<0.001) and decreased FDS’ WOF by 67.3 ± 111.2 N.mm (p=0.042) compared to the intact condition. Furthermore, the outside-chiasm repair resulted in 89.3 ± 65.1 N.mm greater WOF than the inside-chiasm repair (p<0.001). The inside-chiasm repair did not significantly affect WOF.
HYPOTHESIS
The minimal clinically important difference (MCID) defines a threshold for clinically relevant change in patient-reported outcomes scores. These estimates are lacking for the pain visual analog scale (VAS-pain) in a hand surgery population. Our purpose was to calculate anchor-based and 1/2 standard deviation (SD) MCID estimates for VAS-pain in a non-shoulder hand and upper extremity postoperative population.

METHODS
Adult patients undergoing surgeries in the operating room performed by 1 of 5 fellowship-trained orthopaedic hand surgeons at a single tertiary academic medical center between August 2017 and January 2019 were eligible. VAS-pain scores were collected at each clinic encounter. A pain-specific anchor question was asked at follow-up visits (“Compared to your FIRST EVALUATION at the University Orthopedic Center, how would you describe your episodes of PAIN now?”), with responses including “Much improved”, “Improved”, “Slightly improved”, “No change”, “Slightly Worse”, “Worse”, “Much Worse”, and “Not applicable” (excluded). Inclusion for the 1/2 SD analysis required baseline (within 3 months of the surgery date) and follow-up (1-16 weeks postoperatively) VAS-pain scores. Inclusion in anchor-based calculations required an additional response of “No change”, “Slightly Improved”, or “Improved” on the anchor question. Differences in scores were assessed using the Wilcoxon rank-sum test. MCID estimates were calculated with the 1/2 SD method, and using an anchor-based approach using the difference in mean score change between anchor groups reporting “No change” and the combined group reporting “Slightly Improved” and “Improved”.

RESULTS
Of the 667 included patients, mean age was 50 ± 17 years, 57% were female, and mean follow-up was 123 ± 161 days. Surgeries were most frequently related to the following diagnoses: peripheral compressive neuropathies (19%), fracture-dislocation (16%), or cyst/mass (13%). Mean VAS-pain scores improved significantly between baseline and follow-up (3.6 ± 2.8 versus 2.1 ± 2.2, respectively; p < 0.05). Score change was significantly greater for the combined
“Slightly improved/Improved” group than the “No change” group (-2.1 ± 3.0 versus -0.21 ± 2.1, respectively; p < 0.05). The anchor-based and 1/2 SD MCID estimates were 1.9 and 1.6, respectively.

SUMMARY
• We propose MCID values in the range of 1.6 to 1.9 for the VAS-pain instrument in a non-shoulder hand and upper extremity postoperative population.
• These values are subjectively similar to prior reports among rotator cuff tear patients (1.4),[Reference 1] a general postoperative recovery cohort (1.0),[Reference 2] and a wide array of clinical entities pooled in a systematic review (0.8 to 4.0).[Reference 3]

REFERENCES
HYPOTHESIS
Favorable rates of meaningful recovery (defined as >M3/S3 or >M3/S4) of processed nerve allografts (PNA) for mixed and motor nerve injuries have been reported, ranging from 36-88% (1-5) depending on nerve location and reconstruction size. There have been very few reports, however, of patients having complete PNA failure (defined as M0/S0). The purpose of this study was to provide a case series of patients who suffered a complete failure after PNA for a mixed peripheral nerve.

METHODS
This is a retrospective review of outcomes between May 1, 2018 and September 1, 2020. Consecutive patients who underwent nerve repair with PNA to a peripheral, mixed nerve injury of the upper or lower extremity that was >15 mm with a minimum of 6-months postoperative follow-up were included in this study. Patients who were under 18 or those who underwent a pure sensory or motor nerve reconstruction with PNA were excluded. All patients were directly operated on by a fellowship-trained hand surgeon with a clinical practice focusing on microsurgery and peripheral nerve. The primary outcome was whether the patient was defined as a complete failure (M0/S0) at a minimum of 6-months.

RESULTS
A total of 22 patients met our inclusion and exclusion criteria. Twelve patients were lost to follow-up and 10 patients were included in analysis (45% compliance, age: 43.00±15.97 years, 7 females/3 males) with a mean follow-up of 9.25±2.84 months (Table 1). Five patients underwent PNA to the median nerve, 3 to the ulnar nerve, and 2 to the common peroneal nerve. Three patients were indicated for PNA due to the presence of a neuroma in continuity due to a subacute laceration (less than 1 month from injury in all cases), 4 had a laceration with a gap, 2 sustained injury due to a fracture, and 1 sustained iatrogenic injury from a carpal tunnel release. The average gap length was 46.4mm (range 15-110mm). At a minimum of 6-months postoperative, no patients had any motor or sensory improvement; all patients were deemed complete failures. Five patients underwent subsequent revision reconstruction surgery: four autograft reconstructions and one distal nerve transfer (Figure 1).
SUMMARY

• In this study, we demonstrated a high number of complete failures (n=10, 100% failure) at minimum 6-months follow-up (Table 1). Failure in this case series was not observed to affect one nerve type, location, or be related to preoperative injury size.
• Intraoperative assessment of patients who underwent subsequent revision surgery demonstrated the presence of significant neural adhesions surrounding the PNA, associated with large neuromas.
• Caution should be employed when utilizing PNAs for large (> 15 mm), mixed peripheral nerve repairs.

REFERENCES


Figure 1. Intraoperative pictures from a 17 year old male patient who developed (A) significant adhesions and (B) an 8 cm neuroma of the median nerve 10 months after undergoing an PNA nerve repair. The patient subsequently underwent a neuroma resection and cabled sural nerve autograft reconstructions.
| Table 1. Patient demographics, operative, and post-operative outcomes. |

<table>
<thead>
<tr>
<th>Condition</th>
<th>Age</th>
<th>Gender</th>
<th>Race</th>
<th>Ethnicity</th>
<th>Pre-existing Conditions</th>
<th>Comorbidities</th>
<th>Operation Type</th>
<th>Duration</th>
<th>Complications</th>
<th>Post-operative Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthritis</td>
<td>55</td>
<td>Male</td>
<td>White</td>
<td>Hispanic</td>
<td>diabetes, hypertension</td>
<td>congestive heart failure</td>
<td>Total Knee Replacement</td>
<td>3 hours</td>
<td>Infection</td>
<td>Improved mobility</td>
</tr>
<tr>
<td>Rheumatoid Arthritis</td>
<td>48</td>
<td>Female</td>
<td>Black</td>
<td>Asian</td>
<td>hypertension, COPD</td>
<td>congestive heart failure</td>
<td>Partial Knee Replacement</td>
<td>2 hours</td>
<td>Wound Healing</td>
<td>Improved mobility</td>
</tr>
<tr>
<td>Gout</td>
<td>62</td>
<td>Male</td>
<td>White</td>
<td>African</td>
<td>stroke, diabetes</td>
<td>congestive heart failure</td>
<td>Partial Knee Replacement</td>
<td>2.5 hours</td>
<td>No Complications</td>
<td>Improved mobility</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>70</td>
<td>Female</td>
<td>Hispanic</td>
<td>Asian</td>
<td>hypertension, COPD</td>
<td>congestive heart failure</td>
<td>Total Knee Replacement</td>
<td>4 hours</td>
<td>No Complications</td>
<td>Improved mobility</td>
</tr>
</tbody>
</table>

Legend:
- COPD: Chronic obstructive pulmonary disease
- AR: Arthritis
- RA: Rheumatoid Arthritis
- OAR: Osteoarthritis
- Total Knee Replacement
- Partial Knee Replacement
- Improved mobility
- Infection
- Wound Healing
- No Complications
HYPOTHESIS
While risk factors for development of osteoarthritis (OA) of the thumb carpometacarpal (CMC) joint are well described, predictors of CMC OA progression remain poorly understood. We hypothesize that clinical, biomechanical, and radiographic measures can help predict progression of early CMC OA.

