



Oral Presentation Abstracts

Concurrent Scientific Abstract Session I

1. Fat Transplantation in CMC I Arthritis - Operative Technique and Preliminary Results

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Objective: Many treatment options of CMC I arthritis include a partial or total resection of the trapezium and thus alter the anatomy of the hand. Despite the sustained success of the final restoration to less invasive treatment options are view. Fat tissue containing adipose tissue derived stem cells (ADSC) have already been reported a regenerative effect in other areas of the body. Therefore, it was our objective to evaluate the outcome of autologous fat injection into the carpometacarpal joint to achieve symptom relief and a postponement of definitive surgical solution.

Materials and Methods: In a pilot study, 10 patients, both men and women treated. Inclusion criteria were age over 18 years, symptomatic CMC I arthritis with a VAS of at least 40mm / 100mm. Liposuction of the abdominal fat was performed under local anesthesia. There were injected between 1 and 2.5ml of fat obtained under fluoroscopy in the carpometacarpal joint. There was an immobilization of the joint for 10 days in a splint. Follow-up studies included radiographs, grip strength and pinch grip measurements, ROM, Michigan Hand Questionnaire and Quick Dash and were carried out after 1,2,6 weeks and 3,6 and 12 months.

Results: There were no relevant side effects in our study. Patients reported an increase in the pain during the first 2 weeks after operation. After 2 weeks postop we have seen a consistent reduction of pain, both at rest and during exercise. In rest nearly a pain relief was achieved. Both the increase in grip strength and the strength of the pinch grip, as well as a reduction of the DASH and MHQ could be achieved postoperatively.

Summary: Our preliminary results suggest that autologous fat injection is a promising new treatment option in the arthritic changes in the CMC I joint. This new method is safe, few side effects and can be performed under local anesthesia. Although the instability of advanced rhizarthrosis can not be treated with this alternative, the definitive operation, be pushed in terms of a resection arthroplasty at least for months or years, the evaluation of the medium- and long-term outcomes is necessary to make a statement about the sustainability of this method can make. However, it remains unclear whether „cushioning“ and scaring of the joint or the regenerative potential of included ADSC is responsible for the clinical effect.

2. Metacarpophalangeal Arthroplasty for the Management of Inflammatory Arthritis; An Analysis of 583 Arthroplasties

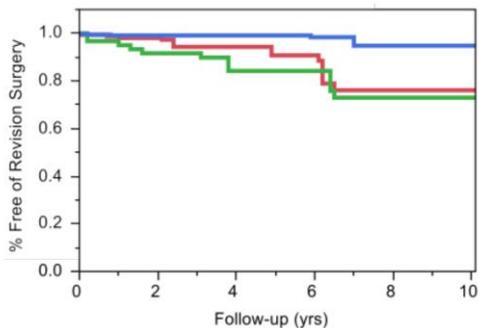
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Hypothesis: Metacarpophalangeal (MCP) arthroplasty has shown promise in treating inflammatory arthritis, however, there is a lack of studies comparing different implant designs and their effect on function. The purpose of this study was to assess the outcomes of MCP joint arthroplasty in inflammatory arthritis, with a comparison of the 3 most common types of implants.

Methods: Utilizing a single institution's joint registry, we examined 583 MCP arthroplasties performed in 142 patients with inflammatory arthritis from 1998 to 2012. The mean age at surgery was 61 years and a BMI of 25.63% involving the dominant extremity. 86% were females, 11% smokers, and 12% had diabetes mellitus (DM). Implant types included pyrocarbon (n=155), silicone (n=366), and SRA (n=61). Patient characteristics comparisons, with the exception of age, did not differ significantly between implants. For pyrocarbon, SRA, and silicone groups age averaged (53, 54, 65), females (81%, 89%, 88%), smokers (12%, 0%, 11%), and DM (12%, 3%, 11%).

Results: There were 38 revision surgeries performed at a mean 2 years postoperatively. The 2, 5 and 10 year survival rates were 98%, 95%, and 87%, respectively. The 5-year survival rates for the pyrocarbon, SRA, and silicone implants were 91%, 84%, and 99%, respectively (**Figure 1**, silicone (blue), pyrocarbon (red), and SRA (green)). Patients receiving a SRA (HR 3.42, p<0.001) and pyrocarbon (HR 2.60, p=0.005) had an increased risk of revision arthroplasty compared to silicone implants. Intraoperative fractures and use of cement also increased implant failure risk (**Table 1**). There were 15 intraoperative complications involving a periprosthetic fracture, while postoperative complications included 19 dislocations, 2 heterotopic ossifications, 4 postoperative fractures and 9 infections. Pyrocarbon implants were associated with an increased rate of dislocation (p<0.001) and HO (p=0.02). In those unrevised patients, at a mean 5 years (2-10) follow-up, preoperative to postoperative pain levels significantly improved (p<0.01). In unrevised implants, there was no significant change in total arc of motion, grip or pinch strength when compared to preoperative values. SRA implants were associated with a increased total arc of motion (51°) compared to pyrocarbon (42°) and silicone (44°) (p=0.005).

Summary Points: MCP arthroplasty for inflammatory arthritis can be a successful motion sparing procedure with reasonable medium term survival and low complications. Silicone prosthesis was associated with a higher survival rate than pyrocarbon or SRA. Patients experience predictable pain relief and maintenance of their motion.



Risk Factor	Hazard Ratio	Confidence Interval	P-Value
Female	2.69	0.82 – 16.53	p = 0.11
Age at Surgery	0.97	0.95 – 0.99	*p = 0.004
BMI	1.00	0.94 – 1.07	p = 0.94
Varus/Valgus Instability	1.35	0.62 – 2.71	p = 0.42
Smoker	1.82	0.50 – 5.26	p = 0.33
Diabetes Mellitus	<0.1	-----	p = 0.21
Prednisone Use	0.81	0.39 – 1.58	p = 0.55
Methotrexate Use	1.05	0.55 – 2.01	p = 0.89
Pyrocarbon	2.60	1.34 – 4.96	*p = 0.005
Silicone	0.16	0.07 – 0.33	p < 0.001
SRA	3.42	1.69 – 6.58	*p = 0.001
Intraoperative Fracture	4.69	1.12 – 13.27	*p = 0.04
Bone Graft	1.94	0.31 – 6.39	p = 0.41
Cemented Implant	3.00	1.46 – 5.81	*p = 0.004

3. Wrist Fusion Using a New Wrist Fusion Plate: First Results

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Wrist arthrodesis is a rarely needed salvage procedure for posttraumatic, degenerative, or inflammatory joint destruction. Stability used to be gained by implants crossing the wrist region from the distal radius over the carpus to the 3rd metacarpal. The 3rd carpometacarpal (CMC) joint could be spared from the fusion allowing some degree of CMC motion if the plate was removed after one year. A recently introduced plate (Medartis Aptus^(TM) Wrist Fusion Plate) was designed in such a way as to spare the CMC joint without the necessity of plate removal, by extending from the distal radius to the distal carpal row only. In a retrospective study we compared the functional results of wrist fusions using one of the two systems: the Aptus^(TM) wrist fusion plate extending distally not further than to the capitate, hamate, and/or trapezoid bone vs. the DePuy-Synthes^(TM) LCP wrist fusion plate extending distally to the 3rd metacarpal.

Patients: 10 male patients were retrospectively included after a wrist fusion with the Aptus plate (group A). They were matched with a group (B) of 10 male patients who had had a wrist fusion with the Synthes^(TM) plate in the past. In all patients, the wrist joint destruction was posttraumatic in nature, and one or multiple operations such as partial wrist fusions preceded the total wrist fusion. We assessed the course of bone healing, revision surgery, and data of functional outcome (forearm rotation, grip strength, pain VAS, DASH score, modified Mayo wrist score).

Results: Mean follow-up in group A was 17 months, age 51,8 years. Two patients of group A had a revision arthrodesis for pseudarthrosis. In the remaining 8 patients bony healing was uneventful, but three revision operations were necessary for plate removal, single screw removal and neurolysis, respectively. Forearm rotation was unrestrained in all patients. Grip strength equalled 42% of the uninjured side (12-77%), pain VAS 5 (1-7) under heavy load, DASH 47 (11-64) and Mayo wrist score 42,5 (20-70). The functional results of group B did not differ from group A. In all patients of group A, CMC-motion was increased with a maximum of 10°-0-5° extension-flexion. Initial CMC pain had resolved completely in all but one at the time of follow-up evaluation.

Conclusion: Total wrist fusion should remain a salvage procedure for exceptional cases only. The functional value of an increased CMC motion after wrist fusion with the Aptus^(TM) plate has yet to be proved.

4. Buying Time: Long-Term Results of Wrist Denervation and Time to Repeat Surgery

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Introduction: Wrist denervation has been shown to be a viable option for chronic wrist pain related to articular degeneration or chronic instability. Removal of the sensory innervation to the wrist joint provides relief of pain; however denervation does not address the underlying pathology. Patients continue to undergo degenerative changes and may need revision procedures. This study reviews the 20 year long term outcomes of patients treated with partial wrist (anterior and posterior interosseous nerve) denervation focusing on need for and time to salvage procedure.

Materials and Methods: Retrospective study was performed over a 20 year period of all patients undergoing wrist denervation by the lead authors (1994-2014). At latest follow up data including range of motion, grip strength, radiographic degeneration and revision surgery were recorded.

Results: The series includes 115 wrists in 104 patients (74 male, 30 female) with average age at surgery of 54 (range 18-80). Average follow up was 69 months (range 3 –249). The principal diagnoses were scaphoid lunate advanced collapse (SLAC) degenerative arthritis (33%) and radiocarpal arthritis (30%). Average flexion-extension arc was 94 degrees for the affected extremity (77% of contralateral) and average grip strength was 71% of the unaffected extremity.

Seventy percent of wrists (81/115) had satisfactory outcomes and did not require revision procedures at average follow up of 69 months (range 3-249). Thirty percent (34/115) underwent revision surgery. The most common procedures were scaphoid excision four corner fusion (13), total wrist fusion (6), proximal row carpectomy (6) and radioscapholunate fusion (4). Time to salvage surgery was on average 24 months after denervation (range 2-165).

Conclusions: Partial wrist denervation is a reliable motion preserving procedure for patients with chronic wrist pain. In this series 70% of patients experienced pain relief and did not require further salvage procedures at an average of 69 months follow up. Thirty percent of patients ultimately underwent salvage procedure. On average patients experienced pain relief for 24 months prior to ultimately undergoing revision operation. The significance of these results better enable surgeons to give time estimates and expectations regarding pain control following wrist denervation in the patient with chronic wrist pain.

Figure 1. Isolation of posterior interosseous nerve on floor of fourth dorsal compartment through dorsal midline approach (proximal to the right, distal left).



Figure 2. Isolation of anterior interosseous nerve immediately volar to interosseous septum.



5. German Hand Trauma Alliance - Current Status

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Severe hand traumata have a significant impact on our health system and on insurance companies, respectively. It is estimated that 33% of all occupational injuries and 9% of all invalidity pensions are due to severe hand trauma. Unfortunately, these high numbers are not only due to the severity of the trauma but to organisational deficiencies. Usually, the patient is treated at the general surgical emergency in the first place and only then forwarded to a microsurgeon. This redirection increases the time that is required for the patient to finally arrive at an expert for hand surgery. On the one hand, this problem can be explained by the population's lack of awareness for distinguished experts for hand and microsurgery, on the other hand, the emergency network, or emergency doctors in particular are not well informed about where to take a patient with a severe hand trauma – clearly a problem of communication between the hospitals and the ambulance. It is possible to tackle this problem, but participating hand trauma centres have to work hand in hand as a network and thus exploit synergy effects. The French system “FESUM” is a good example for such a network and even comprises centres in Belgium and Switzerland. To improve the treatment of severe hand trauma, a similar alliance was initiated in Germany just recently. The pilot project “Hand Trauma Alliance” (www.handverletzung.com) was started in April 2013 and currently comprises two hospitals within the region of upper Bavaria. The network provides hand trauma replantation service on a 24/7 basis and aims at shortening the way from the accident site to the fully qualified hand surgeon, to improve the therapy of severe hand injuries and to optimise acute patient care in general. In order to further increase the alliance's impact it is intended to extend the project's scope from regional to national coverage – nevertheless, such an endeavour can only be done in collaboration with the German Society for Hand Surgery (DGH). This paper reviews the current status of the German Hand Trauma Alliance effort.

6. Spiral Tenodesis for Metacarpophalangeal Instability with Trapeziometacarpal Arthroplasty

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Introduction: In more advanced stages of trapeziometacarpal arthritis, the thumb metacarpal may develop an adduction contracture, leading to secondary hyperextension instability of the metacarpophalangeal joint. Following trapeziometacarpal arthroplasty, uncorrected metacarpophalangeal hyperextension (greater than 50 degrees) may contribute to ongoing Z-collapse deformity, weakness of pinch and grip, and patient perception of diminished function. Fusion eliminates all metacarpophalangeal motion and may reduce interphalangeal motion. Local capsulodesis techniques using a volar incision can produce excessive local scar tissue around the digital nerves (paresthesias and hypersensitivity) and the flexor pollicis longus (reduced metacarpophalangeal and interphalangeal motion) as well as an initial rigid end-point that ultimately fails over time.

Materials & Methods: We prospectively analyzed a consecutive case series of 55 trapeziometacarpal arthroplasty patients (mean age 60, 7 males) that received simultaneous spiral tenodesis for thumb metacarpophalangeal hyperextension of at least 50 degrees. Through a 2 cm incision at the dorsal-ulnar metacarpophalangeal joint, the extensor pollicis brevis (detached proximally) was dissected distal to the axis of metacarpophalangeal motion, routed deep to the extensor pollicis longus, volar to the adductor aponeurosis, deep to the neurovascular bundles, and external to the flexor sheath in a spiral path to reach the radial base of the thumb metacarpal where it was anchored to the joint capsule and the accessory abductor pollicis longus. Before tensioning and anchoring the tenodesis, the metacarpophalangeal joint was pinned in 20 degrees of flexion with a 1.4 mm Kirschner wire, removed at 4 weeks post-operatively. Pre-operative / post-operative (mean 24 weeks) objective measurements and DASH scores were compared using paired t-tests with $p < 0.05$.

Results: Mean pre-operative / post-operative measurements were: metacarpophalangeal hyperextension 62.0 / -1.7 degrees; metacarpophalangeal flexion 52.1 / 50.1 degrees; interphalangeal arc of motion 66.4 / 65.5 degrees; key pinch 3.6 / 5.4 kg; grip strength 14.1 / 20.1 kg; DASH score 56.6 / 8.4. Differences were statistically significant for: metacarpophalangeal hyperextension, key pinch, grip strength, and DASH score. Differences were not significant for metacarpophalangeal flexion or interphalangeal arc of motion. No patient demonstrated paresthesias or hypersensitivity of the digital nerves. All patients achieved stability at the metacarpophalangeal joint. One Kirshner wire was removed earlier than planned after migration and penetration through the skin.