METHODS
Ninety-one subjects with basilar thumb pain and/or a modified radiographic Eaton-Littler Stage (ELS) of 1 or less were followed prospectively. Subjects received x-rays and CT scans at baseline, 1.5 years, and 3 years. Baseline values were determined for subjects’ medical history, thumb and wrist range of motion (ROM), and grip and pinch strength. The primary outcome was progression defined as an increase in ELS. After variable normalization, a predictive model for progression was created with logistic regression using the least absolute squares shrinkage operator (LASSO) for automated variable selection and parameter estimation, followed by cross-validation. The secondary outcome was increased Patient-Related Wrist and Hand Evaluation (PRWHE) score. A predictive model for PRWHE score was created using linear regression with automated backward variable selection, with a threshold of $p = 0.10$ for removal from the model.

RESULTS
Fifty-five subjects (60.4%) had radiographic disease progression at 3 years; 5 subjects were lost to follow-up. Clinical predictors of radiographic progression included high body mass index (BMI) (Odds Ratio (OR) = 1.33) and low ROM in thumb CMC extension (OR = 0.86). CT parameters, including increased surface area of the trapezium (OR = 1.12), were also predictive of progression by 3 years. The cross-validated area under the receiver operator curve for this model was 0.829, indicating excellent predictive ability of the model (Reference 1). Baseline factors associated with an increased PRWHE score at 3 years included a higher numeric rating score for pain with grasping motions ($p = 0.006$), low ROM in thumb CMC extension ($p = 0.021$),
and the presence of radiographic joint space narrowing (p = 0.016). This model was associated with an R-squared value of 0.418.

SUMMARY
• 60.4% of patients with early CMC OA experienced radiographic progression within 3 years.
• Limited thumb CMC extension predicts both radiographic progression and worsened PRWHE score at 3 years.
• Predictors also included high BMI and CT trapezial surface area for radiographic progression; and pain with grasping and joint space narrowing for PRWHE score.
• This study identified factors predictive of radiographic and clinical progression of early CMC OA. These findings may be helpful for educating patients with early basilar thumb arthritis about disease progression and treatment planning.

REFERENCES
1: Mandrekar JN. Receiver Operator Characteristic Curve in Diagnostic Test Assessment. J Thorac Oncol. 2010; 5(9): 1315-6. PMID 20736804
Annual Meeting Live Paper 19: Reduced Pain with Opioid-Free Pain Management Following CMC Arthroplasty

SPP0913
Hand

Level 1

Glenn Gaston
Nady Hamid
Nicholas Lake

HYPOTHESIS
An opioid-free, multi-modal pain management pathway can provide a safe and predictable alternative to conventional opioid-based pain management regimens with no difference in overall satisfaction and lower rates of complications and negative side effects.

METHODS
A randomized controlled trial was performed with a total of 47 patients undergoing primary 1st CMC arthroplasty. Exclusion criteria included revision surgery, chronic opioid use, significant renal or liver disease, worker’s compensation status, alcohol dependence and history of bleeding problems. The control group underwent surgery with an opioid-based pain protocol per the treating surgeon’s routine pain management pathway. The intervention group underwent surgery with a multimodal, opioid-free protocol. The primary outcome variable was pain at patient discharge or 24-hours postoperatively - whichever came first - measured on a 0-10 numeric rating scale (NRS). We called this 24-hour pain. Secondary outcomes measures included pain at intervals up to 1 year postoperatively, medication side effects, overall satisfaction, and validated functional outcome measures. The student T-test was used to compare means of our outcome variables.

RESULTS
26 patients were randomized to the opioid-free intervention group and 21 to the control group. Baseline characteristics were similar between the groups. 24-hour pain following surgery was significantly lower in the non-opioid group compared to the control group (2 vs. 4, p=.018). Statistically significant differences in comfort on postoperative day 2 and 3 favored the non-opioid group. There was no difference in satisfaction with surgical experience between groups. Only 2 of the 26 (8%) patients in the intervention group crossed over and used opioids postoperatively.

SUMMARY
- Pain 24 hours after CMC arthroplasty was significantly lower in the non-opioid group than in the control group.
- There were no negative effects of the non-opioid pain management pathway.
• Only 8% of patients who were randomized to into the opioid-free group crossed over and requested opioids postoperatively
• Well-designed non-opioid pain management pathways can be applied to this and other surgical procedures to minimize the negative effects of opioid use
HYPOTHESIS
Pediatric forearm fractures are a common injury at a rate of 557 per 100,000 for individuals between ages 5-14 (1). Operative treatment of forearm fractures have increased at an average rate of 1-2% per year with approximately 80% of adolescents treated surgically (2). We are interested in evaluating the cost of operatively treated forearm fractures comparing between those treated with open reduction and internal fixation with a plate and screws and those treated with intramedullary nail fixation, as well as the financial impact of surgical complications and infections.

METHODS
We utilized the pediatric health information system (PHIS) to pull data from 49 Children’s Hospitals across the United States between years 2016-2020. We utilized ICD-10 codes and CPT codes to group operatively treated patients with forearm fractures into plate fixation and intramedullary nail (IMN) groups. Variables of interest included: age, sex, ethnicity, adjusted billed charges, estimated cost, surgical complications, and infections. Summary statistics were performed and costs were log-transformed for analysis and back-transformed with 95% confidence intervals using a gamma distribution. A multivariate analysis was utilized with significance was set at 0.05 and adjusted billed costs as the primary outcome.

RESULTS
Our cohort included 6,770 patients with an average age of 11.1 years in the plate fixation group and 10.5 years in the IMN group. The IMN approach was more common in the North-East and North-West United States at 33.9% and 35.4% while the North-East (36.9%) and South-East (36.6%) were similar in use of plate fixation. The estimated mean cost for the IMN and plate fixation procedures was $17,100 and $31,000 respectively (P<0.0001). Surgical complications occurred at a rate of 0.77% in the plate fixation group versus 0.10% in the IMN group (P<0.0001). Infections were the same in each group 0.59% (P=0.99). Our multivariate analysis revealed each year increase in age led to a 3% increase in cost. Plate fixation led to a 80% increased cost relative to the IMN approach, and surgical complications increase cost by 233% and infections by close to 350% (P<0.0001).
SUMMARY

- Surgical complications and infections are costly to patients and healthcare systems by increasing healthcare costs from 233%-350%.
- The intramedullary nailing of forearm fractures represents a less costly option and can reduce surgical costs by 80% but does not account for hardware removal.
- Surgical complications are more common in the plate than IMN group.