Conclusion: Performed in conjunction with trapeziometacarpal arthroplasty, spiral tenodesis effectively stabilizes the metacarpophalangeal joint without compromising metacarpophalangeal flexion, interphalangeal motion, or the digital nerves. Post-operatively, patients demonstrate significant improvements in key pinch, grip strength, and DASH scores.

7. The Role of the Synovia in the Nociception in Rhizarthritis

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Background: The aim of this study was to investigate the immunohistochemical markers in synovia of trapeziometacarpal joint ligaments in surgical specimens, to examine the nociceptive role of the synovia in osteoarthritis.

Methods: The dorsoradial (DRL) and oblique anterior ligaments (AOL) were harvested during resection-suspension arthroplasty in ten females and one male patient, six right and five left thumbs, affected with advanced osteoarthritis. The ligaments were divided in proximal and distal parts and stained with the following immunohistochemical antibodies: Calcitonin Gene Related Peptide (CGRP), Acetylcholin (Ach), Substance P, Neuroproteine Y (NBP Y), Noradrenaline, N-Methyl-D-Aspartate (NMDA)-receptor as well as Met/Leu-Enkephaline. Hematoxylin-eosin staining were used to classify the synovia according to Krenn et al. into No, Low-grade, and High-grade synovitis. The degree of osteoarthritis of the basal thumb joint was analyzed preoperatively with modified Eaton-Littler radiographic grading. Two parts of the AOL had to be excluded from further analysis given insufficient tissue for staining.

Results: Radiological examination revealed grade II in four, grade III in three, and grade IV in four patients. The synovitis score showed the following results for the single ligament parts: no synovitis: nine AOL and eleven DRL, low-grade synovitis: seven AOL and ten DRL, as well as high-grade synovitis: four AOL and five DRL, respectively. The amount of blood vessels increased with higher synovitis score, however they did not correlate to higher grade of radiographic arthritis. Furthermore, no relation was found between the radiographic grade of arthritis and the synovitis score. The synovial lining cell layer had a pronounced immunoreactivity for CGRP, Ach, substance P, NBP Y, noradrenaline, NMDA-receptor, and Met/Leu-enkephalin with higher synovitis score. In contrast, the synovial stroma had no increased immunoreactivity with higher synovitis score.

Conclusion: The synovia in ligaments is higher involved in nociception with increased synovitis score via sympathetic inflammatory (noradrenaline, NBP Y) as well as parasympathetic anti-inflammatory (substance P, CGRP), and opioid anti-inflammatory (enkephalin) neural pathways. Therefore, the synovia plays an important role in nociception in osteoarthritis of the thumb.

8. Outcomes of a Cementless Thumb Basal Joint Hemiarthroplasty for Treatment of Trapeziometacarpal Osteoarthritis

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Introduction: Multiple surgical procedures and implants have been developed to treat trapeziometacarpal joint osteoarthritis. Recently, a promising thumb basal joint hemiarthroplasty (BioPro® Modular Thumb; BioPro, Port Huron, MI, USA) was reported in the literature to provide pain relief and improved function. In the aforementioned study, the authors reported a 94% implant survivorship with revision as an endpoint at a mean follow-up of 72.1 months. The purpose of our study was to evaluate the senior author's clinical results and survivorship of thumb basal joint hemiarthroplasty using the same device.

Methods: We performed 35 basal joint hemiarthroplasties in 32 patients from 2011 to 2014. Of these, 26 thumbs (25 patients) had clinical follow-up of at least 12 months. Mean age of the patients was 54 years (range 43-68 years) with 88% females. All patients had Eaton-Littler Stage II or III arthritis pre-operatively. Average follow up was 17.2 months (range 12-26 months). The main outcomes were revision rate and time to revision. Pre- and postoperative radiographs were examined to determine the amount of overall thumb ray lengthening and amount of subsidence of the implant between those revised and unrevised. Student's t-test and Fisher exact test was used for statistical analysis ($p < 0.05$).

Results: At final follow-up 13 of 26 thumbs (50%) had been revised with implant removal, resection of remaining trapezium, and ligament reconstruction with tendon interposition (LRTI). Another 3 thumbs were symptomatic and planning on future revision. Continued pain and implant subsidence through trapezium was the clinical reason for revision. Mean time to revision was 13.8 months (range 8-23 months). Those needing revision were younger (52 vs 57 years $p < 0.03$) and had index procedure more often on the dominant side (46% vs 31%). There was no significant difference between those revised and unrevised in terms of percentage of thumb ray lengthening (8% vs. 9%, $p = 0.486$) and amount of trapezium subsidence (2.8mm vs. 2.2mm, $p = 0.202$). Kaplan-Meier analysis with revision as the endpoint showed 61% survivorship at mean follow-up of 17.2 months.

Conclusions: Although a limited number of cases were examined, we found poor implant survivorship and an unacceptably high rate of reoperation with the BioPro thumb basal joint hemiarthroplasty device. These results are in stark contrast to previous reports in the literature. Therefore, we can not advocate for continued use of the device and no longer use this implant for thumb basal joint arthroplasty.

9. An Investigation of the Effects of Joint Protection Strategies on the Hand Force Requirements of Women with Hand Osteoarthritis when Opening Sealed Jars: Is Non-Skid Material Enough?

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Design and Methods: A 2x2x2 experimental cross-sectional design was used to study within-subject differences in pain, perceived effort (PE), hand forces, hand forces across time, and torques during a jar-opening task across three factors: 1) orientation of hand used to stabilize the jar's base (supinated vs. oblique), 2) hand twisting the lid (right vs. left), and 3) use of nonskid material on lid (yes vs. no). A jar device designed by McGee et al. (2011) was used to quantify hand forces and torques acting upon the sealed jar's lid. Participants completed 2 trials of all combinations of the aforementioned factors (16 total) (*Figures 1a&b*). After each trial, participants were asked to report pain and PE using the Numerical Rating Scale (NRS) and Borg CR10, respectively.

Data sources: Women (n=31), aged 18 years+ with radiographically confirmed and symptomatic hand osteoarthritis (OA).

Data Analysis: Descriptive statistics and within subjects comparisons (Student's t, Cochran's Q, and Wilcoxon Signed Rank) for baseline characteristics, hand forces, hand forces/time, success, and pain were performed. Using a mixed-effects linear model, the effect of and interactions between the three experimental factors on PE, pain, peak hand force, and hand forces across time were estimated.

Results: The sample had a symmetrical distribution of hand OA (ns). Participants used less hand force when twisting with their left hand ($p < .0001$). The smallest hand force across time was produced by the left nonskid supinated approach ($p < .05$) (*Figure 1c*). The left hand had significantly lower pain ratings than the right hand ($p = .05$) after turning. For both hands, participants rated significantly less pain when using a supinated grasp pattern ($p < .0001$). Participants rated PE significantly lower when using the left hand to turn ($p < .0001$), the supinated grasp pattern ($p < .0001$), and nonskid material ($p < .0001$) (*Figure 1d*). A left supinated grasp with a nonskid material was a significantly more successful strategy to open jars than was any other ($\chi^2 = 9.4$, $p < .001$).

Implications: The data supports that women with hand OA will know more success, report less pain and effort, and use less hand force with the left hand, grasping the base of the jar with a supinated right hand, and using nonskid material. Hand therapists should consider how the stabilizing hand supports the jar and which hand grasps the lid when recommending use of nonskid materials for opening sealed jars. The use of nonskid material without additional reasoning will likely increase loads on arthritic joints, pain and, dysfunction.

Figure 1a: Jar Instrument-83 mm lid Figure 1b: Four Grasp Patterns of the Left Hand



Figure 1c: Force Production across Grasp Patterns

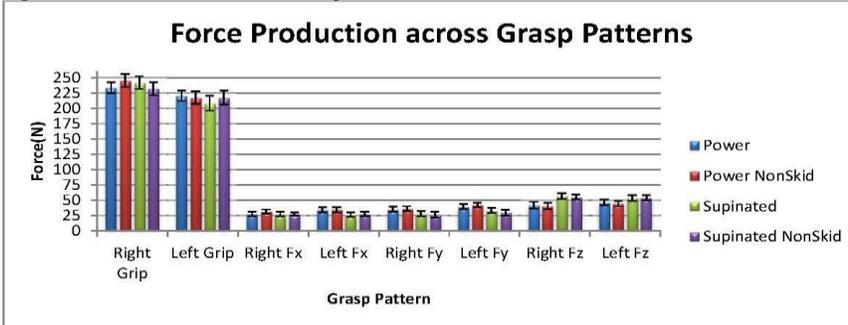
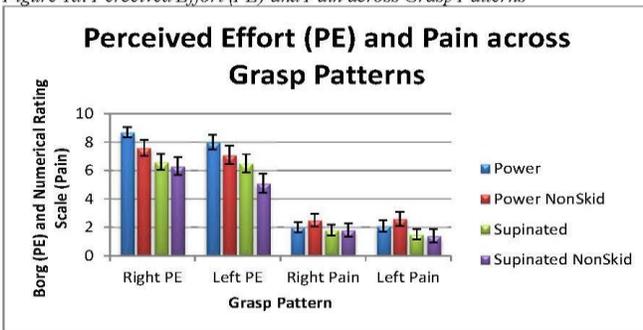


Figure 1d: Perceived Effort (PE) and Pain across Grasp Patterns



10. Prevalence and Predictors of Second Metacarpal Fracture After Suture Button Suspension for 1st CMC Arthritis

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Introduction: A relatively new method to treat 1st CMC arthritis is suture button suspensionplasty. A potential complication for this procedure is second metacarpal fracture. In this study, we perform a retrospective analysis to determine the potential factors that may lead to fracture. We hypothesize that the angle of suspension, the placement of the suture button on the index metacarpal, and the use of the 2.7 mm overdrill directly correlate to the presence of metacarpal fracture.

Methods: A retrospective chart review was performed from 2011-2015. Demographic factors, length of follow up, presence of fracture, previous and simultaneous procedures, and use of the overdrill were recorded. Radiographic analysis included the angle of suspension and the ratio of suture button height to the height of the index metacarpal. Statistical analyses were performed.

Results: 51 patients underwent suture-button suspension. All patients underwent simultaneous trapeziectomy. All patients were immobilized for 10-14 days in a thumb spica splint prior to start of physical therapy. The average length of follow up was 9 months. 19 patients had simultaneous procedures, and 15 patients had previous ipsilateral hand procedures. The 2.7 mm overdrill was used in 39 patients, and the tapered 1.1 mm K wire was used in 12 patients. 4 patients suffered index metacarpal fracture (7.8%). There were no statistical differences in the angle of suspension (42.35 degrees non-fracture group vs 40 degrees fracture group, $p = 0.76$), the ratio of suture button height to second metacarpal height (0.41 non-fracture group vs 0.38 fracture group $p = 0.67$), or the use of the overdrill (79% overdrill in non-fracture group vs 50% overdrill in fracture group).

Conclusion: Second metacarpal fracture after suture button suspension is a concerning complication. Our study demonstrates that this complication may be more prevalent than originally thought, and demonstrates that fracture is not related to the angle of suspension or the location of the index metacarpal suture button. It demonstrates that fracture can occur even in the absence of the 2.7 mm overdrill. This lends credence to alternative theories for the mechanism of fracture, namely that the fiberwire may cause osteolysis of the bone and increase the propensity for eventual fracture. The sample size is small, and therefore, further long term follow up is necessary to determine if this pattern of fracture continues; if so, discussions must be held with regards to the acceptability of this complication.

11. The Role of First Metacarpal Osteotomy in the Management of Basilar Thumb Arthritis

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Introduction: Basilar thumb arthritis is a common and disabling condition. Surgical treatment include arthroplasty, trapeziectomy, arthroscopic resection and arthrodesis. First metacarpal extension (Wilson) osteotomy has been described for both early and late stage arthritis. Current literature does not adequately demonstrate the spectrum of utilization of osteotomy, particularly in late stage arthritis. This study reviews the long term outcomes of osteotomy in both early and late stage CMC arthritis.

Methods: An IRB approved retrospective study was performed over a 26 year period of patients undergoing first metacarpal osteotomy. At latest follow up, data including range of motion, grip strength, complications, need for subsequent surgery and progression of arthritis were recorded.

Results: The series includes 10 patients (10 female) with an average age at surgery of 48 (range 25-63). Average follow up was 36 months (range 3-90). The main diagnoses in this series were early degenerative changes of the CMC joint with painful subluxation or instability and adduction contracture with weakness and deformity.

For early degenerative changes, average postoperative radial abduction was 49 (range 40-70) degrees and palmar abduction 43 (range 30-70) degrees on the affected extremity (101% and 89% of the contralateral) and average oppositional pinch strength of 95% (range 63-117%), appositional pinch strength 92% (range 70-127%) and grip strength was 82% (range 71-87%) of unaffected extremity.

For late adduction deformity the average postoperative radial abduction was 39 (range 15-62) degrees and palmar abduction 35 (range 15-55) degrees on the affected extremity (67% and 60% of the contralateral) and average oppositional pinch strength of 42% (range 40-43%), appositional pinch strength 44% (range 33-55%) and grip strength was 75% (range 72-78%) of unaffected extremity. (Table 1)

Three patients required secondary surgery for symptomatic hardware. All patients in the series had satisfactory outcomes and did not require revision procedures for pain or instability at average follow up of 36 months (range 3-90).

Discussion and Conclusion: Metacarpal osteotomy is a reliable motion preserving procedure for patients with early CMC arthrosis and instability that did not show progression of disease while decreasing pain, increasing pinch and grip strength. Later stages of arthritis with painless adduction contractures were noted to have increased pinch strength and better palmar and radial abduction. (Figure 1) No patients in this series required additional procedures for their CMC arthritis. The significance of these results better enable surgeons to utilize metacarpal osteotomy in managing both early and late CMC arthritis

	Early Stage Arthritis		Late Stage Arthritis	
	Preop	Postop	Preop	Postop
Radial abduction	53 (range 35-75)	49 (range 40-70)	17.5 (range 5-30)	39 (range 15-62)
Contralateral radial abduction	56 (range 40-75)	49 (range 40-75)	32.5 (range 20-45)	54 (range 25-83)
Palmar abduction	44 (range 35-60)	43 (range 30-70)	37.5 (range 30-45)	35 (range 15-55)
Contralateral palmar abduction	46 (range 38-55)	49 (range 30-80)	37.5 (range 30-45)	55 (range 30-80)
Oppositional pinch (kg)	2.6 (range 1-5)	4.7 (range 2.5-7)	2.5 (range 2-3)	1.5 (range 1.5)
% of contralateral oppositional pinch	102 (range 100-104)	95 (range 63-117)	70 (range 39-100)	42 (range 40-43)
Appositional pinch (kg)	4.2 (range 0.4-7.6)	6 (range 3.5-9)	1.75 (range 1.5-2)	2.6 (range 2-3.2)
% of contralateral appositional pinch	88 (range 88)	92 (range 70-127)	44 (range 38-50)	44 (range 33-55)
Grip strength (kg)	22 (range 15-27)	21 (range 19-24)	19 (range 11-28)	12 (range 10-14)
% of contralateral grip strength (kg)	90 (range 80-100)	82 (range 71-87)	75 (range 56-93)	75 (range 72-78)



12. Revision Trapeziometacarpal Arthroplasty with Dermal Xenograft Interposition

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Purpose: To evaluate a surgical technique for failed primary trapeziometacarpal arthroplasty (TMA).

Methods: A retrospective review of all patients treated with a porcine dermal matrix (Conexa) for failed TMA by a single surgeon at a single institution was performed. Data collected included primary procedure performed, reason for failure, time from failure to revision surgery, thumb range of motion, grip strength, pinch strength, return to work, VAS pain score, pre-operative and post-operative radiographs, and complications.

Results: Three hundred and fifty five thumb TMA procedures were performed from 2005-2015. Of these, 9 (2%) were revision procedures. Seven of the 9 revisions were performed with xenograft interposition and 2 with flexor carpi radialis interposition. These 7 TMA revisions in 7 patients with a mean age of 57 years were included for final data evaluation. Four were performed on the right hand and three on the left hand. The mean time from primary procedure for TMA arthritis to revision surgery was 120 weeks (14-520). Original procedures included flexor carpi radialis ligament reconstruction tendon interposition (LRTI) (3/7), APL suspensionplasty (3/7), and TMA titanium joint arthroplasty (1/7). All revisions were performed for continued thumb pain, subsidence of the thumb metacarpal, and index metacarpal impingement. The mean follow-up of patients was 41 weeks (5-151). Mean Thumb interphalangeal ROM was 0-58 degrees and mean metacarpalphalangeal ROM was 0-40 degrees. Mean VAS pain score on final follow-up was 1.7 out of 10. Mean grip strength was 18 kg and mean pinch strength was 6 kg in the affected hand. Mean grip strength was 22 kg and mean pinch strength was 6 kg in the unaffected hand. Mean return to work was 23 weeks. Final radiographs of the involved thumb showed change in 1st-2nd metacarpal space from 1.5mm to 3.1mm. Change in thumb metacarpal - scaphoid space from 2.5mm to 5.3mm. No complications were encountered in any patient.

Conclusions: Treatment of a failed primary TMA with porcine xenograft dermal matrix shows good clinical outcomes for patients and is a valid treatment option when facing these difficult revisions.

13. Safety and Efficacy of a Novel Topical Analgesic for Treatment of Basal Thumb Arthritis: A Pilot Study

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Objective: To measure the efficacy and safety of a novel topical anti-inflammatory/analgesic formulation for the treatment of primary thumb carpometacarpal (CMC) osteoarthritis (OA).

Methods: A retrospective review of patients prescribed a custom topical analgesic containing active ingredients: Meloxicam, Baclofen and Lidocaine, with a 3% pentoxifylline base (*Bellevue Pharmacy, St. Louis, MO*) for treatment of thumb CMC OA was performed. Patients were excluded if they had corticosteroid injection of the affected joint within 2 months of treatment with the topical. Patients were given a QuickDASH survey after completing a course of topical treatment and results were compared to pre-treatment scores, when available. In addition, patients were given a 9-item survey regarding specific physical properties related to the cream itself (the “Cream Score”). Each item was scored 1-5, with 1 being the best possible score for each item (total minimum score = 9, maximum = 45). Patients were also asked to list any local adverse reactions or systemic side-effects or from using the cream.

Results: A total of 22 (19 female, 3 male) patients satisfied inclusion in this study. Average age was 54.8 +/- 10.5 years. Mean post-treatment QuickDASH was 22.3 +/- 7.3 compared to 25.4 +/- 6.6 pre-treatment ($p = 0.252$). For QuickDASH item regarding pain severity, mean post-treatment item score was 2.5 +/- 0.94 compared to 3.3 +/- 0.83 ($p = 0.027$). The mean Cream Score for all patients was 12 +/- 3.12. No patients reported any local adverse skin reactions. In addition, no cardiac events, gastrointestinal bleeding or ulcers were reported.

Conclusion: In this pilot study, we found that a novel topical analgesic/anti-inflammatory medication containing Meloxicam, Baclofen and Lidocaine was safe and well tolerated when used in for the treatment of patients with thumb CMC OA. Patients reported improvements in outcome scores, particularly with regards to pain, which saw significant improvement when compared to pre-treatment levels. Further investigation regarding this cream’s efficacy in treating thumb CMC arthritis and other upper-extremity conditions is warranted.

14. Disabilities of the Arm, Shoulder and Hand (DASH) Users Viewpoint Clarifies Interpretability of Scores

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Introduction: The DASH Outcome Measure is a well-recognized instrument for measuring upper-limb function and symptoms. One of the most difficult challenges is the ability to interpret an individual's numeric score. Some benchmarks and means of interpretation are available. The viewpoint of the stakeholder is an important perspective. The aim of this study was to help us understand how DASH users are interpreting individual scores.

Materials & Methods: A cross-sectional survey was administered to registered DASH Outcome Measure. The survey included user's work setting, interpretation of DASH scores based on clinical experiences, highest and lowest scores typically seen, satisfaction and agreement with information on interpretability, and how they think about their patients' progress. Descriptive statistics were used. Differences were assessed between work settings (clinical vs. research) with the chi-square (χ^2) test.

Results: 172 DASH users completed the survey. Most respondents were treating clinicians (77%), and the remaining being researchers/educators (23%).

Interpretation of DASH scores: Most respondents thought DASH scores ranged from **10 to 29** in patients who were: a) "*at a threshold for returning to work*" (39%), b) "*ready for discharge from treatment/therapy*" (47%) and c) "*aware of their upper limb limitations but it is not a problem*" (55%). Most (55%) thought that DASH scores ranged from **40 to 69** in patients who were "*having a lot of difficulty.*" Most (61%) thought DASH scores ranged from **0 to 29** in patients who were "*no longer considering their upper limb disorder a problem.*"

Over 75% indicated that the highest DASH scores they typically saw were in the range of 50 to 100 (80-90 range was most endorsed 18%). Greater than 70% indicated that the lowest scores they typically saw were in the range of 0 to 29. (χ^2 p>0.5)

Minimal Clinically Important Difference (MCID): Survey respondents were given information about the MCID and day-to-day variability, as well as thresholds for interpreting true change. Almost 90% of respondents were satisfied with this recommendation. Most thought the MCID was likely about right (59.8%). (χ^2 p>0.6)

Interpreting Progress in Patients: Almost 70% reported that they considered a combination that the patient had changed AND their final scores. 26% only thought about how much the patient had changed. Fewer reported thinking only about the final score (3.4%). (χ^2 p=0.29)

Conclusions: DASH users viewpoint clarifies interpretability of DASH Outcome Measure scores despite not pointing respondents to published cut-points. Users can manage the idea of multiple MCIDs and there is consensus.

15. Incidence and Extent of Tenosynovitis in Trigger Fingers

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Introduction: Trigger finger is also known as stenosing tenosynovitis of the flexor tendon, however there are some trigger finger cases without tenosynovitis. The purpose of this study is to find out percentage of trigger fingers with and without tenosynovitis and also to evaluate the extent of length of tenosynovitis through the use of ultrasonography. Materials &

Methods: 200 cases of trigger finger were selected and examined with ultrasound for the presence or absence of tenosynovitis. Sonosite M-turbo was used for the sonographic evaluation of the flexor tendons in trigger finger cases. Exclusion criteria was presence of – rheumatoid arthritis, gout, Diabetes, infection. Flexor tendon of the involved digit was examined using the ultrasound to look for presence or absence of tenosynovitis and extent of tenosynovitis from A1 pulley to A5 pulley.

Results: It was found that about 95.5 % of Trigger finger cases had tenosynovitis of the flexor tendon and the most commonly affected area was A1 pulley region. Within this group, in some cases (22 %) tenosynovitis extended from A1 to A2 pulley and in a very small percentage of the cases (1.5%) the entire tendon from A1 to A5 pulley showed presence of tenosynovitis. 4.5% of fingers had no evidence of any tenosynovitis. This group of patients had minimal or no tenderness at the distal palmar crease.

Conclusions: With this study we found that there is a small percentage of cases (4.5%) where there is no evidence of tenosynovitis based on sonographic examination, however the clinical presentation in this group was similar to other cases of trigger fingers with triggering but minimal tenderness at the distal palmar crease.

16. Prospective Evaluation of Post-Operative Opioid Utilization after Upper Extremity Surgery: We are Over Prescribing!

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Rothman Institute at Thomas Jefferson University Hospital, Philadelphia, PA

Introduction: While adequate management of post-operative pain with oral analgesics is an important aspect of surgery, it remains unclear how many pills are necessary to appropriately manage post-operative pain. The purpose of our prospective study was two-fold: (1) to evaluate opioid consumption after outpatient upper extremity surgery, and (2) to evaluate opioid utilization patterns in order to develop prescribing guidelines.

Methods: Nine board-certified hand surgery fellowship-trained orthopaedic surgeons prospectively collected data for six consecutive months on all patients undergoing outpatient upper extremity surgery. Data included patient demographics, surgical details, anesthesia type, and opioid prescription and consumption patterns. Linear regression was used for statistical analysis.

Results: A total of 1,466 patients with an average age of 55 years (range 5-93) were included. On average, surgeons prescribed 25 pills (range 0-110), while patients consumed 8.1 pills (range 0-90), resulting in a utilization rate of 32%. Only 6% of patients received disposal information. Soft tissue procedures required less opioids (5.1 pills for 2.2 days) compared to fractures (12.2 pills for 4.1 days) or joint procedures (14.6 pills for 5.0 days) ($p<0.01$). Both hand and wrist surgeries utilized an average of 7.6 pills, compared to 10.6 pills for forearm/elbow surgeries, and 22 pills for arm/shoulder surgeries ($p<0.01$). Patients undergoing surgery with only local anesthesia consumed the least opioids (4.5 pills for 2 days), compared to patients anesthetized with sedation (5.7 pills for 2.6 days), general (12.2 pills for 4.0 days), and regional (15 pills for 4.8 days) ($p<0.01$). Based on morphine equivalents, procedure type, anatomical location, and anesthesia type significantly influenced the amount of opioid used ($p<0.001$). In contrast, age and insurance, was found to not statistically affect opioid consumption.

Discussion & Conclusion: To the best of our knowledge this is the largest prospective evaluation of opioid consumption to date and we found that patients in our series are being over-prescribed pain medications post-operatively for hand & upper extremity surgery. Patients only utilized 32% of their prescribed pain medication, thereby leaving 68% of unused prescribed narcotics available for potential diversion. Very few patients (6%) received safe disposal information for excess pain medication by their prescriber, surgical facility, or pharmacy. Surgeons should consider prescribing less pain medications on average and base it upon the procedure type, anatomic location, and mode of anesthesia.

17. Cost-Utility Analysis of Clinic-Based Hand Therapy versus Home Therapy after Distal Radius Fracture

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Introduction: In recent prospective randomized trial, home based and clinic based therapy have yielded similar improvements in hand function after operatively treated distal radius fractures. Home based therapy is less costly, for both the hospital and for the patient, and challenges the paradigm of starting all patients in clinic based therapy. The aim of the study is to determine if initiating clinic based physical therapy for all patients after distal radius fractures is cost effective, compared to home exercise programs.

Methods: We developed a decision tree model (Fig. 1) using the cost, quality adjusted life years, health state probabilities and incremental cost effectiveness ratio of home exercise program, as compared to clinic based therapy, for patients treated operatively for distal radius fractures. The three health states are clinic therapy, home therapy with good progression and home therapy with poor progression requiring closer monitoring with clinic therapy. The probability for the health care states and the Patient-Rated Wrist Hand Evaluation (PRWHE) are derived from prospective, randomized trial. PRWHE scores were used to estimate quality adjusted life years. We obtained cost from national DRG reimbursement. We tested the robustness of the model using one-way, two-way and threshold sensitivity analysis. We performed Monte Carlo simulation to sample uncertainty distributions.

Results: The total cost of clinic-based therapy is \$1796.43, versus \$1016.09 for home exercise program (Table 1). The incremental cost effectiveness ratio of clinic vs. home therapy is \$145,642.36/QALY (Fig. 2). We set the willingness-to-pay threshold at \$50,000, therefore, clinic based therapy is *not* a cost effective option compared to home exercise program. One-way and two-way sensitivity analysis shows clinic based therapy becomes more cost effective as the cost per therapy session is lowered and the efficacy of home therapy is decreased (Fig. 3). Threshold analysis revealed the cost of each therapy session would have to be as low as \$36.73 for clinic based therapy to be cost effective, 34% of mean national reimbursement. Monte Carlo microsimulations showed even after adjusting for variations in costs and PRWHE scores, home exercise program is the optimal strategy.

Conclusion: Initiating clinic based hand therapy program for all patients after operatively treated distal radius fracture is not cost effective. Instead, starting patients on home exercise program as first line treatment and transitioning non-progressing patients into clinic-based therapy is a more cost effective alternative and would result in \$780.34 savings per patient or \$98,884,000 annually.



Fig 1. Hand therapy decision tree model. The two modes of compared therapy are home based versus clinic based (therapist-supervised) therapy programs. If patients in the home exercise program are not progressing appropriately, they will then switch to therapist-supervised program.

Cost Effectiveness Analysis

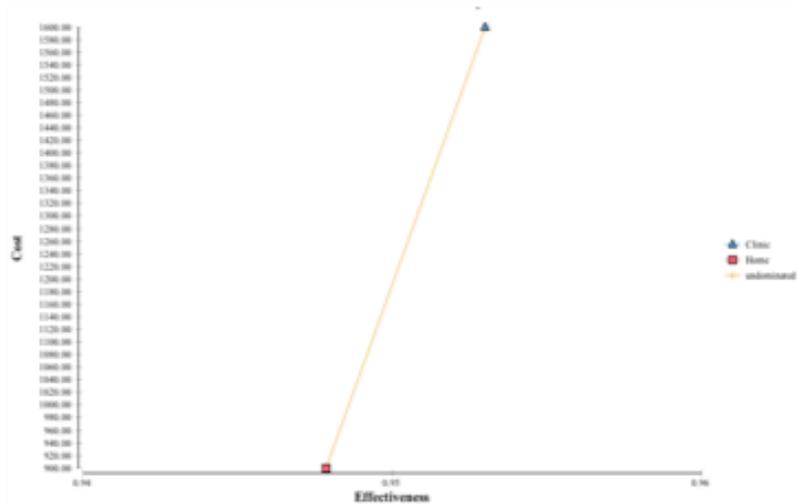


Fig 2. Cost effectiveness analysis of clinic vs home-based therapy plotting cost against effectiveness. Clinic based therapy is both more costly and slightly more effective compared to home based therapy. The slope of the line, which represents the incremental cost effectiveness ratio (ICER), is \$145,642.36.