REFERENCES


Multivariate analysis for Adjusted Billed Cost as outcome

<table>
<thead>
<tr>
<th></th>
<th>Estimate of log scale</th>
<th>On original scale*</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept mean at all low levels</td>
<td>9.74</td>
<td>16,984</td>
<td></td>
</tr>
<tr>
<td>Age at admit</td>
<td>0.0295</td>
<td>1.03</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Plate vs Nail</td>
<td>0.5988</td>
<td>1.82</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Surgical Complication Yes vs No</td>
<td>0.9479</td>
<td>2.58</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Infection Yes vs No</td>
<td>1.1275</td>
<td>3.09</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic vs Unknown</td>
<td>-0.1063</td>
<td>0.90</td>
<td>0.0017</td>
</tr>
<tr>
<td>Non-Hispanic vs Unknown</td>
<td>-0.0006</td>
<td>0.99</td>
<td>0.9854</td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast vs Southwest</td>
<td>-0.4611</td>
<td>0.63</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Northwest vs Southwest</td>
<td>-0.4612</td>
<td>0.62</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Southeast vs Southwest</td>
<td>-0.4362</td>
<td>0.65</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
Annual Meeting Live Paper 27: Biomechanical Comparison Between Double-Plate Fixation and Posterior Plate Fixation for Comminuted Olecranon Fracture with Small Triceps Fragment

SPP0121
Elbow/Shoulder

N/A

Joonha Lee
Yohan Lee
Min Bom Kim
Kee Jeong Bae
Young Ho Lee

HYPOTHESIS
Preventing triceps fragment displacement is essential for treating an olecranon fracture to preserve extensor mechanism. The aim of this study was to compare stabilities of double-plate fixation and posterior plate fixation for olecranon fractures when triceps fragment was small and only two screws could be inserted.

METHODS
For the biomechanical test, 32 composite model ulnas were used. The comminuted fracture was simulated with a fracture gap of 5 mm. Double-plate and posterior plate were paired with cortical and locking screws to form four groups. Each group was assigned 8 specimens. Only two screws were fixed to the triceps fragments of all specimens. Cyclic loading test was conducted for 500 cyclic loads with 5-50N on a specimen. Cyclic loading test measures gapping during exercise and displacement after exercise. Load-to-failure test was performed by applying load until fixation loss. Fixation loss was defined as when fracture gap increased by 2 mm or more or catastrophic failure. Failure load measured in the failure-to-load test means the ultimate load up to the fixation loss.

RESULTS
Gapping during exercise and failure load were significantly (p < 0.001) different among four groups. In gapping during exercise, the posterior plate with cortical screws was the most stable one (0.09 ± 0.02 mm) while the double-plate with cortical screws was the most unstable one (0.42 ± 0.11 mm). At failure load, the posterior plate with locking screws was the strongest (205.3 ± 2.8 N) while the double-plate with cortical screws was the weakest (143.3 ± 27.1 N). There was no significant difference in displacement after exercise among groups.

SUMMARY
In comminuted olecranon fractures with small triceps fragments, a posterior plate was more biomechanically stable than a double-plate.
REFERENCES


Specimens simulated for a comminuted olecranon fracture with retained implants. (A) Double plate, (B) Posterior plate. A vertical load applied to triceps fragment to simulate triceps pull (C).

Gapping during exercise for four groups (D), Maximum load for four groups (E).
HYPOTHESIS
Low-velocity gunshot wounds (LV-GSWs) are a common reason for emergency department visits. Optimal nonsurgical treatment has not been thoroughly studied and is therefore not standardized. The goal of this study is to evaluate the effect of positive pressure irrigation on bacterial wound contamination in a low velocity gunshot model.

METHODS
19 lamb thigh specimens were prepared with denim inoculated with S. marcescens cultures. A nine-millimeter (mm) pistol round was fired from a distance of three meters through the contaminated denim into the lamb specimens. A culture swab was placed in the wound directly after firing, after 250 cubic-centimeters (cc) irrigation with normal saline, and after an additional 250cc irrigation (for a total of 500cc). Swabs were then cultured to determine amount of bacterial growth.

RESULTS
Before irrigation, 0 (0%) plates showed no growth, 2 (10.5%) showed rare growth, 8 (42.1%) showed few growth, 6 (31.6%) showed moderate growth, and 3 (15.8%) showed many growth. After 500cc irrigation 2 (10.5%) showed no growth, 1 (5.3%) showed rare growth, 11 (57.9%) showed few growth, 2 (10.5%) showed moderate growth, and 3 (15.8%) showed many growth. Fisher’s exact test confirmed no significant change in bacterial concentration after irrigation (p=0.59). A Pearson test found no correlation between amount of irrigation and level of bacterial growth when controlling for specimen (r=-0.15, p=0.25).

SUMMARY
• Positive pressure irrigation, utilizing the described method, with up to 500cc normal saline did not significantly alter the quantity of bacterial growth within a simulated GSW cavity.
• The data suggest bedside positive pressure irrigation may not be beneficial in the initial treatment of LV-GSWs.

SPP0978
Hand

Level 4

Joseph Messana, M.D.
Tara G. Nagaraja, M.D.
Casey M. Codd, B.A.
Danielle A. Hogarth, B.S.
Joshua M. Abzug, M.D.
Kevin J. Little, M.D.

HYPOTHESIS
Proximal phalanx fractures are common in pediatric patients. While non-displaced and minimally displaced fractures are often treated by immobilization, there are few studies exploring management options and outcomes for displaced and angulated proximal phalanx base fractures. We hypothesized that closed reduction and immobilization will produce comparable results to operative fixation.

METHODS
A retrospective review was conducted of all patients treated with a reduction attempt at 2 tertiary care pediatric hospitals from 2010 to 2018 for angulated and/or malrotated Salter Harris II proximal phalanx hand fractures. Exclusion criteria included patients with open fractures, phalangeal shaft or neck fractures, pathologic fractures, intraarticular fractures of the proximal phalanx, and those without follow up imaging or clinical information after closed reduction/cast immobilization or surgery. Patients were grouped at final follow-up based on radiographic criteria where “excellent” results were patients with angulation of 0-10° at time of first follow up, “good” had 10-15° with no clinical deformity, and “poor” had >15° of residual angulation or residual malrotation.

RESULTS
A total of 135 patients met inclusion criteria, of whom 114 were treated with closed reduction and casting (CRC) and 21 were treated with closed reduction and percutaneous pinning (CRPP). Both groups had a similar demographics (CRC: 10.32 years (3-16), 56% Male; CRPP: 10.71 years (5-15) 62% male) and initial coronal angulation (CRC: 16.25° (2-49°); CRPP 17.76° (6-42°)(p=0.29)). In the CRC group, immediate post reduction imaging demonstrated improved angulation (5.3° (0-23°)) which was maintained at final follow-up (4.7° (0-16°)). When compared to the CRPP group there was a statistically but not clinically significant final angulation of 2.67°
(0-7°) (p<0.02). In the CRC group, the mean pre-manipulation to post-reduction coronal angulation change was 11° (p<0.001) and the mean pre-manipulation to first follow up coronal angulation change was 11.6° (p<0.001) with no statistically significant change in angulation between post-reduction and final coronal angulation (0.57° (p=0.29)). In the CRC group 109 of 114 (95.6%) had excellent outcomes, with 4 (3.5%) good, and 1 (0.9%) poor, while all 21 patients in the CRPP group had excellent outcomes (p=0.62). Complications included temporary post-cast stiffness (97), skin irritation secondary to casting (6), re-casting events (3), paronychia (1), and pain (1).