Two-Way Sensitivity Analysis, Efficacy of Home Therapy vs. Cost of Each Therapy Session

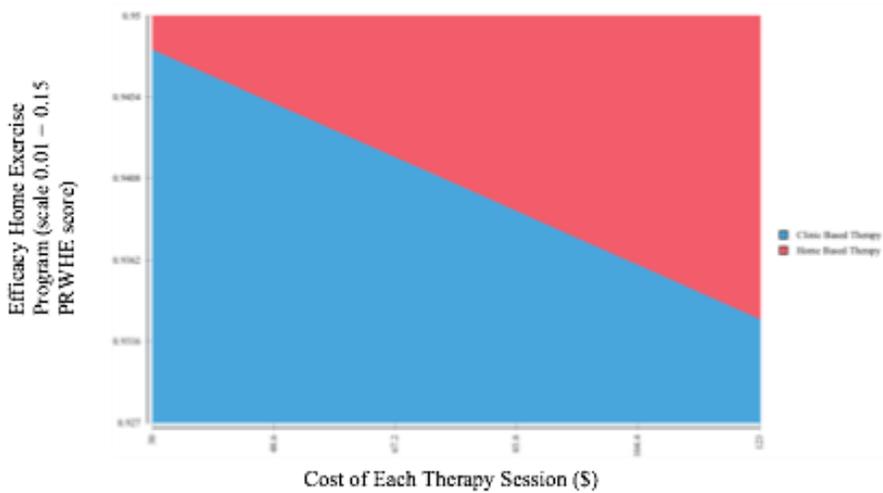


Fig 3. Multivariate sensitivity analysis. This diagram plots efficacy of home exercise program vs cost per therapy session. Blue area favors clinic based therapy and red area favors home. As the cost per therapy session decreases, clinic based therapy is more likely to be cost effective. Similarly, as efficacy of home exercise program decreases, clinic based therapy again becomes more cost effective.

18. The Deltoid Lift: A Comparison Study of Exposure Area in Proximal Humeral Approaches

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Introduction: A novel extensile approach of the proximal humerus which involves release of the deltoid at its insertion was compared to the anterior deltopectoral approach, the lateral non-extensile approach, and the anterolateral extensile approach with deltoid splitting. We hypothesized that the new approach would provide a greater area of exposure and greater access to anatomical landmarks.

Methods: Each approach was done a minimum of eight times on eighteen formalin fixed cadavers. After identifying landmarks, exposure area of exposed humerus was quantified using digital photos and Image J.

Results: The extensile approach with deltoid lift had an average exposure area of 46 cm² (SD of 5.2 cm², range of 38 to 53 cm²), and the greater tuberosity, lesser tuberosity, posterior-most aspect of humeral head, superior-most aspect of humeral head were observable through visual inspection. The novel extensile approach provided two times more exposure area than the anterolateral extensile approach with deltoid splitting, the next comparable approach. Comparison of the exposure area for the extensile approach with deltoid lift against all other approaches yielded statistical significance with a P-value < 0.01.

Conclusion: The extensile approach with deltoid lift provided the most exposure area with the greatest visibility of landmarks.

Concurrent Scientific Abstract Session II

19. Disabilities of the Arm, Shoulder and Hand (DASH) 20 Years Old: The Little Tool that Grew

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Introduction: The DASH (Disabilities of the Arm, Shoulder and Hand) Outcome Measure is a well-recognized instrument for measuring upper-limb function and symptoms. The self-completed questionnaire was designed to measure the impact on function (at the level of disability) of a wide variety of musculoskeletal conditions and injuries affecting the upper limb. Understanding how the DASH Outcome Measure Users are utilizing the outcome measure may provide opportunities to identify gaps in knowledge and provide direction for future research and application. The purpose of this study was 1) To describe how the DASH Outcome Measure was being used in clinical practice and/or research, and 2) To determine the level of endorsement of DASH items by DASH users.

Materials & Methods: A cross-sectional survey was administered to registered DASH Outcome Measure users. The survey inquired about the nature of users' practice, the patients for which the DASH and *QuickDASH* were being used, users' engagement in research activities using the DASH and *QuickDASH*, and users' endorsement of DASH items.

Results: 172 DASH users completed the survey. Respondents were mostly from the United States (52%) followed by Europe (23.6%) and Canada (9.5%). Most respondents were treating clinicians (77%), and the remaining being researchers/educators (23%).

One or both of the DASH and/or *QuickDASH* were consistently (89.5%) being used. 62.3% were using one or both of the DASH Optional Modules. About 90% of users were using the DASH and *QuickDASH* in adults (21-65 years). However, a majority (72.9%) was also using the instruments in patients over the age of 65, and a smaller proportion (13.9%) in patients under the age of 15. The DASH and *QuickDASH* were being used across the entire upper extremity (70-82%), including the neck 10% of the time. The measures are mostly (66.9-73.7%) being used as designed for primary musculoskeletal disorders (including joint-, tendon-, and nerve-related disorders), with some users applying the instrument for other non-musculoskeletal specific conditions (2.5-16.6%). All DASH items had at least 10% endorsement, suggesting that we need information on all 30-items.

Conclusions: This survey indicates that DASH Outcome Measure has grown beyond its intended use. The DASH and *QuickDASH* are being used outside of the body regions, types of disorders and age groups for which it was originally developed. Future measurement research on the DASH Outcome Measure should target the populations that have not yet been studied.

20. Novel Approach to Treat Rotator Cuff Tear Using Tendon Stem/Progenitor Cell (TSC) Sheets

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Introduction: Rotator cuff tear is a highly prevalent clinical problem. The healing tendon tissue recovers poorly and does not have the same biochemical and mechanical properties of an uninjured tendon because of scar formation and ossification. Therefore, there is an urgent need to discover new treatment measures to effectively improve the rate and quality of healing cuff tendons. Here, we established a chronic rabbit rotator cuff tear model and used novel tendon stem/progenitor cell (TSC) sheets to enhance tendon healing.

Methods: TSCs were isolated from rabbit biceps tendons and cell sheets were prepared by plating 1.5×10^5 TSCs on temperature-responsive culture dishes (UpCell™, Cell Seed Inc. Tokyo, Japan). A total of 40 rabbits underwent the supraspinatus tendon detachment surgery (Figure 1e) and then were randomly allocated to 2 groups: repair and repair + implantation of autologous TSC sheet. Six weeks after the detachment, torn tendons were repaired using suture anchors (Figure 1f). In TSC sheet group, TSC sheet was grafted at the site of repair (Figure 1g). At 4 and 8 weeks after the repair surgeries, we perform histological and immunohistochemical evaluation, and biomechanical testing of the repaired tendons.

Results: Rabbit TSCs were successfully isolated from biceps tendons (Figure 1a) and showed stem cell features. The TSCs sheets were successfully produced as a transplantable monolayer sheet form using temperature-sensitive culture dish (Figure 1b, 1c and 1d). Next, in vivo histology and immunohistochemistry examinations demonstrated that the cell sheet was observed on surface of footprint at tendon-bone junction 8 weeks after implantation (Figure 1h and 1i). Tissue at tendon-bone junction in TSC sheet group appeared thicker and well organized, and there were elongated spindle shape cells. In contrast, relatively thinner tissue and disorganized cellular arrangement were observed in control. Biomechanical testing of the repaired supraspinatus tendons is currently underway.

Discussion: This study represents the first efforts to systemically evaluate the role of TSCs in the form of sheet implantation in the healing of injured rotator cuff tendon in a rabbit model. Since TSC sheet stayed on the footprint surface it is likely that transplantation of a monolayer sheet of TSCs with collagen rich extracellular matrix at the site of rotator cuff tear would accelerate tendon-bone healing. The use of TSC sheets may eliminate the need of synthetic scaffolds for cell delivery, which may not be biocompatible and biodegradable, but be immunogenic.

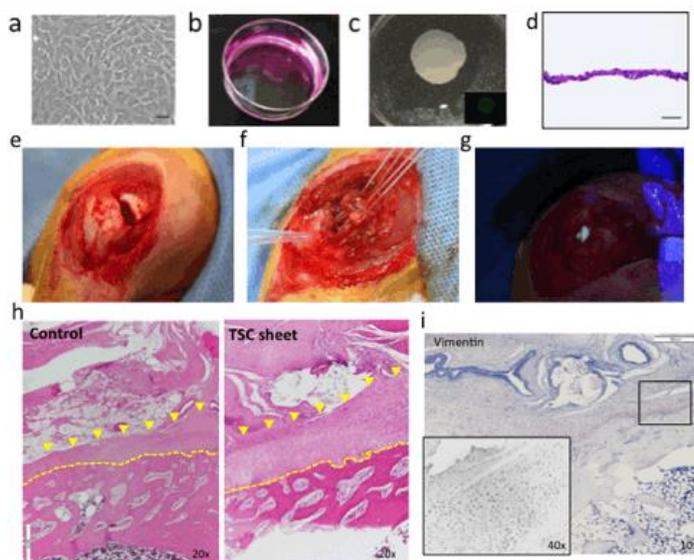


Figure 1

21. Do Prefabricated Splints Limit Wrist Motion as well as a Traditional Cast? A Pilot Study

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Introduction: Prefabricated high performance wrist splints have been used in the treatment of minimally angulated distal radius fractures in children with improved clinical outcomes, high patient acceptance and decreased cost. Similar incentives are present to use prefabricated high performance splints for adult injuries, however outcomes have not been documented. Limitation of wrist motion is felt to be the determinant for clinical success in non-operative management of minimally distal radius fractures. The purpose of this study is to quantitatively determine wrist motion under immobilization by a high performance wrist splint, compared with other forms of immobilization.

Methods: Skeletal motion under five immobilization conditions was studied in six normal young adult subjects using the Motion Monitor™, motion analysis system. Subjects were instrumented with seven high-fidelity six degrees of freedom Ascension™ electromagnetic trackers (1. Lister's tubercle, 2. thumb P1, 3. index P3, 4. long finger metacarpal, 5. lateral humeral epicondyle, 6. mastoid process, 7. C7 spinous process, 8. control tracker placed on the table). Subjects then performed six motion tasks (palmar/dorsiflexion, radial/ulnar deviation, supination, pronation) under five immobilization conditions (no immobilization, thumb spica cast, high performance thumb spica splint, high performance wrist splint, and a pharmacy wrist brace).

Results: There were four male and two female study subjects ranging in age from 25-32 years. Percent reduction in motion from baseline (no immobilization) was calculated for each immobilization type and each motion. Using ANOVA, no significant difference was found in percent reduction between the thumb spica cast, high performance thumb spica splint, and high performance wrist splint for palmar/dorsiflexion, radial/ulnar deviation, supination, or pronation (see figures). Pharmacy wrist brace was inferior to the other groups in palmar/dorsiflexion and radial/ulnar deviation.

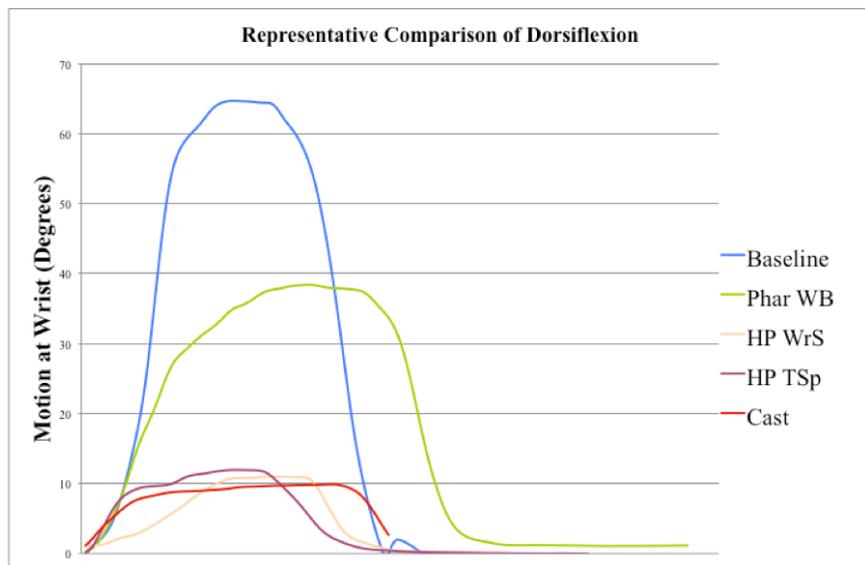
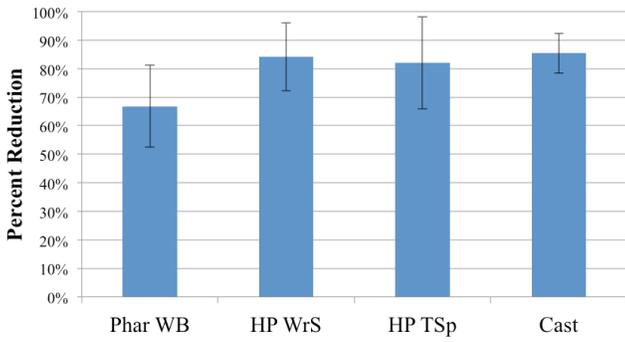
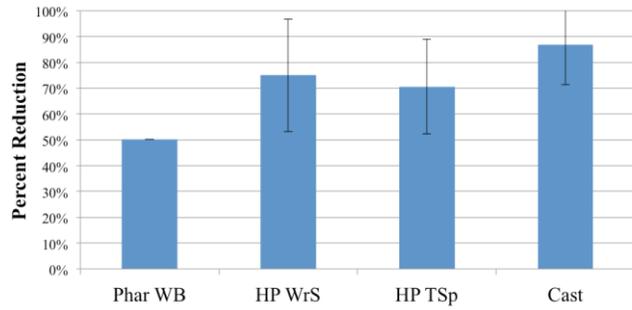


Figure 1: Dorsiflexion for one subject with different immobilization conditions

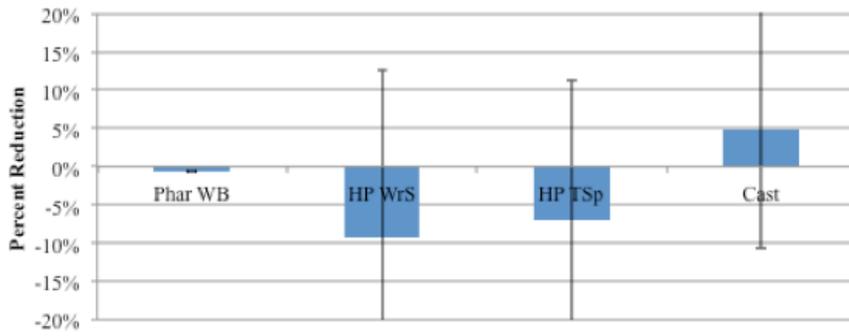
Average Percent Reduction in Palmar Flexion



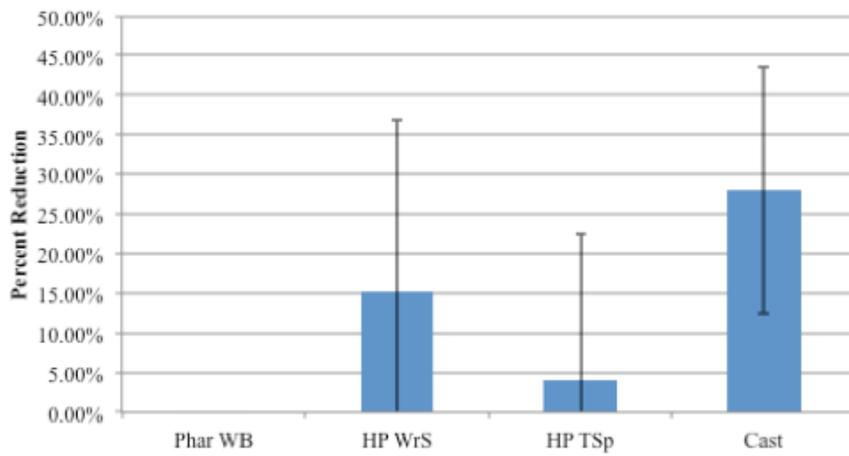
Average Percent Reduction in Dorsiflexion

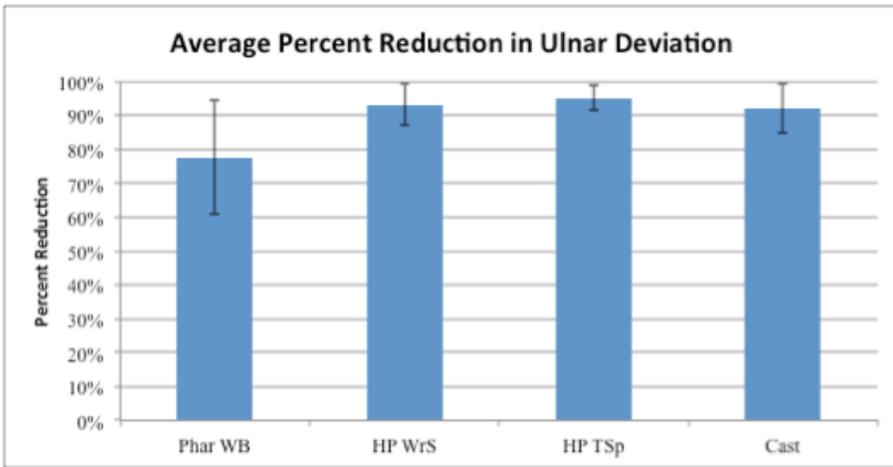
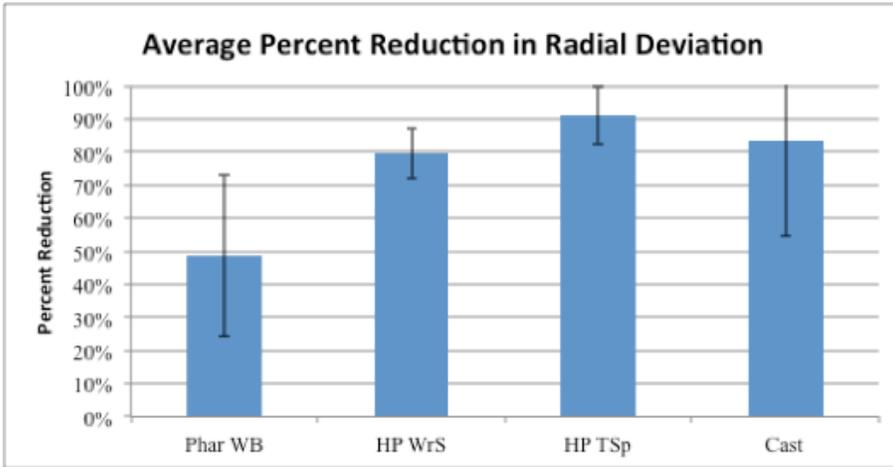


Average Percent Reduction in Pronation



Average Percent Reduction in Supination





Discussion: We studied skeletal wrist motion under various splint/cast immobilization types to determine the relative immobilization efficacy of each to limit motion. Limitation of motion is the therapeutic effect considered to be important in achieving healing without displacement for minimally displaced fractures of the distal radius. A removal, moldable prefabricated high performance splint limits motion of the wrist in adults similarly compared to a surgeon applied thumb spica cast. We have developed a novel methodology to study skeletal motion under joint/cast immobilization using motion analysis, which may be applicable to a multitude of clinical questions at other anatomic sites.

22. Distal Ulnar Stump (DUS) Stability: The Role of the Distal Interosseous Membrane (DIOM). Anatomic Research Study

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Introduction: DUS instability is often a problem when performing a Darrach or Sauvé-Kapandji procedure. Recent studies have stressed that the DIOM reinforces the Triangular Fibrocartilage Complex (TFCC), providing additional stability to the distal radio-ulnar joint (DRUJ). The aim of this study was to determine whether the DIOM stabilizes the ulnar stump and the ideal level to perform the osteotomy.

Methods: Random left and right forearms in 20 fresh-frozen cadavers were dissected to the volar and dorsal aspects of the DIOM. The Distal Oblique Band (DOB), when present, was recorded and measured. The radius was fixed to a board and the ulna kept free. The DRUJ was stabilized with a transverse lag-screw and a K-wire. Two transverse ulna osteotomies were performed at 10 and 15mm proximal to the ulno-carpal joint. The bone slice was removed. Dorsal and volar translation maneuvers were done applying a force of 10N through an analogic dynamometer. The displacement was measured with calipers accurate 1/20mm. Transection of the DIOM was then performed, the maneuvers were repeated and new measurements done and compared with those of the intact DIOM. The results were assessed by means of the software g-stat 2.0 ®. The level of significance was defined as $p > 0.05$.

Results: All of the specimens showed a distinct distal membrane. An obvious DOB measuring a mean of 28mm was noticed in 70%. It attached to the dorsal rim of the sigmoid notch, ran obliquely from distal to proximal and from radial to ulnar, and fixed to the distal third of the lateral border of the ulna. This attachment starts 31mm proximal to the ulnocarpal joint and ends at 40mm (average). Initial displacements averaged 18mm dorsally and 12mm volarly. After DIOM transection, ulnar translocation increased to an average of 30mm dorsally and 20mm volarly. The difference was statistically significant.

Discussion and Conclusions: The DIOM and the DOB act as stabilizers of the DUS. In Sauvé-Kapandji procedure it should be advisable to perform the distal osteotomy at no more than 15mm proximal to the ulnar head articular surface, and the proximal one at no more than 20 mm. For the Darrach procedure, a 10 mm resection seems to be in a very safe area. However, the retaining effect of the DIOM will not be enough to prevent up to 18 mm of dorsal displacement of the ulnar stump. Therefore, in Darrach or Sauvé-Kapandji procedures, some augmentation method should be added.

23. Performance of Automated Mobile Phone Text Messaging in the Delivery of Patient Reported Outcome Instruments

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Introduction: Patient-reported outcome (PRO) instruments are integral in evaluating orthopaedic treatments and outcomes. Mobile phone use is high in the United States at 85% of the adult population and we recognize that mobile phones and software algorithms enable health care systems to communicate with and evaluate patients outside of the traditional hospital setting. This investigation is the first attempt to validate text message or software driven delivery of orthopaedic PRO instruments (12-Item Short Form Health Survey (SF-12) and short form of the Disabilities of the Arm, Shoulder and Hand (QuickDASH)) on mobile phones. We hypothesized there would be a high correlation between PROs collected by automated delivery of text messages on mobile phones compared to paper delivery.

Materials & Methods: Written versions of the SF-12 and the QuickDASH were completed by patients in our orthopaedic hand and upper extremity clinic. Over the next 48 hours, the same patients also completed the mobile phone portion of the study outside of the clinic which included software driven, automated text message delivery of the SF-12 and QuickDASH, assigned in a random order. Correlations between written and text message delivery of the two PROs were assessed. Based on a power analysis (80% power, alpha 0.05), 39 patients were required to detect an intraclass correlation coefficient (ICC) value of 0.8 (excellent reproducibility) distinguishable from 0.6 (fair reproducibility).

Results: Seventy-two patients were enrolled in the investigation. Completion rates for mobile phone delivery of QuickDASH and SF-12 were 75% and 77% respectively. There were no significant differences in patient demographics between completers and non-completers of SF-12 or QuickDASH delivered by mobile phone. The ICC between the written and mobile phone delivery of QuickDASH was 0.91 (95% CI: 0.85-0.95). The ICC between the written and mobile phone delivery of the SF-12 physical health component summary was 0.88 (95% CI: 0.79-0.93) and 0.86 (95% CI: 0.75-0.92) for the SF-12 mental health component summary.

Conclusions: We find that text message delivery using mobile phones permits valid assessment of SF-12 and QuickDASH scores. The findings suggest software driven automated delivery of text communication to patients via mobile phones may be a valid method to obtain other PRO scores in orthopaedic patients. The results also suggest that appropriately designed software and mobile phone technology platforms may be utilized to communicate with patients outside of the hospital setting, and we emphasize the need for further inquiry in this area.

24. Late Onset Upper Extremity Lymphedema Following Elective Hand Surgery in Breast Cancer Survivors

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Purpose: The safety of elective hand surgery in breast cancer survivors is controversial due to concerns of developing *de-novo* upper extremity lymphedema. The purpose of this study was to evaluate the risk of developing lymphedema following elective hand surgery among patients that underwent ipsilateral axillary lymph node dissection (ALND), sentinel lymph node biopsy (SLNB), and/or radiation therapy (RT).

Method: A retrospective cohort of breast cancer patients treated with ALND, SLNB and/or RT was identified from 1997-2012. Patients with ipsilateral elective hand surgery following their breast cancer treatment were included if there was ≥ 1 year of followup and no pre-existing lymphedema. The primary outcome was the development of medically documented lymphedema following hand surgery. Data pertaining to both hand surgery and breast cancer treatment were compared between patients with and without lymphedema. Dichotomous and continuous variables were compared with Fisher's exact and Student T-tests, respectively.

Results: The analysis included 103 patients, of which four (3.8%) had documented lymphedema following hand surgery. Lymphedema developed early and was self-limited. Patients with and without lymphedema were similar with regard to age and type of hand surgery. Tourniquet time was longer in the non-lymphedema group. The lymphedema group all received adjuvant chemotherapy and RT with either ALND or SLNB. Compared to the non-lymphedema group, the lymphedema group had a shorter interval between hand surgery and completion of breast cancer surgery (2.1 versus 6.2 years; $p < 0.05$) and RT (2.0 versus 3.3 years; $p = 0.05$).

Conclusions: Lymphedema is uncommon following elective hand surgery among breast cancer survivors and does not appear to be influenced by tourniquet use. The combination of adjuvant therapies and axillary procedures and a short temporal relationship of these to the hand surgery may put these women at higher risk of developing lymphedema.

25. Do Pre-Operative Antibiotics Reduce Bacterial Culture Growth from Hand Abscesses?

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Purpose: Traditional management of hand abscesses consists of withholding antibiotics prior to drainage in order to optimize bacterial culture growth and outcome. The purpose of this study was to determine the effect of pre-operative empiric antibiotics on the rate of culture growth and rate of adverse events in patients with simple acute hand abscesses.

Methods: We performed a retrospective review of prospectively collected data on 88 consecutive hand abscesses that received empiric antibiotics prior to incision and drainage from 2012 to 2013 at an urban academic institution. We analyzed patient demographics, bacteriology, culture growth results, time to surgery, and frequency of adverse events.

Results: The overall rate of positive culture growth was 90% (n=79) despite running the antibiotics for a mean of 31 hours prior to debridement. Furthermore, 96% of the isolates were given a susceptible antibiotic during that time. The mean number of debridements was 1.5 per patient, but 4 re-operations were necessary for wound complications. No patients required an amputation or were upgraded to intensive care.

Conclusions: Preoperative empiric antibiotic administration does not appear to greatly reduce bacterial culture growth from hand abscesses. The adverse events are few for simple abscesses treated with pre-surgical antibiotics and decompression within 24 hours. **Level of Evidence:** Therapeutic IV

Outcome Measures		
Positive culture (%)	90	
Empiric antibiotic covered organism (%)	96	
Number of surgeries (mean)	1.5	range (1-4)
Time of day first I+D (mean)	12:17	range (00:47 – 23:51)
Time from antibiotics to I+D	31:18	range (0:50 – 138:49)
Length of stay (days)	4.4	range (0-16)
Re-admissions, (%)	5.5%	
Re-operations, (%)	4.5%	
Amputations	0	
Upgrade of care to ICU, n	0	

26. An App Provides Reliable Finger Measurement Faster Than a Goniometer

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Introduction: In orthopaedic hand clinics, measurement of finger joint motion is commonly performed using mechanical goniometers, producing results that are accurate and precise but time-consuming. Recent studies have validated the use of a smartphone clinometer for measuring motion of the shoulder and knee. We investigated a custom iOS application for finger measurement designed to provide equivalent precision and superior efficiency compared to a mechanical goniometer with paper recording.

Methods: Examinations of finger range of motion were conducted by two orthopaedic hand surgeons and five residents using the custom iOS application (app) and an off-the-shelf mechanical goniometer. Plastic anatomic models of the hand, glued in flexion for standardization, were examined. The examiners followed a printed protocol and familiarized themselves with the devices before starting. Each hand examination measured the flexion angles of the thumb MP and IP joints and the finger MCP, PIP, and DIP. The angle was immediately recorded when captured in the app. Goniometric measurements were recorded on paper in a pre-printed grid. Examiners measured each hand twice with each device, for a total of 8 exams and 112 data points per examiner and 784 measurements overall. Each hand examination was timed.

Results: The app and the goniometer both demonstrated high reliability for repeated and comparative measurements as tested by ICC. The Cronbach's alpha score for the goniometer was 0.929 and for the app, 0.938. Pearson correlation coefficient between device measurements was 0.845. The app provided more rapid and statistically significant data acquisition with mean times of 2:13 for the app and 2:52 for the goniometer.

Discussion: The app is a similarly reliable measurement instrument to the goniometer and allows significantly faster capture of the range of motion of finger joints than a mechanical goniometer.

27. Publication Bias in the Hand Surgery Literature

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Introduction: Scientific publications are the primary vehicle for the delivery of novel experimental data and clinical practices in medicine. Therefore, it is important that research publications make meaningful contributions to the advancement of medical science. However, certain topics seem to dominate the published literature in many fields including hand surgery. Although it is not clear if this is a form of publication bias, or merely the primary focus of researchers in these fields, the most frequently published subjects in the hand surgery literature have never been quantified.

Methods: We reviewed each of the three major hand surgery journals – HAND, Journal of Hand Surgery (American), and Journal of Hand Surgery (European) – to identify the most frequently published topics in the hand literature. During the initial hypothesis-testing phase, we used content analysis to create a list of topic domains from a 6-month pilot period. We then reviewed each issue of the hand journals from May 2012 to May 2015 to quantify the total number of scientific articles according to topic domain. We also collected level of evidence, length, and frequency of citation for each article

Results: Two topics were significantly dominant: distal radius (DR) and flexor tendon (FT). DR accounted for the highest proportion of the published literature with 131 scientific articles in the 3-year period (7% of articles). These articles combined for a total of 754 pages, with an average length of 6.4 pages. DR articles were cited an average of 2.1 times annually following publication. We also identified 119 FT articles (6% of all articles), with an average length of 6.3 pages, and a total of 653 pages. Citation frequency for FT articles was 2.8 annually.