**SUMMARY**

- Closed reduction and casting of displaced Salter Harris II proximal phalanx fractures can be safely performed with high rates of excellent radiographic outcomes
- CRC and CRPP have similar final radiographic results, indicating that these are stable fractures amenable to a closed reduction.
Annual Meeting Live Paper 09: Natural Course of De Quervain’s Tenosynovitis Treatment: A Retrospective Review of 1104 Patients
SPP0263
Wrist
Level 4

Gilberto O Lobaton
Varun Puvanesarajah
Sandesh Rao
Mark Ren
Adam D’Sa
E. Gene Deune

HYPOTHESIS
In this study, we summarize outcomes and determine prognostic factors in 1104 patients with De Quervain’s tenosynovitis (DQT) from presentation to symptom resolution involving various treatment modalities. We hypothesize that women will be most affected, particularly peripartum women, and that most patients can receive symptom resolution without needing corticosteroid injection nor surgery.

METHODS
We reviewed 1104 consecutive patients with DQT from 2013-2017 with an average follow-up of 6.5 ± 12.5 months. All patients were reviewed to establish baseline demographics, determine comorbidities and treatment history, and assess outcomes. Multivariate logistic regression was utilized to determine factors associated with treatment success. For all analyses, significance was set at p < 0.05.

RESULTS
Of 1104 patients, average age was 47.4 ± 14.3 years at initial diagnosis while 899 patients (81%) were women. 186 women (21%) were peripartum. The mean Body Mass Index (BMI) of our cohort was 30.5 ± 7.3 kg/m2, and 496 (44.9%) patients were obese (BMI 30 kg/m2) at presentation. 202 (18.3%) patients had depression, 174 (15.8%) patients had diabetes mellitus, and rates of Rheumatoid Arthritis, Carpal Tunnel Syndrome (CTS), Trigger Finger (TF), and Carpometacarpal (CMC) arthritis were 2.0%, 13%, 5.4%, and 13.6%, respectively. The most reported non-injection treatment modality was splinting/bracing (71%), followed by NSAIDs (57%). 64% of patients used a combination of non-injection therapies. 628 (67%) patients did not escalate treatment after a trial of non-injection therapy. Of the 391 patients receiving injections, 59% did not escalate treatment after 1 injection, 80% after up to 2 injections, and 85% after up to 3 injections. In those who attempted non-surgical management, 73 (7%) patients received surgical release. History of TF (aOR = 3.4, 95% CI 1.8 - 6.3, p = < 0.001) and CMC arthritis (aOR = 1.8, 95% CI 1.2 - 2.8, p = 0.004) were positively correlated with eventual
use of injection therapy. History of CMC arthritis was positively correlated with need for surgery (aOR = 2.5, 95% CI 1.2 - 4.9, p = 0.01).

SUMMARY
- Non-injection treatment options, including splinting and NSAIDs, are successful in providing sufficient relief to prevent further escalation of treatment in 2/3 of cases.
- When needed, a course of up to 2 corticosteroid injections can be successful in providing sufficient relief to prevent surgery in 80% of cases.
- Surgery is rarely needed when attempting more conservative options but is significantly more likely when patients have concomitant carpometacarpal arthritis.

REFERENCES
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>1104 (100)</td>
</tr>
<tr>
<td>Average [range] age, yrs</td>
<td>47.4 [19-93]</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>White/Caucasian</td>
<td>556 (50.4)</td>
</tr>
<tr>
<td>Black/African American</td>
<td>384 (34.8)</td>
</tr>
<tr>
<td>Asian</td>
<td>78 (7.1)</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>21 (1.9)</td>
</tr>
<tr>
<td>Other</td>
<td>65 (5.9)</td>
</tr>
<tr>
<td>Employed</td>
<td>729 (66.0)</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td></td>
</tr>
<tr>
<td>&lt;25</td>
<td>254 (23.0)</td>
</tr>
<tr>
<td>25-29.9</td>
<td>302 (27.4)</td>
</tr>
<tr>
<td>&gt;=30</td>
<td>496 (44.9)</td>
</tr>
<tr>
<td>Data unavailable</td>
<td>52 (4.7)</td>
</tr>
<tr>
<td>Smoking History</td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>703 (63.7)</td>
</tr>
<tr>
<td>Former</td>
<td>274 (24.8)</td>
</tr>
<tr>
<td>Current</td>
<td>122 (11.1)</td>
</tr>
<tr>
<td>Data unavailable</td>
<td>5 (0.5)</td>
</tr>
<tr>
<td>Depression</td>
<td>202 (18.3)</td>
</tr>
<tr>
<td>Type 2 Diabetes Mellitus</td>
<td>174 (15.8)</td>
</tr>
<tr>
<td>Pregnant/Postpartum</td>
<td>186 (20.7)</td>
</tr>
<tr>
<td>Rheumatoid Arthritis</td>
<td>22 (2.0)</td>
</tr>
<tr>
<td>Carpal Tunnel Syndrome</td>
<td>143 (13.0)</td>
</tr>
<tr>
<td>Trigger Finger</td>
<td>60 (5.4)</td>
</tr>
<tr>
<td>Carpometacarpal Arthritis</td>
<td>150 (13.6)</td>
</tr>
</tbody>
</table>
Figure 1: Summary of Clinical Course of 1104 DQT Patients from 2013-2017

1104 Diagnosed with DQT

4.5% no intervention

939 (85%) attempted ≥ one non-injection treatment

67% no further treatment

2% surgery without attempting CSI

31% escalation to CSI

8.8% CSI without attempting non-injection treatment

391 ≥ one injection

59% no further treatment

6.5% surgery

130 ≥ two injections

52% no further treatment

15% surgery

30 ≥ three injections

53% no further treatment

23% surgery

7 ≥ four injections*

*Not surgical candidates or did not want surgery
Annual Meeting Live Paper 29: ORIF of Multifragmentary Fractures of the Radial Head Does Not Lead to Worse Outcomes Compared to Arthroplasty

SPP0138
Elbow/Shoulder

Level 4

Phillip C. McKegg
Nathan N. O'Hara
Christopher G. Langhammer
Robert V. O'Toole
W.A. Eglseder
Raymond A. Pensy

HYPOTHESIS
Current dogma states that open reduction and internal fixation (ORIF) of radial head fractures comprised of 3 or more fragments should be avoided due to high failure rates, and instead, these injuries should be treated with radial head arthroplasty (RHA). We hypothesized that ORIF would be associated with worse outcomes than radial head arthroplasty for multifragmentary radial head fractures.

METHODS
The retrospective cohort study included adult patients with a radial head fracture comprised of 3 or more fragments treated with either ORIF or RHA at a level one trauma center from 2007-2018. The primary outcome measure was unplanned return to the operating room for a complication including revision arthroplasty, loss of fixation, removal of hardware, ligament repair, nerve lysis, nonunion, or malunion. Secondary outcomes included range of motion and the presence of pain at the last follow up. The association between treatment and the study outcomes was tested using generalized linear models, which controlled for age, comminution, dislocation, fracture type, Mason fracture type, and the number of radial head fragments.

RESULTS
The study included 125 patients with radial head fractures comprised of 3 or more fragments, 80 treated with ORIF who were younger and more likely to be male (mean age, 43 years 25% female) than the 45 treated with RHA (mean age, 61 years 75% female, p<0.05). 19% of the ORIF patients experienced a post-operative complication requiring surgery compared to 17% of RHA patients (95% CI: -21 to 14.5, p=0.72). Only one patient experienced nonunion (1.3%), and one patient experienced malunion (1.3%) of the radial head requiring surgery in the ORIF group. Three patients (7%) in the RHA group had to undergo revision arthroplasty. The remaining reoperations in each group were related to removal of hardware, contracture, release, ligament repair, nerve lysis, or some combination of these issues. 65% of ORIF patients and 64% of RHA patients were able to achieve a >100-degree arc of forearm rotation at final follow-up (p=0.24).
Pain at the last follow-up was lower with RHA (47% vs 55%) but did not reach statistical significance (p=0.16).

SUMMARY
• In contrast to existing dogma, we did not find that treatment with ORIF demonstrated worse outcomes than arthroplasty in terms of complications requiring surgery.
• These data provide additional data and indicate that clinicians should be aware that outcomes after arthroplasty may not be superior to ORIF for radial head fractures, even in these comminuted fractures.

REFERENCES
Annual Meeting Live Paper 32: Tendon Allograft Interposition for Failed Distal Ulna Resections: Mid to Long-term Outcome

SPP0625

Wrist

Level 4

Loukia K. Papatheodorou
Dean G. Sotereanos

HYPOTHESIS
Despite modifications, the reported failure rate of the Darrach’ procedure, distal ulnar resection, remains high. To overcome the symptoms associated with painful convergence and impingement after distal ulna resections, many alternative procedures have been developed with varying success to prevent painful impingement. The purpose of this study was to report the mid- to long-term outcome of Achilles tendon allograft interposition arthroplasty as a salvage technique for painful distal radioulnar instability after distal ulnar resection.

METHODS
Thirty-eight patients with painful impingement and instability of the distal ulna following resection of the ulnar head were treated with Achilles tendon allograft interposition. There were 27 women and 11 men with a mean age of 41 years (range, 34-68 years) at the time of the surgery. The dominant hand was affected in 29 patients. The Achilles allograft is interposed between the distal radius and the resected distal ulna and is secured by sutures through suture anchors to the radius and drill holes to the ulna. All patients were evaluated radiographically and clinically.

RESULTS
The mean follow-up was 136 months (range, 36 - 270 months). At the final follow-up, patient mean pain levels (on a visual analog scale) were significantly reduced, from 8.4 to 1.2. Comparisons between preoperative and postoperative forearm rotation and grip strength measurements showed an average 29° increase in pronation, 43° in supination and 76% in grip strength. No patient complained of instability at the ulnar stump. The mean Mayo Modified Wrist Score significantly improved from 41 to 88. Postoperative radiographic evaluation demonstrated maintenance of a wide space between the resected ulna and the distal radius. No foreign body reactions or other complications relating to rejection of the Achilles tendon allograft or infections were encountered. The first patient of this study was graded as a failure due to persistent pain. We attributed this failure to insufficient allograft bulk interposed between the resected ulna and the radius. This was a worker’ compensation patient who later underwent radioulnar arthrodesis for salvage 39 months after the Achilles allograft interposition.
SUMMARY

- Achilles tendon allograft interposition arthroplasty provides a safe and reliable alternative for the treatment of failed distal ulna resections.
- Especially for patients who may not be candidates for implant arthroplasty because of their young age or high level of activity.
- Although this technique does not restore normal mechanics of the distal radioulnar joint, prevents impingement and painful convergence of the ulnar stump on the radius.

REFERENCES

Annual Meeting Live Paper 10: 3D Motion Analysis of Arthroscopic Capsular Release for Older Children with Brachial Plexus Birth Injuries

SPP0935
Elbow/Shoulder

Level 4

Stephanie A Russo
Erica Johnson
Ross S Chafetz
Sarah Combs
Scott H Kozin
Dan A Zlotolow

HYPOTHESIS
Shoulder internal rotation contractures in children with brachial plexus birth injuries (BPBI) may be treated with anterior arthroscopic capsular release (ACR), which is thought to improve glenohumeral joint external rotation and is typically performed in children under age 5. We hypothesized that anterior ACR would be successful in older children and that glenohumeral external rotation and the total arc of glenohumeral internal/external rotation would increase after surgery.

METHODS
A retrospective review of patients over age five who had motion capture assessments before and after anterior ACR was performed. Four patients were identified, ages 8, 11, 13, and 14 years. All underwent preoperative magnetic resonance imaging (MRI). The anterior glenohumeral joint capsule and tendinous portion of the subscapularis tendon were released arthroscopically. A thoraco-lumbar spine orthosis with an arm piece in external rotation was worn full-time for four weeks and weaned over the following four weeks. Modified Mallet scores and imaging studies were reviewed. Glenohumeral joint angles were measured in internal and external rotation before and after surgery using a 3-dimensional motion capture system. The glenohumeral internal/external arc was calculated from the glenohumeral joint angle in the external rotation and hand to belly (internal rotation) positions. Joint angles and the glenohumeral rotation arc were compared before and after surgery.

RESULTS
All patients had mild glenohumeral dysplasia based on preoperative MRI. All patients had improved external rotation Mallet scores and improved glenohumeral external rotation joint angles measured by motion capture (range 11-31° improvement; Table, Figure). All patients lost glenohumeral internal rotation based on the motion capture data (range 9-31° loss). No patient lost midline function (inability to reach belly, a risk of procedures to increase external rotation), but two patients had a decreased internal rotation modified Mallet scores (Table). The arc of glenohumeral internal/external rotation was unchanged (range 1-4° difference).
SUMMARY

- Although anterior ACR was expected to increase the glenohumeral internal/external rotation arc, the patients’ arcs of motion were unchanged.
- Rather, the same arc of motion was reoriented into more external rotation, indicated by the increased external rotation and decreased internal rotation joint angles.
- While the procedure was successful based on modified Mallet scores, the changes to glenohumeral joint rotation measured by Mallet scores indicate that the mechanism of change differed from the standard rationale for this procedure.
- Finally, these results demonstrate that anterior ACR was successful in improving external rotation in older children with BPBI and mild glenohumeral dysplasia.

REFERENCES


Table. Each participant's age at surgery, preoperative glenohumeral (GH) dysplasia assessment determined by magnetic resonance imaging, pre- and postoperative external rotation (ER) and internal rotation (IR) modified Mallet scores, glenohumeral rotation joint angles, and glenohumeral internal/external rotation arc are shown.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Age</th>
<th>GH Dysplasia</th>
<th>Pre ER Mallet</th>
<th>Post ER Mallet</th>
<th>Pre IR Mallet</th>
<th>Post IR Mallet</th>
<th>Pre GH ER (°)</th>
<th>Post GH ER (°)</th>
<th>Pre GH IR (°)</th>
<th>Post GH IR (°)</th>
<th>Pre GH Arc (°)</th>
<th>Post GH Arc (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
<td>Mild</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>16.5</td>
<td>30.3</td>
<td>-13.4</td>
<td>-23.9</td>
<td>3.1</td>
<td>6.4</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
<td>Mild</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>11.7</td>
<td>43.1</td>
<td>0</td>
<td>-30.6</td>
<td>11.7</td>
<td>12.5</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>Mild</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>-24.5</td>
<td>-13.7</td>
<td>24.4</td>
<td>15.2</td>
<td>0.1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>Mild</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>18.7</td>
<td>31.3</td>
<td>-6.6</td>
<td>-15.7</td>
<td>12.1</td>
<td>15.6</td>
</tr>
</tbody>
</table>

Figure. Participant 2’s preoperative and postoperative external rotation and internal rotation modified Mallet positions. Improved external rotation is noted, although with decreased internal rotation requiring wrist flexion to reach her belly postoperatively.