Conclusions: There is a high publication frequency of scientific articles on DR and FT injury and treatment in the hand surgery literature. Together these subjects accounted for 250 articles, 1407 pages, and 16% of all scientific publications in a 3-year period – more than a two-volume textbook. It is unclear whether these results are due to topic publication bias or increased attention to these subjects by researchers. We believe such high frequency and volume of publication creates a challenge for many hand surgeons to keep up with the current literature and the standard of care for such subjects. Our future research will study the perception of hand surgeons regarding the frequency of these publications, and the overall impact on clinical practice.

28. Major Upper Extremity Amputations and Prosthetics: Comparison of Prosthetist and Surgeon Preferences

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Background: Approximately 41,000 Americans are living with a major upper extremity amputation and up to 50% discontinue use of their prostheses within the first year. Studies of the population have been rare and mostly patient based via survey. No studies have been done on surgeon or prosthetist preferences.

Purpose: 1) Assess and compare the current state of knowledge among hand surgeons and prosthetists regarding the surgical planning for upper extremity amputations, 2) Propose surgical guidelines to optimize prosthesis fitting in major upper limb amputations.

Materials and Methods: A 34 question survey was developed by a team consisting of a board certified plastic/hand surgeon and a certified prosthetist. The questionnaire was sent to members of the American Association of Hand Surgery (AAHS) and the American Society for Surgery of the Hand (ASSH) after obtaining appropriate approval. Additionally, the survey was sent to subscribers of www.oandp.com, an online resource for orthotics and prosthetics professional. The study queried preferences in optimal amputation length, intra-operative decision-making process, the balance of soft tissue vs. length, and post-operative therapy of amputees.

Results: Twenty-nine ABCOP certified prosthetists, 2 CPc certified prosthetists, 1 hand/ occupational therapist, and 154 physicians or surgeons responded to the survey. When determining intraoperative stump length, only 52% considered prosthetic fit. There was agreement between the two groups that both stump length and soft tissue were important factors, but prosthetists placed a greater emphasis on proper length over soft tissue coverage. When asked about optimal trans-radial stump length, the majority of surgeons (55%) favored the distal 1/3; however, prosthetists favored the middle 1/3 (61%). Both surgeons and prosthetists agreed that the minimum stump length needed distal to the elbow was 5-10cm. For Trans-humoral stump length, the majority of surgeons felt the supracondylar ridge was optimal (46%) but prosthetists favored the middle 1/3 (76%). All parties agreed that early prosthesis intervention was ideal; however, the time from operation to prosthetic fitting was >4 weeks in 49% of cases and 1-4 weeks in only 33%.

Conclusion: There remain many discrepancies between prosthetists and surgeons regarding upper extremity amputations. Data suggests that surgeons may be able to surgically plan for a shorter amputation stump in the middle 1/3 of the forearm or upper arm, which may allow for better soft tissue coverage and improve prosthesis fit. Our hope is this data opens a dialogue among those treating patients with major upper extremity amputations during the perioperative period.

29. A Comparison of Headless Screw, Locking Plate, and Non-Locking Plate Fixation for Simulated Scaphoid Defects: A Biomechanical Study

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Introduction: Headless screw fixation is the current gold standard of surgical repair for scaphoid fractures. However, maintaining reduction of certain types of scaphoid fractures is challenging with a compression screw. Plate fixation has been used clinically with success and may offer superior fixation in some cases of scaphoid fractures, particularly those with comminution, nonunion, segmental bony defects, and osteopenic or osteoporotic bone. To date, no biomechanical evaluations have compared plates with headless screw fixations.

Methods: Polyurethane models were fashioned to simulate scaphoids with 3mm segmental defects. Defects were bridged by one of three constructs: a locking plate, a non-locking plate, or a headless compression screw. Three samples for each fixation construct were tested for both normal bone density (20PCF) and osteopenic bone density (10PCF). Constructs were stressed in axial compression at a 45° angle to mimic the load that a scaphoid encounters in a neutral wrist. Load to failure was recorded as the load at which the 3mm segmental defect was closed. These loads were compared between fixation methods using ANOVA to test the null hypothesis, and a post-hoc t-test to determine statistical significance.

Results: Gap closure occurred in all trials. In simulated normal bone, there were no statistically significant differences in load to failure between fixation methods ($\mu=125.607\text{N}$, 89.287N , 133.05N for locking plate, non-locking plate, and screw fixation, respectively; $p = 0.1983$). In simulated osteoporotic bone, the locking plate had a 28 percent greater load to failure as compared to screw fixation ($\mu = 52.34\text{N}$ vs. 40.792N , $p = 0.0426$). Other differences between fixation methods in osteoporotic bone were not statistically significant.

Conclusions: While all methods of fixation perform similarly in normal bone, locking plate fixation performs superiorly to screw fixation in simulated osteoporotic bone. As this is a biomechanical study with simulated bone, the clinical relevance of these results cannot be determined conclusively. It can be inferred from this study that locking plate fixation is at least equivalent to the current gold standard headless screw fixation in a scaphoid fracture with segmental defect. If open reduction and internal fixation of a scaphoid fracture with segmental defect is indicated, plate fixation is a reasonable alternative from a biomechanical standpoint. Plate fixation may be more structurally resilient to hardware failure, especially if cancellous bone graft is used. In lower density bone, locking plates may also be superior to screw fixation for prevention of gap closure and subsequent carpal collapse.

30. Stability and Pain Relief After Arthroscopic Transosseous Repair Of The Triangular Fibro-Cartilage Complex (TFCC)

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The TFCC stabilizes not only the ulno-carpal joint but also the distal radio-ulnar joint (DRUJ). Injuries of the TFCC normally lead to pain and depending on the type of the lesion to instability of the DRUJ. One important aspect of this instability is the foveal detachment of the TFCC at the base of the processus styloideus ulnae (PSU). Foveal ruptures of the TFCC are detectable during arthroscopic treatment (positive “hook” test). Nakamura proposed an arthroscopic transosseous refixation of the TFCC. From 2007 to 2013 we treated 61 patients in a slight modification of the manner described by Nakamura. In opposite to the common recommendation we treated chronic (>6 month) ruptures of the TFCC as well. We examined 39 patients with the modified Mayo-Wrist- and DASH-score and checked clinically the stability of the DRUJ. The minimal postoperative time range was 12 months. The questionnaire revealed no obvious difference between acute and chronic TFCC lesions after surgery. Almost every patient showed good stability of the DRUJ and satisfying to good pain relief after the treatment.

Regarding our results we can recommend the arthroscopic assisted transosseous refixation of the TFCC (Nakamura’s tecnic) as a good option in the operative treatment of acute as well in chronic lesiones of the TFCC and DRUJ instability.

31. Human Scaphoid Non-Unions Exhibit Increased TNF- α and Osteoclast Activity Compared To Adjacent Cancellous Bone

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Scaphoid bones have a high prevalence for non-union. Even with adequate treatment, bone regeneration may not occur in certain instances. Although this condition is well described, the molecular pathology of scaphoid non-unions is still poorly defined. In the present study, gene expression of osteogenic and angiogenic growth and transcription factors as well as inflammatory mediators were analyzed in human scaphoid non-unions and intraindividually compared to adjacent autologous cancellous bone from the distal radius. In addition, histology and immunohistochemical stainings were performed to verify qRT-PCR data. Gene expression analysis revealed a significant upregulation of TNF- α , RANKL, ALP, CYCLIN D1, MMP-13, OPG, NFATc1, TGF- β and WNT5A in scaphoid non-unions. Interestingly, TNF- α was highly upregulated in all non-union samples (mean: 26 fold increase). Moreover, RANKL, a marker for osteoclastogenesis was increased by 20 folds in non-unions. TRAP staining confirmed this observation. With respect to genes related to osteogenesis, alkaline phosphatase was significantly upregulated in scaphoid non-unions. No differences were detectable for other osteogenic genes such as RUNX-2 or BMP-2. Importantly, we did not detect differences in angiogenesis between scaphoid non-unions and controls in both gene expression and immunohistochemistry. Summarized, our data indicate chronic inflammation and increased osteoclast activity in scaphoid non-unions. These data increase our understanding for the reduced bone regeneration capacity present in scaphoid non-unions and may translate into identification of new therapeutic targets in order to avoid secondary damages and prevent occurrence of non-unions to scaphoid bones.

32. Tendon Regeneration with Tendon Hydrogel-Based Cell Delivery: A Comparison of Fibroblasts and Adipose Derived Stem Cells

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Introduction: Tendon hydrogel is a promising injectable biomaterial for improving repair strength after tendon injury. This study compares the capacity of fibroblasts and adipose-derived stem cells (ASCs) to proliferate, survive, and acquire tenogenic properties when seeded into tendon hydrogel *in vitro* and *in vivo*.

Materials and Methods: To assess the effect of cell density on hydrogel contraction, cells were seeded in several concentrations *in vitro* and measured macroscopically. To assess tenogenic properties, RNA was isolated from cells seeded in hydrogel and tenocyte markers quantified. To assess proliferation and survival, cells were seeded *in vitro* and MTS and live-dead assays were performed respectively. Finally, to assess the *in vivo* survival of cells in hydrogel, subcutaneous injections were performed on rats and *in vivo* imaging system (IVIS) measurements acquired daily.

Results: At 0.5 million cells/mL, both the fibroblast and ASCs induced minimal hydrogel contraction compared to higher cellular concentrations. Fibroblasts and ASCs seeded at 0.5 million cells/mL in tendon hydrogel upregulated several specific tenocyte markers after one week. On MTS assay, fibroblasts and ASCs proliferate in hydrogel at similar rates *in vitro*. On live-dead assay, fibroblasts survive longer than ASCs *in vitro*. With IVIS imaging, fibroblasts survived longer than ASCs in hydrogel *in vivo*.

Conclusions: Tendon healing is mediated by the proliferation, survival, and tenogenic differentiation of cells at the site of injury. Tendon hydrogel delivering dermal fibroblasts may improve and stimulate this process compared to ASCs. Future studies will be needed to evaluate the effects of this hydrogel-based cell delivery on chronic tendon injuries.

33. Hypoxia Maintains the Connective Tissue Microenvironment

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Purpose: The role of oxygen in connective tissue regeneration is poorly understood. We have recently discovered that human tenocytes cultured in a low oxygen environment transdifferentiate to a fibrochondrocyte phenotype. The purpose of this study was to evaluate the effect of normoxia (22%O₂) or hypoxia (1%O₂) on human tenocyte differentiation in a three dimensional microenvironment.

Methods: Human tenocytes were isolated from patients undergoing revision amputation from traumatic hand injury ('normal' tenocytes) or delayed tendon reconstruction ('adherent' tenocytes) using IRB-approved protocols. Cells were cultured in normoxia until passage four then plated onto PLA electrospun nanofiber scaffolds. Scaffolds were cultured in normoxia or hypoxia for 1, 2, 4 or 8 weeks and then harvested for immunohistochemical stains for Collagen I, Aggrecan or Collagen II as well as qRT-PCR of tenocyte and fibrochondrocyte molecular markers.

Results: Normal and adherent human tenocyte scaffolds develop dense cellular microarchitecture when cultured in hypoxia, but fail to develop consistent tissue in normoxia. Tissue quality is maximal at week 8 in hypoxia. Interestingly, immunohistochemical staining for collagen I was increased in normal tenocyte scaffolds cultured in normoxia while decreased in hypoxia, while the converse was true of aggrecan staining: aggrecan staining was increased in normal tenocyte scaffolds cultured in hypoxia. Furthermore, adherent tenocyte scaffolds demonstrated increased aggrecan expression in hypoxia compared to normal tenocyte scaffolds. These findings were confirmed by qRT-PCR.

Conclusions: In transitioning from the two dimensional to three dimensional environment it is clear that hypoxia is key to maintaining the tendon cellular microenvironment as well as fibrochondrocyte differentiation, in particular:

- 1) Tendon tissue maintains its cellular microarchitecture in the hypoxic environment more than the normoxic environment
- 2) Adherent tendon tissue produces more proteoglycans in the hypoxic environment than in the normoxic environment
- 3) Adherent tendon tissue produces more proteoglycans in the hypoxic environment than normal tendon tissue
- 3) In the absence of mechanical forces, tendon tissue transdifferentiates to a fibrochondrocyte phenotype in the hypoxic environment
- 4) These findings may explain the tendency for tendon adhesion formation in the hypoxic environment -- as demonstrated by increased proteoglycan formation and decreased collagen I formation -- and provide insight into tendon tissue regeneration and repair.

34. The Influence of Dominant Limb Involvement on DASH and QuickDASH

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Introduction: When completing the Disabilities of the Arm Shoulder and Hand (DASH), patients rate their ability to complete specific tasks (e.g. writing) regardless of which hand they use for the task. In contrast, the Michigan Hand Outcome Questionnaire (MHOQ) takes the affected side into account. We aimed to determine whether involvement of the dominant limb affects DASH scores.

Methods: A convenience sample of 948 patients from 12 prospective studies that recorded hand dominance, affected side, diagnosis, and a DASH or QuickDASH score was used to assess the influence of involvement of the dominant limb on DASH scores. Diagnosis was categorized as traumatic and non-traumatic. Region was categorized as hand and wrist, elbow, and arm and shoulder.

Results: In bivariate analysis, involvement of the dominant limb, diagnosis, region, and sex had significant influence on DASH/QuickDASH score. In multivariable analysis, dominant hand condition, traumatic diagnosis, arm and shoulder involvement, and female sex were associated with significantly higher DASH scores (more disability), and accounted for 10% of the variability in scores.

Conclusion: Upper extremity disability as measured by the DASH is slightly, but significantly greater when the dominant limb is involved. In addition the involvement of the dominant limb, sex, region, and trauma affected DASH scores.

Table 1. Characteristics of patients with hand and upper extremity problem from 12 prospective studies (n=948)

Characteristics	Total	DASH-QuickDASH Score		P-value [‡]
Age, mean±SD, (Range)	52±16 (15-90)	33±21 (0-96)		0.97*
Sex, no. (%)				
Women	584 (61)	35±20 (0-96)		0.0060 [^]
Men	361 (38)	31±22 (0-93)		
Missing	3 (1.0)	23±16 (4-34)		
Diagnosis, no. (%)				
Non-traumatic	496 (52)	30±19 (0-88)		<0.001 [^]
Traumatic	409 (43)	39±21 (0-96)		
Missing	43 (5.0)	25±22 (0-91)		
Dominant side affected, no.(%)				
No	472 (50)	31±20 (0-92)		<0.001 [^]
Yes	476 (50)	36±22 (0-96)		

[‡] Bivariate analysis of patients after DASH/QuickDASH scoring

* = Correlation, [^] = Independent t-test

Table 2. Multivariable Linear Regression Analysis: Predictors of DASH and QuickDASH (n=948)

Parameter	P-value	Partial R- Squared	Adjusted R-square
Best model			0.079
Dominant side affected	<0.001	0.017	
Sex	0.0020	0.0098	
Diagnosis	<0.001	0.061	

35. Independence in Hand and Plastic Surgery – Benefit or Barrier? Analysis of the Publication Performance in Academic Plastic Surgery Depending on Varying Organizational Structures

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Introduction: Despite its recognition as an independent specialty the field of plastic surgery remains underrepresented in terms of independent departments with a dedicated research-focus at German university hospitals. Similar is true for hand surgery.