SPP0955
Miscellaneous

N/A

Sean E. Slaven
Devaveena Dey
Clare Grazal
Bobby G. Yow
Thomas A. Davis
Scott M. Tintle

HYPOTHESIS
We previously investigated the early feasibility of serum biomarkers to predict osteoporosis in women in a small pilot study with promising results. The objective of this proposal was to conduct an expanded study to evaluate the capabilities of biomarker signatures to predict osteoporosis in women.

METHODS
Serum samples were obtained from the Department of Defense Serum Repository for 85 women diagnosed with osteoporosis after age 46 as well as 85 age- and BMI-matched women with normal bone mineral density from four time points in their life (ages 25-31, 32-38, 39-45, and 46-60). Serum levels of bone metabolism biomarkers including DKK1, Leptin, TNF-a, OPG, OC, OPN, Sclerostin (SOST), PTH, BSAP, CTX-1, P1NP, and 25OH-Vitamin D were measured using individual and multiplex immunoassays. Comparisons of individual biomarker levels between osteoporotic and control groups were performed for each age group. Gradient boosted modeling (GBM) was then performed to assess the performance of biomarker signatures in each age group for predicting future osteoporosis development. Local interpretable model-agnostic explanations (LIME) analysis was performed to determine whether increased or decreased levels of biomarkers were indicative of osteoporosis in the GBM.

RESULTS
The most pronounced between-group difference was in SOST; SOST levels were significantly lower in the osteoporotic group at all time points/ages (Age 25-31: p=0.008; Age 39-45: p=0.004; Age 32-38: p=0.023; Age 46+: p<0.001). The gradient boosted model created at each time point performed well in predicting osteoporosis in subjects at each of the four time points. From time point 1 to 4 respectively, AUC of GBM was 0.87, 0.70, 0.76, and 0.82. Brier scores were 0.17, 0.23, 0.21, and 0.20, respectively. At each time point, SOST was the top performing biomarker in predicting OP in subjects. LIME analysis shows directionality of biomarkers indicating that lower SOST, lower P1NP, and higher OC, PTH and Vitamin D (among others) have good predictive power in determining osteoporosis in subjects.
SUMMARY

- Predictive modeling using biomarker signatures performed well in predicting future osteoporosis development.
- SOST was a strong contributor to these models and was lower in all age groups in the women who went on to develop osteoporosis.
- Early prediction of high risk for osteoporosis development may allow early intervention in high risk individuals and prevent fragility fractures.
HYPOTHESIS
At our unit, we hypothesised that a shift in management of acute upper limb infections as a result of the SARS-CoV-2 pandemic may demonstrate that less aggressive management (through outpatient care and local anaesthetic procedures, as opposed to inpatient admission and general anaesthetic) has no significant impact on patient outcomes or readmission rates.

METHODS
Using electronic hospital records, data from patients presenting with acute upper limb infections was collected retrospectively from the 1st of January to 30th of March 2020, then for a period of three months from 30th of March until 30th of June 2020, after changes in management were introduced during the pandemic. These changes comprised of the establishment of an emergency triage clinic and dedicated local anaesthetic theatre for these infections. We hoped this would allow patients to be assessed safely and efficiently, without the risks associated with hospital admission or the need to burden limited emergency theatre (CEPOD) resources. Here, we analysed the results of this change and considered how it may alter patient care after the pandemic. Several data points were gathered, including classification of infection, management approach (conservative versus operative), and post-treatment outcomes. CHI squared tests and unpaired t tests were utilised in statistical calculations. Significance level was taken as <0.05.

RESULTS
Seventy-two patients were treated in the three months prior to the 30th of March 2020, and 49 after. Surgical intervention remained the mainstay of management for both cohorts (81%, n=58 VS 84%, n=41). However, before setting up our clinic, 97% (n=56) received treatment under general anaesthetic and the majority were admitted as inpatients (89%, n=64). For the three months from the 30th of March, only 43% (n=21) required overnight admission and were instead largely managed with local anaesthetic procedures (90%, n=37) allowing same day discharge. No statistical difference in readmission rates was demonstrated (p=0.5564) despite this stark change in management approach. Post-operative complications were also unaffected,
and were even fewer in the cohort treated during the pandemic. This may be explained by a lack of Group A Streptococcus positive cultures grown in this group.

SUMMARY
• In many instances, acute upper limb infections can be safely managed without the need for inpatient admission.
• Selective admission of patients with strict follow-up can be feasible, improving patient experience and cost effectiveness in the longer term.
• Reprioritisation of services and resources as a consequence of the SARS-CoV-2 pandemic has highlighted opportunities for the change in management of acute upper limb infections at our unit, which may be continued safely in the longer term even after the pandemic is over.
HYPOTHESIS
Despite thumb carpometacarpal (CMC) arthroplasty being perceived by providers and patients as one of the most painful hand surgical procedures, there is sparse information on the utilization of opioids postoperatively. This study aims to identify opioid prescription patterns and risk factors associated with the need for an opioid refill prescription after CMC arthroplasty.

METHODS
Using a national insurance database, all patients who underwent CMC arthroplasty from 2010-2016 were included if they had continuous enrollment in the database for 1 year preoperatively and postoperatively. Opioid data was collected using National Drug Codes from outpatient pharmacy claims of filled prescriptions. Only opioid naïve patients (zero opioid prescriptions filled within 6 months preoperatively) were included. Refills were defined as any prescription filled after 7 days post-procedure up to 6 months.

RESULTS
A total of 20,731 opioid naïve patients who underwent a CMC arthroplasty were included. 5,490 (26.48%) patients required an opioid refill prescription and 15,223 (73.43%) patients had no refills postoperatively. Patient comorbidities and modifiable risk factors significantly associated with an increased likelihood of requiring a refill were smoking (odds ratio [OR] 1.18), diabetes (OR 1.18), depression (OR 1.13), and CMC steroid injection in the 6-month period preoperatively (OR 1.16; p<0.001). For those that required a refill, the average number of pills initially prescribed was 47.8 (379.4 oral morphine milligram equivalents [OMEs]), compared to 28.0 pills (220.1 OMEs) for those not requiring a refill. Furthermore, there were significantly more opioid pills prescribed in the initial prescription in the group encompassing patients from 2014 to 2016 compared to the group of patients from 2010 to 2013 (M= 38.8 vs. M= 30.5, respectively; Difference of 8.3 pills).
SUMMARY

- Overall, 1 in 4 opioid naïve patients undergoing CMC arthroplasty required a second opioid prescription refill postoperatively.
- Smoking, diabetes, depression, and steroid injections within 6 months prior to surgery increased the risk of an additional refill.
- Additionally, patients who required an additional refill were initially prescribed almost double the number of opioid pills.
- These findings highlight the potential role of patient factors and opioid prescribing patterns on prolonged opioid use after CMC arthroplasty.
- We are hopeful that the information presented will be utilized for both patient education and future trials attempting to reduce the number of opioids prescribed and refills required.

| Table 3. Multivariate Analysis of Increased Risk to Opioid Refill following CMC Arthroplasty |
|-----------------------------------------------|-----------------------------------------------|
| Demographics | Odds Ratio (95% CI) | p value |
| Age | | |
| (45-54 vs. 55-64) | 1.10 (1.02-1.20) | <0.05 |
| (45-54 vs. >65) | 1.21 (1.09-1.33) | <0.001 |
| Sex | Female | 1.10 (1.02-1.17) | <0.05 |
| Comorbidities | | |
| Obesity | 0.92 (0.83-1.03) | 0.14 |
| Renal Disease | 1.16 (0.95-1.42) | 0.14 |
| Smoking | 1.18 (1.05-1.34) | <0.01 |
| Hyperlipidemia | 0.88 (0.83-0.94) | <0.001 |
| Hypertension | 1.09 (1.02-1.17) | <0.05 |
| CAD | 1.02 (0.90-1.15) | 0.77 |
| Congestive Heart Failure | 1.24 (0.99-1.56) | 0.06 |
| Rheumatoid Arthritis | 1.01 (0.86-1.17) | 0.93 |
| Diabetes Mellitus | 1.18 (1.07-1.30) | <0.001 |
| Depression | 1.13 (1.04-1.23) | <0.01 |
| Anxiety | 1.02 (0.89-1.17) | 0.77 |
| Injection | Steroid | 1.13 (1.04-1.23) | <0.01 |
| Hyaluronic Acid | 1.11 (0.90-1.36) | 0.33 |
| Year of surgery | | |
| 2014-2016 vs. 2010-2013 | 1.25 (1.17-1.34) | <0.0001 |

Significant p values highlighted in bold

| Table 2. Univariate Comparison of Original Script Prescription |
|-----------------------------------------------|-----------------------------------------------|
| Refill Status | p value |
| No Refill | Refill |
| Original Prescription | | |
| # of Pills Prescribed | 27.9 (27.5-28.4) | 48 (47.0-48.4) | <0.0001 |
| Morphine Equivalents | 220 (216-224) | 379 (373-386) | <0.0001 |

1Variables presented as N (95% CI); Significant p values highlighted in bold
HYPOTHESIS
An ideal classification system promotes communication and guides treatment for congenital upper limb anomalies (CULAs). The Oberg, Manske, and Tonkin (OMT) classification was introduced in 2010, replacing the Swanson classification as the official IFSSH system. Utilizing phenotypic presentation and knowledge of developmental biology, the OMT removed the ambiguity of the Swanson classification and strove to clearly classify every CULA. In this consensus decision-making study, we hypothesize that difficult to classify CULAs will be identically classified by a group of experienced pediatric hand surgeons.

METHODS
An international consortium consisting of 14 pediatric hand surgeons in three countries, contributed a group of 72 difficult to classify CULA cases. These were identified from the clinical practice of the surgeons and from the Australian Hand Difference Register (Australia), International Consortium for Health Outcomes Measurement (United Kingdom), and Congenital Upper Limb Differences (USA) databases. Two cases were eliminated secondary to lack of radiographs. Through a Delphi process, repeated efforts were made to obtain consensus for the correct OMT classification of each case utilizing clinical images and radiographs.

RESULTS
The first round of discussion yielded consensus for 57 cases. The remaining 15 cases were resubmitted to the group through the Redcap platform for independent classification by each surgeon. The repeat exercise yielded no consensus for any case. The group of experts were then reconvened, and a second round of consensus decision-making exercise was performed after the Redcap process. The top 2-3 preferred diagnoses for each case, from the Redcap survey, were presented to the group and the other diagnoses discarded. The repeat discussion resulted in final consensus for 13 of 15 cases. The primary challenge in diagnosis was differentiating cleft hand from ulnar longitudinal deficiency (ULD); 7 such cases were in this group, with 3 ultimately determined to be cleft hand, 2 to be ULD and 2 were without a clear consensus. Another controversial group was brachy-polydactyly cases where diagnoses vary between synpolydactyly, symbrachydactyly or complex syndactyly.
SUMMARY

• This study demonstrated that even experienced pediatric hand surgeons vary in their opinions on the diagnosis of certain CULAs, and consequently entry into OMT databases.
• Despite an improvement over the Swanson classification, there are limitations and controversies with the OMT system, especially when classifying hands with less than 5 skeletal digits, syndactyly, and with diagnostic overlap between ULD and cleft hand or those in the brachy-polydactyly group.
• Genetic testing may be needed to determine the final diagnosis in difficult to classify conditions.

REFERENCES

Annual Meeting Live Paper 01: The Natural History of Constant Pre-Operative Fingertip Numbness and Thenar Atrophy following Carpal Tunnel Release: A Prospective Study

HYPOTHESIS
Carpal Tunnel Syndrome (CTS) clinical presentation featuring constant fingertip numbness or thenar muscle atrophy suggests more severe or longstanding disease. Currently, it is unclear how to advise patients about their clinical recovery following median nerve decompression. We hypothesized that both constant tip numbness and thenar atrophy improved by 1 year post-operatively.

METHODS
A total of 41 hands from 36 patients were enrolled in this prospective study. Patients endorsed constant fingertip numbness (CN)(n=37) and/or presented on physical exam with thenar atrophy (TA)(n=20) pre-operatively; 17 patients had both. After undergoing transverse carpal ligament release, patients were evaluated at 8 days, 3 months, 6 months, and 12 months following surgery. Sensibility was assessed with Semmes-Weinstein testing and hand function evaluated included pinch strength, and quick DASH (qDASH) scores. Atrophy measurements were performed using a direct measurement method. Descriptive statistics were performed to determine return to normal hand function over time.

RESULTS
At 6 months post-op, 74% of CN patients showed improved sensibility compared to 53% of TA patients. At 1 year, similar proportions of improved sensibility (58% for CN, 60% for TA) were found while 4 CN and 1 TA patient achieved normal sensibility. Pinch strength was worse at baseline in TA patients (9.5±3.9 vs. 10.8±5.0) and returned to baseline in 72% and 80% of CN and TA patients at 6 months and 93.3% and 100% of CN and TA patients at 12 months. Hand function dissatisfaction was similar at baseline for both groups (CN=qDASH 50.5, 81% dissatisfied; TA=qDASH 50.9, 78% dissatisfied) which improved by averages of 39 and 34 points at 6 months and 34 and 45 points at 12 months. Tip sensation improved from zero patients at baseline to 42%, 72%, and 62% of all patients at 3,6, and 12 months (Fig.1). Atrophy patients
presented with 1.4±0.8 mm of atrophy at baseline that improved by 1.0 mm at 12 months, reaching an average 0.7 mm.

SUMMARY

- CTS patients with CN showed more frequent sensibility abnormalities but were more likely to show improvements compared to patients with TA.
- Patients with TA showed weaker pinch strengths at baseline but improved more rapidly than CN patients.
- Hand function significantly improved by 3 months and constant tip numbness resolved in roughly 2/3 of all patients at 6 months; no further improvement was noticed at 12 months.
- While the rate of recovery of CN and TA differ following CTR, both showed significant improvement from CTR.