The aim of this study was to analyze the publication performance within the German academic plastic surgery environment and to compare independent departments and dependent, inferior organizational structures regarding its publication performance.

Material and Methods: Organizational structures and number of attending doctors in German university hospitals were examined via a website-analysis. A pubmed-analysis was applied to assess the publication performance (number of publications, cumulative impact factor, impact factor/publication, number of publications/MD, number of publications/unit) between 2009 and 2013. In a journal-analysis the distribution of the cumulative impact factor and number of publications in different journals as well as the development of the impact factor in the top-journals were analyzed.

Results: Out of all 35 university hospitals there exist 12 independent departments for plastic surgery and 8 inferior organizational structures. In 15 university hospitals there were no designated plastic surgery units.

The number of attending doctors differed considerably between independent departments (3.6 attending doctors/unit) and inferior organizational structures (1.1 attending doctors/unit). The majority of publications (89.0%) and of the cumulative impact factor (91.2%) as well as most of the publications/MD (54 publications/year) and publications/unit (61 publications/year) were created within the independent departments. Only in departments top-publications with an impact factor > 5 were published. In general a negative trend regarding the number of publications (-13.4%) and cumulative impact factor (-28.9%) was observed. 58.4% of all publications were distributed over the top-10 journals. Within the latter the majority of articles were published in English journals (60% of publications, 79.9% of the cumulative impact factor). The average impact factor of the top-10-journals increased by 13.5% from 2009 - 2013.

Summary: In contrast to inferior and dependent organizational structures independent departments of plastic surgery are the key performers within German academic plastic surgery, which however suffers from a general declining publication performance. Hence, the type of organizational structure has crucial influence on the research performance.

36. Functional Assessment of Thumb Spica Cast Immobilization versus Short Arm Cast Immobilization

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Purpose: The purpose of this study is to compare the functional outcome differences between patients with a short arm cast immobilization (SAC) versus forearm based thumb spica short arm cast immobilization (TSC).

Methods: 50 healthy volunteers completed a baseline and post casting typing assessment and a PROMIS short form upper extremity functional scoring assessment. The volunteers were randomly assigned to one of two groups. Participants in group 1 were initially assigned to a TSC of their dominant hand followed by a SAC, while participants in group 2 were initially assigned to a TSC of their non-dominant hand followed by a SAC. The casts were each maintained for 24 hours.

Results: A total of 50 participants were enrolled in the study with 25 in group 1 and 25 in group 2. Clinical characteristics and demographics for each study group were comparable. There was a significant difference between the average PROMIS score and typing speed of participants with SAC compared to participants with TSC (Tables 1 & 2). Table 3 shows that there were differences in the PROMIS scores and typing test results when comparing participants who had undergone casting of dominant hand versus non-dominant hand.

Conclusion: There is a significant difference in functionality of a thumb spica cast immobilization versus a short arm cast immobilization according to the PROMIS functional outcome score. When possible, short arm cast immobilization should be used given the functional deficits associated with thumb spica casting.

Table 1: PROMIS Scores

Type of Cast	# casts	Average PROMIS	Mean Difference	p-value
SAC	50	93	24.3	0.0001
TSC	50	68.7		
Dom SAC (Group 1)	25	89.12	36.92	0.0001
Dom TSC (Group 1)	25	52.2		
Non Dom SAC (Group 2)	25	96.88	11.68	0.0001
Non Dom TSC (Group 2)	25	85.2		

Table 2: Typing Speed

Type of cast	# casts	Average Typing speed	Difference	p-value
SAC	50	49.38	10.54	0.0001
TSC	50	38.84		
Dom SAC (Group 1)	25	47.52	11.72	0.0001
Dom TSC (Group 1)	25	38.16		
Non Dom SAC (Group 2)	25	51.24	9.36	0.0001
Non Dom TSC (Group 2)	25	39.52		

Table 3: Hand Dominance

Type of cast	# casts	Mean PROMIS	p-value	Typing Accuracy	p-value	Typing speed	p-value
Dom SAC	25	89.12	0.0001	94.36	0.5070	47.52	0.2642
Non Dom SAC	25	96.88	0.0001	94.76	0.5070	51.24	0.2642
Dom TSC	25	52.2	0.0001	92.8	0.4696	38.16	0.7559
Non Dom TSC	25	85.2	0.0001	93.2	0.4696	39.52	0.7559

Concurrent Scientific Abstract Session III

37. Modified Great Toe Wraparound Flap Preserving Plantar Triangular Flap

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Introduction: The traditional great toe wrap-around flap design involves preservation of a medial strip of skin. However this can be associated with wound healing problems. Here we discuss the clinical outcome of a modified great toe wrap-around flap design for thumb reconstruction.

Materials and Methods: 11 patients underwent reconstruction with a modified great toe wrap-around flap for thumb injuries with degloving of the distal phalanx. Instead of a medial skin flap, a triangular plantar skin flap is preserved (Fig. 1). The width of the flap measures 1.5 to 2.0 cm and does not extend beyond the midaxial line at its widest extent. The dorsal aspect of the great toe is covered with a skin graft. By preserving the blood supply to the plantar skin flap through the tibial neurovascular bundle, wound healing problems are reduced.

Results: All flaps survived. There were no major complications. Duration of follow-up ranged from 2 to 8 years. The contour of the reconstructed digits was the same as the contralateral one. Two-point discrimination (2PD) of digits ranged from 4 to 8 mm. The average active range of motion of the thumb interphalangeal joint was 63 ± 2 °. There was no extensive scar formation at the donor foot. The skin-grafted area regained sensation from S₂~S₃⁺. Three patients complained of slight tenderness at the donor toe without difficulty in wearing shoes. The width of the preserved plantar triangular flap expanded 35% to 67% with nearly the same 2 PD as the contralateral one. All patients could walk, run and jump without restrictions.

Conclusions: Thumb reconstruction with a modified great toe wrap-around flap preserving a plantar triangular flap results in a thumb with excellent contour and functional outcome. Donor site morbidity in the foot is minimal.

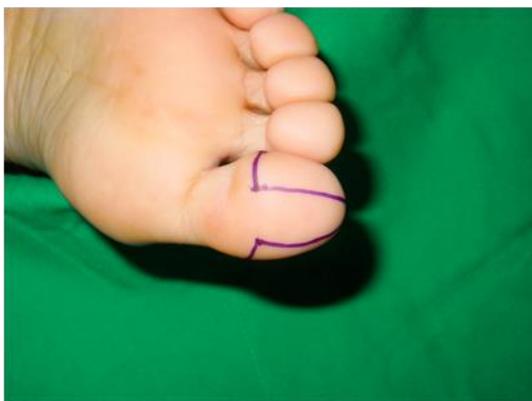


FIGURE 1. Plantar skin flap design



FIGURE 2. Reconstructed right thumb matches the normal left thumb in size



FIGURE 3. Volar scar is well healed



FIGURE 4. Plantar flap expands over time



FIGURE 5. Dorsal skin grafted area over right toe donor site is well-tolerated

38. Restoration of Finger Flexion in Children Using Functioning Free Gracilis Transfer

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Introduction: Finger flexion is yet the most difficult task to achieve in upper limb reconstruction.

Patients and Methods: A study on 30 Children were operated upon from for restoration of finger flexion via free vascularized gracillis muscle transfer. The mean follow up period was 71.87 months (about 6 years). The mean age: 7.83 years (range 4 to 12years). 13 of the children were girls (57%). 14 cases (60%) were operated upon by FFMT before one year has passed since the incident. 14 cases had Volkman's ischemic contracture, 6 cases OBPP, 2 cases traumatic muscle loss, one case post tumor excision. FFMT was the first operation in 7 children (30.4%). All muscles harvested were with skin monitors. 16/18 muscles restoring finger flexion only were anastomosed to the ulnar artery or a side branch of it. 3/5 muscles restoring elbow and finger flexion were anastomosed to the thoracodorsal a.

Results: 24 autotransplants survived (80%). Clinical active motion started after the operation by a mean of 4m. The mean total active range of finger flexion very highly significantly increased from a preoperative 10.47° (4.36%) to 141.96° (64%) {of the available passive ROM}. In cases of Volkmann's ischaemic contracture best results are obtained when the patient is operated within 6 months from the incident injury. 73.9% of the cases had M0 active power grade before the operation. 78.2% of the cases reached M4 muscle power grade at late follow up. 51.4% of the cases, had further reconstruction during the follow up period 65.7% of the patients, are probably still in need for further reconstructive procedures. Tenolysis was the most frequently done operation after FFMT. 88% of the children in this series had other operation (s) besides that for FFMT.

39. Smartphone Based Thermal Imaging: A Valid New Modality For Tissue Temperature Measurement?

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Introduction: Recently handheld smartphone based thermal imaging technology was introduced. The technique allows aside from temperature measurements obtaining real time digital photographic thermal images. This technology appears useful for perioperative monitoring of microsurgical cases. Its clinical validity to date has not been studied. The presented study compares smartphone based thermal image (TI) temperature measurements against standard infrared temperature scanners (TS).

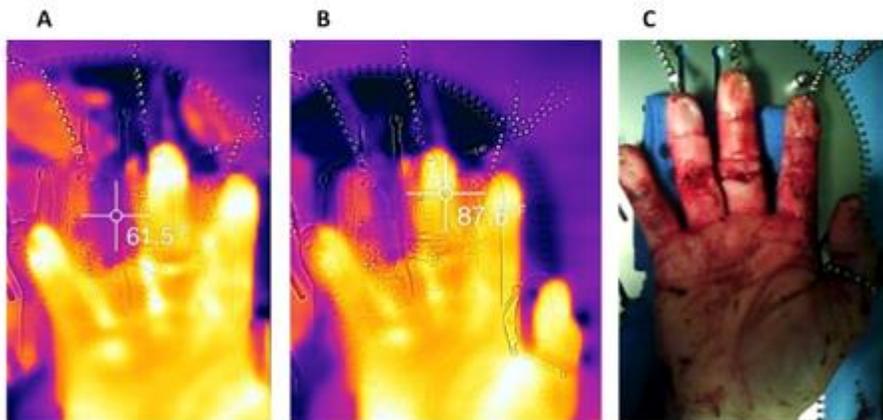
Methods: A standard infrared thermal scanner was compared to a smartphone based thermal imaging camera. 2 groups of measurements were designed: Warm fluid inside a thermos container served as control measurement (group 1); a point at the palmar intersection of Kaplan's cardinal line and the radial border of the ring finger was used as clinical measurement (group 2). Measurement distance was set at close to skin contact (1mm) in the TS group per manufacturer recommendation and at 10 cm distance for the TI group. 12 measurements each were obtained from groups 1 and 2 using TS and TI resulting in 2 groups of paired measurements; temperature was measured in Celsius. Data was analyzed using a paired student T test with significance set as $p < 0.05$.

Results: Paired measurement of the control group using both TS and TI showed comparable mean temperature readings and variation: TS: 41.3, TI 42.5; Variance TS 0.11, TI 0.26; p was less than 0.05. Paired measurements of a standardized palmar region in group 2 using TS and TI demonstrated comparable mean temperature measurements and variation: TS: 33.4, TI 33.3; Variance TS 0.01, TI 0.03; p was less than 0.05. In addition to pure temperature measurements, thermal imaging allowed documentation of whole hand temperature distribution.

Conclusion: Smartphone based thermal imaging devices offer reliable temperature measurements compared to conventional infrared thermal scanners. Thermal images of injured hands offer additional information and documentation in the acute trauma setting. Documentation of thermal images can be a valuable resource assessing microvascular patients in the prehospital as well as the postoperative recovery environment.

Intraoperative temperature measurement in a dysvascular ring finger with transected neurovascular bundles:

- A: Temperature in injured ring finger is 61.5F.
- B: Temperature in adjacent long finger is 87.6. As opposed to the ring finger, in the long finger the neurovascular bundles were spared.
- C: Standard intraoperative photo, taken synchronously with thermal image in image B



40. Microsurgeons Do Better –Tactile Training Prevents the Age-Dependent Decline of the Sensibility of the Hand

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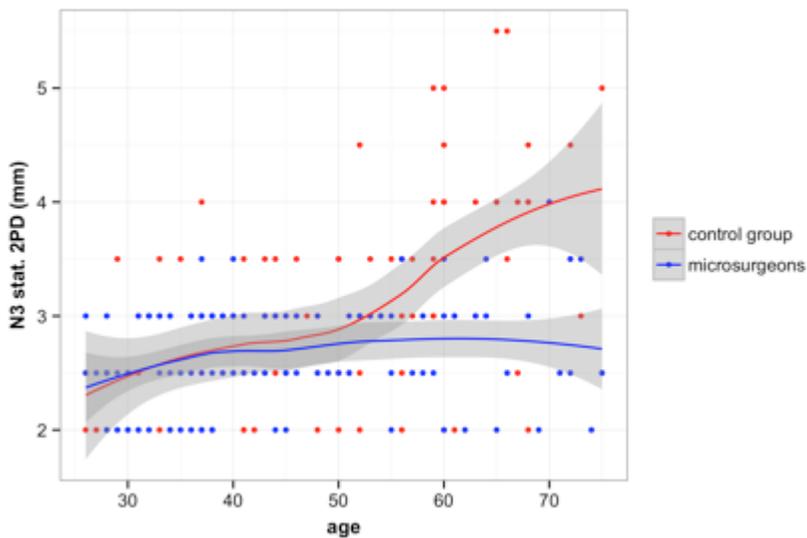
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Purpose: Recent data demonstrate that the normal sensibility of the hand seems to be age-dependent with the best values in the third decade and a subsequent deterioration. However, it is not clear if long-term tactile training might prevent this age-dependent decline of the sensibility.

Methods: We evaluated the normal sensibility of the hand in 125 probands who perform microsurgery, thus undergoing regular tactical training. We examined the sensibility of the radial digital nerve of the index finger (N3) and the ulnar digital nerve of the small finger (N10) using static and moving 2-point discrimination tests and compared the results to a collective without specific long-term tactical training consisting of 154 probands.

Results: We found lower static and moving 2-point discrimination values for both nerves in the group of microsurgeons, with statistically significant differences after the fifth decade of life.

Conclusion: This study demonstrates that long-term tactile training might prevent the known age-dependent decline of the sensibility of the hand.



41. Outcome in Reconstruction of Upper Limb Defects After Free Flap Salvage

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Introduction: Microvascular free tissue transfer has become a reliable method for the reconstruction of complex upper limb defects. However, the reconstructive aim is not only soft tissue coverage, but also restoration of form, function, and sensation. Despite high success rates, microvascular complication after free tissue transfer is a major challenge and necessitates urgent reexploration. The aim of this study was to analyze functional and cosmetic long-term results after successful upper limb free flap salvage.