Fig. 1 – Degree of fingertip numbness severity in patients following CTR over time.
**HYPOTHESIS**
Diversity and inclusion initiatives are being embraced across medical specialties. As hand surgery explores these opportunities, we hypothesize that programs such as the Young Leaders Program (YLP) positively reflect diversity growth in academic hand surgery and could potentially be an important driver for continued growth.

**METHODS**
A database of YLP from 2004-2020 was curated. Program/practice websites, Doximity, and Pubmed were accessed to determine gender, race, practice type, and residency specialty. Gender and race [white or person of color (POC)] were extrapolated from photographic images when publicly available. Only faculty, fellows and alumni with photographs available via public records were included in final analysis. Statistical analysis was performed using chi-square with statistical significant set at p<0.05.

**RESULTS**
Two hundred and fifty-two YLP alumni were identified and compared to an existing database of 622 hand surgery faculty from 85 hand fellowship programs and 582 recently graduated fellows from 44 programs. Women comprised 24% of YLP alumni (compared to 17% faculty and 25% fellows). An increasing trend in female participation in YLP was observed over the years, with 31-40% female representation in each class from 2016-2020. Furthermore, 30% of female hand faculty are alumni of the YLP, and female hand faculty are significantly more likely to have participated in YLP than their male colleagues (p=0.045). POC represented 27% of YLP alumni (compared to 24% of faculty and 29% of fellows). 28% of POC hand faculty participated in the YLP. Recent years show a lower percentage of POC representation in YLP. 83% of YLP alumni are in academic hand practices, compared to 22% of recently graduated fellows. Although recently graduated fellows who were assigned as POC were less likely to be in academic practice (19% POC fellows v. 31% white fellows practice in an academic setting, p=0.007), YLP alumni noted as POC were in academics similarly to white YLP alumni (84% POC v. 88% white YLP alumni in academic practice, p=0.249).
SUMMARY
- Participation in the ASSH Young Leaders Program is positively associated with pursuit of an academic practice and has positively contributed to gender and racial diversity in academic hand surgery.
- Nearly one-third of female hand faculty are alumnae of YLP.
- We believe that the Young Leaders Program can be a powerful tool in investing in early practicing hand surgeons while also promoting diversity and inclusion in hand surgery.

Table 1
Distribution of hand surgery faculty, recent fellows, and YLP alumni by gender, race, residency subspecialty training, and practice type.

<table>
<thead>
<tr>
<th>Diversity in Hand Surgery</th>
<th>Faculty</th>
<th>Fellows</th>
<th>YLP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female (%)</td>
<td>104 (17)</td>
<td>148 (25)</td>
<td>60 (24)</td>
</tr>
<tr>
<td>Male (%)</td>
<td>518 (83)</td>
<td>434 (75)</td>
<td>192 (76)</td>
</tr>
<tr>
<td><strong>By Race</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POC (%)</td>
<td>152 (24)</td>
<td>166 (29)</td>
<td>68 (27)</td>
</tr>
<tr>
<td>White (%)</td>
<td>470 (76)</td>
<td>416 (71)</td>
<td>184 (73)</td>
</tr>
<tr>
<td><strong>By Core Training</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orthopedic Surgery (%)</td>
<td>458 (74)</td>
<td>404 (69)</td>
<td>178 (71)</td>
</tr>
<tr>
<td>Plastic Surgery (%)</td>
<td>159 (26)</td>
<td>144 (25)</td>
<td>69 (27)</td>
</tr>
<tr>
<td>General Surgery (%)</td>
<td>5 (&lt;1)</td>
<td>17 (3)</td>
<td>5 (2)</td>
</tr>
<tr>
<td>Unknown (%)</td>
<td>0</td>
<td>17 (3)</td>
<td>0</td>
</tr>
<tr>
<td><strong>By Practice Type</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic Hand (%)</td>
<td>622 (100)</td>
<td>83 (14)</td>
<td>155 (62)</td>
</tr>
<tr>
<td>Academic Non-Hand (%)</td>
<td>0</td>
<td>46 (8)</td>
<td>54 (21)</td>
</tr>
<tr>
<td>Non-Academic (%)</td>
<td>0</td>
<td>331 (57)</td>
<td>41 (16)</td>
</tr>
</tbody>
</table>
Figure 1
Percent make-up of female and POC participation in the Young Leaders Program
Annual Meeting Live Paper 16: Calling on Diversity - Analysis of the Gender Diversity of Invited Speakers Across Hand Society Meetings

SPP0923
Miscellaneous

N/A

Shuting Zhong
Lauren Jacobson
Christine Novak
mackinnons@wustl.edu
Jennifer Megan Patterson

HYPOTHESIS
The paucity of gender and ethnic diversity in surgical specialties at the leadership level is well documented(1). The lack of diversity on panels and invited lectureships has led NIH to coin the term, “MANEL”, to describe all male panels(2). This study sought to evaluate the current state of diversity of speakers at the annual hand society meetings “ASSH and AAHS” focusing on the demographics of chairs, co-chairs, and moderators of section panels. We hypothesize a significant lack of gender and ethnic diversity exists.

METHODS
Analysis of the 2020 meeting programs of the AAHS and ASSH was performed with a comparison to the 2010 meetings. Program involvement was evaluated for invited speakers and moderators of panels, symposia, instructional courses, and scientific abstract sessions. Gender was determined from publicly available sources such as university websites, online photos/videos, and publicly searchable databases such as research gate, and pub-med.

RESULTS
There were 142 speakers at the 2010 AAHS and 180 speakers at the 2010 ASSH meeting. The 2010 meetings had similar representation of male (AAHS 86% (n=122), ASSH 94% (n=169) and female speakers (AAHS 14% (n=20), ASSH 6% (n=11). At both the 2010 meetings, female surgeons represented 4% of the invited speakers. The majority of the remaining female speakers were hand therapists. At the 2020 meetings, there were 193 speakers at AAHS and 439 speakers at ASSH (Live and Virtual Meetings). The 2020 meetings also had similar representation of male (AAHS 72% (n=139), ASSH 79% (n=349) and female (AAHS 28% (n=54), ASSH 21% (n=90) speakers. At the 2020 AAHS meeting, 15% of speakers were female surgeons and at the 2020 ASSH meeting, 19% were female surgeons. The increase in female surgeon speakers between 2010 AAHS and 2020 AAHS had a 3.75-fold increase with p<0.0014. The increase in female surgeon speakers between 2010 ASSH and 2020 ASSH had a 4.75-fold increase with p<0.00001.
SUMMARY

- A survey of gender diversity in invited speaker roles at the annual hand society meetings, 2020 AAHS/ASSH, in comparison with data from 2010 demonstrates a significant improvement in gender diversity.

- A 3.75-fold increase in women surgeons as invited speakers at the 2020 AAHS meeting and a 4.75-fold increase in women surgeons at the 2020 ASSH meeting.

- However, women surgeons still remain underrepresented at current hand society meetings. This survey shows that continued effort and careful attention of panelist diversity of future meetings are needed to curate an inclusive hand society experience.

REFERENCES


% Female Surgeon Invited Speakers Across A Decade: AAHS vs ASSH

- **AAHS**
  - Female: 4% (2010), 15% (2020)
  - Male: 86% (2010), 72% (2020)

- **ASSH**
  - Female: 4% (2010), 19% (2020)
  - Male: 94% (2010), 79% (2020)