Materials & Methods: From 1999 to 2010, a total of 836 patients underwent free microvascular tissue transfer for reconstruction of differing defects at our center. The retrospective analysis identified 138 patients, who underwent free flap reexploration (17%). Free flap salvage was achieved in 81 patients (59%). Microvascular complications were arterial thrombosis (59%), venous thrombosis (36%), and combined arterial and venous thrombosis (5%), and led to urgent reexploration in 45 patients (33%). A subgroup analysis identified 10 patients with upper limb free flap salvage. Follow-up was obtained in 8 patients. The free tissue transferred included latissimus dorsi flap (n=2), osteocutaneous fibula flap (n=2), parascapular flap (n=1), combined osteocutaneous scapula/parascapular flap (n=1), lateral arm flap (n=1), and radial forearm flap (n=1). Active range of motion (AROM) was measured and force measurements were obtained with hand-held dynamometers. The subjective disability of the upper limb was evaluated by means of the disabilities of the arm, shoulder and hand (DASH) questionnaire. The Vancouver Scar Scale (VSS) was used to evaluate the scar appearance.

Results: Force measurements and AROM were higher than the requirements for coping with everyday tasks. The subjective outcome after upper limb free flap salvage reached an average DASH score of 30.7 points according to a moderate limitation in activities of daily living. According to the VSS, overall patient satisfaction with the scar appearance was good.

Conclusions: Microvascular free tissue transfer is a reliable method for the reconstruction of complex upper limb defects. Despite of upper limb free flap reexploration due to microvascular complications, acceptable functional and cosmetic results were achieved. To be successful in face of economic pressure in hospitals, the recognition and reexploration of a compromised free flap must be immediate.

42. Comparisons of Functional Recovery Outcomes Between Processed Nerve Allograft and Hollow Tube Conduits for Short and Long Gap Digital Nerve Repairs

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Introduction: Processed nerve allograft and tube conduit both offer convenient options for digital nerve gap repair. Despite their wide availability, no consensus exists as to the optimal treatment gap length. To evaluate for potential differences in recovery outcomes with these repair methods, we queried a national nerve registry for digital nerve repairs 30mm or less repaired with processed nerve allograft or tube conduit. Here we report our findings on the functional in digital nerve repairs for two gap length groups, gaps ≤ 14 mm and 15-23mm.

Methods: The RANGER registry is an active database designed to collect outcomes data for processed nerve allografts (Avance[®]Nerve Graft, AxoGen, Inc), tube conduits, and nerve autograft. The database was queried for digital nerve injuries with gaps up to 30mm with a minimum of 5 months of quantitative follow-up. Complex injuries such as amputations, avulsions, gunshots/blast injuries were excluded from the dataset to minimize confounding variables. The dataset was stratified into two gap length groups, gaps ≤ 14 mm and 15-30mm. Meaningful sensory recovery was defined by the MRCC scale at S3 or greater. Comparisons of meaningful recovery outcomes were completed by repair method between and across the gap length groups.

Results: Four RANGER sites contributed data for both types of repairs. The dataset consisted of 41 subjects with 70 injuries. The ≤ 14 mm gap group consisted of 22 PNA and 8 conduit repairs. The 15-30mm gap group consisted of 24 PNA and 16

conduit repairs. Subject demographics and repair characterizes were comparable between treatment groups. Saw type lacerations were the most common mechanism of injury in both groups. In the ≤ 14 mm gap group, PNA and conduit reported 95% and 75% meaningful recovery respectively. In the 15-30mm gap length group, PNA and conduit reported 83% and 31% recovery respectively ($p < 0.05$) with four revisions reported in the conduit group. See Table 1. There were no reported adverse events.

Conclusion: Processed nerve allografts performed consistently well while the quality of recovery with conduit decreased as gap length increased. Conduits reported a statistically significant difference by gap length with < 14 mm repairs reporting more consistent levels of recovery as compared to gaps 15mm or greater. Data from this study should be considered when designing future studies. The RANGER registry remains ongoing; additional clinical data collected from participating sites will allow for further comparisons of PNA to conduit.

Table 1: Comparisons of Processed Nerve Allograft and Tube Conduit by Gap Group

Repair Group	GAPs ≥ 14 mm		GAPs 15- 30mm	
	PNA	Conduit	PNA	Conduit
No. Subjects	11*	8	13*	10
No. of Repairs	22	8	24	16
Average Age (years)	38 \pm 15 (18, 72)	42 \pm 17 (29, 71)	35 \pm 12 (20, 62)	42 \pm 17 (22, 76)
Median Time to Repair (days)	0 (0, 245)	0 (0, 240)	1 (0-949)	0 (0, 48)
Mechanism of Injury				
Laceration-Saw	19	5	14	13
Laceration-Sharp	2	2	1	1
Crush	-	-	3	2
Neuroma Resection	1	1	6	-
Average Gap Length (mm)	8 \pm 3 (5, 15)	9 \pm 2 (4, 10)	17 \pm 3 (12, 20)	18 \pm 4 (15, 30)
Average Follow-up (months)	15	14	13	14
Revision Repairs	0	0	0	4
Meaningful Recovery**	95%	75% [§]	83% ⁺⁺	31% ^{++§}

* One subject had 1 repair in each gap group
 **53 or higher on the MRC scale
 ++ Significantly different ($p < 0.05$)
 § Significantly different ($p < 0.05$)

43. A Direct Cost Comparison Study of Open Carpal Tunnel Surgery

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Background: Wide-awake hand surgery under local anesthesia has led many surgeons to move from the operating room (OR) or outpatient surgery center (OSC) to the clinic. With the cost of healthcare rising, procedures must be performed in the most cost-effective venue with the lowest cost to maximize profits.

Objective: We performed a direct costs analysis of a single surgeon performing an open carpal tunnel release as an isolated procedure in the OR, OSC and clinic.

Methods: Four treatment groups were prospectively studied; OR with monitored anesthesia care, OSC with MAC, OSC with local anesthesia and the clinic with local anesthesia. To determine direct costs, a detailed inventory of all supplies and the price per unit was recorded including the weight and disposal of medical waste.

Indirect costs such as support-staff salaries and equipment depreciation were not included as a quantitative number could not be objectively assigned.

Results: Five cases in each treatment group were prospectively recorded. Average direct costs were OR (\$216.55), OSC-MAC (\$105.12), OSC-local (\$58.16) and clinic (\$32.09). The surgical waste per case was collected and the average weight

was the OR (4.78kg), OSC-MAC (2.78kg), OSC-local (2.6kg) and the clinic (0.65kg). Using ANOVA, there was a statistically significant decrease in the direct costs and medical waste in the clinic versus every other setting ($p < 0.005$).

Conclusions: The direct costs of an open CTR with local anesthesia were two times more expensive in the OSC compared to the clinic. Increased costs were the result of full sterility which is reflected by a five-fold increase in medical waste. Conversely, in the clinic, field sterility with re-usable towels is utilized.

The direct costs in the OR were seven times more expensive than the clinic. Increased costs were due to full sterility with an eight-fold increase in medical waste. Increased costs were incurred as all patients in the OR received MAC while all patients in the clinic were satisfactorily managed with local anesthesia. Anesthetic agents were included in the direct costs analysis but the anesthesiologist's professional fee was not included which would significantly increase the overall cost.

A limitation is the exclusion of indirect costs, however, one can argue that indirect costs are more substantial in the OR and OSC than the clinic and thus the overall cost would be increased and the profit margin decreased.

Open carpal tunnel release is more cost-effective and generates less medical waste when performed in the clinic.

44. Arthroscopical Assisted Scapholunate Capsuloplasty: the Role of the Dorsal Capsulo-Scaphlunate Septum (DCSS)

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Introduction: scapholunate (SL-) dissociation is caused by both a disruption of intrinsic ligament portions, as well as a disturbed interaction in between intrinsic and extrinsic ligaments, which synergistically stabilize the wrist through the dorsal capsulo-scapholunate septum (DCSS).

This assumption is based on the fact that interosseous ligament portions between scaphoid and lunate are not strong enough to withstand higher wrist load alone. (Berger et al., 1999) Second, the important role of extrinsic ligaments (DIC, DRCL, palmar STT) in wrist stabilization - preventing both scaphoid flexion and DISI position of the Lunate - has been shown in many studies. (Elsaidi et al., 2004)

We surmise that the DCSS is a key structure in maintenance of SL- stability. It attaches dorsally to the carpal bones and - as a septum - is then continued into the intercarpal ligaments.

By arthroscopic suture of these septal attachments, which often are disrupted in higher SL- instability, a realignment of the bones can be reached, restoring - at least partially - the original biomechanics, avoiding to harm dorsal intercarpal ligaments.

Materials and Methods: Between 2009 and 2014, we performed a modified dorsal SL-capsuloplasty in 34 patients with clinical and radiological signs of manifest SL- instability. 27 patients were eligible for postoperative follow up: standard clinical assessment for pain, ROM and grip-strength was performed, followed by radiographic assessment of SL-gap, SL- and RL-ankle.

Results: In our collective 63% were men, 37% were women. Geissler III instability of SL-Ligament was found in 77.8%, while 22.2% were classified Geissler IV. After a mean follow up of 1.9 years, on radiographies no statistically significant increase in SL- and RL- angle was found, when compared to preoperative radiographies. Postoperative DASH was 14.5 ± 16 , postoperative Mayo Wrist Score was 82.5 ± 9 .

Conclusion: a modified dorsal SL-capsuloplasty seems to be a valid alternative to open surgical procedures in patients with SL- instability.

45. Burden of Hand Maladies in US Emergency Departments

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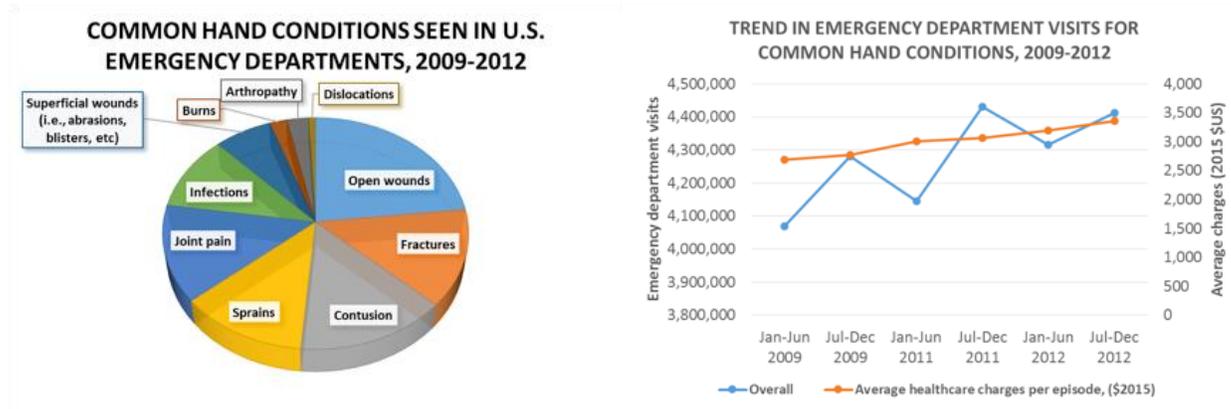
Introduction: Hand conditions commonly present to the emergency department (ED). Yet despite their frequency, few studies have described the magnitude of hand related conditions in the emergency setting beyond traumatic fractures. Therefore, we conducted this study to describe the burden and quantify the healthcare resource utilization of common hand conditions seen in EDs across the United States.

Methods: Using the National Emergency Department Sample, a nationally representative sample of ED encounters, we identified all ED encounters by patients at least 18 years of age that were associated with a common hand condition in 2009, 2011, and 2012. The primary outcomes were prevalence, etiology, and associated charges for common hand conditions. Significance in trends was tested using regression models. All analyses were weighted to account for complex sampling design and to provide national estimates.

Results: The final sample included 25,671,037 ED encounters associated with a common hand condition generating \$50,639,394,894 in healthcare charges, of which 74.4% had the hand condition as the primary diagnosis. Open wounds (24.9%) predominated, followed by contusions, fractures, and non-specific joint pain (**Figure 1**). Trauma was the most common etiology (77.4%) with falls (26.3%) and cuts (19.7%) accounting for over half of the presentations. The majority of presentations were able to be managed in the ED (92.2%). There was a trend toward more frequent ED encounters (5%

increase, $p < 0.001$) for common hand conditions and higher healthcare charges (24% increase, < 0.001) generated in their care over the study period (**Figure 2**).

Conclusions: Hand related conditions impose a significant burden on EDs nationwide, consuming substantial healthcare resources. We describe the most common hand conditions of various etiologies presenting to U.S. EDs and quantify the aggregate healthcare cost generated as a result. We show that there is an upward trend in both the number of encounters and costs related to hand conditions



46. Distal Radius Fractures – Does Obesity Affect Fracture Pattern, Treatment and Functional Outcome

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Introduction: Current recommendations for treatment of distal radius fractures (DRF) have been provided by the American Academy of Orthopaedic Surgery however they fail to identify body habitus or obesity in their treatment algorithm. Despite addressing many issues surrounding the treatment of this relatively common injury, the guidelines make no mention of the role obesity might play in initial injury, treatment or outcomes.

Materials & Methods: A retrospective chart review of 122 adults who sustained a DRF after a fall from standing height was completed. All patients were treated by the senior author. Age at the time of injury, gender, and body mass index (BMI) was obtained. Radiographs at presentation were then classified by AO group (23-A, 23-B or 23-C). Distal radius fractures were categorized as simple (closed extra-articular (AO group 23-A) without an additional ipsilateral upper extremity fracture) or complex (intra-articular (AO groups 23-B and 23-C) or any open injury or with an additional ipsilateral upper extremity fracture). Chart review identified patients treated initially with surgery or non-operatively as well as those who failed non-operative management (in most cases due to loss of reduction). Patients were contacted and a QuickDASH score was obtained.

Results: The average age was 61.4 years of age (range 28-86). Average BMI was 28 (range 17.2-67.34). 84% were female. Those with a BMI >24 were more likely to have a complex DRF. Overweight/obese individuals were initially treated with surgery more often (80%) whereas only 60% of those with a BMI < 25 were treated initially with surgery.

Conclusions: Obesity is associated with a more complex fracture of the distal radius. Overweight and obese patients met operative parameters more frequently.

47. Outcomes of Surgical Treatment for High Energy Open Forearm Fractures

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¹Walter Reed National Military Medical Center, Bethesda, MD; ²Uniformed Services University of the Health Sciences, Bethesda, MD

Introduction: We hypothesized that open forearm fractures in the military population are primarily high-energy injuries with high rates of complications, but have high rates of union after surgical treatment.

Methods: The surgical records of all patients surgically treated for open radius/ulna fractures between January 2006 - January 2014 at a single military facility were reviewed. Primary outcome was bony status of the injured extremity (union, nonunion, amputation) following definitive treatment. Secondary outcomes included rate and severity of heterotopic ossification and radioulnar synostosis.

Results: A total of 66 patients with open fractures were reviewed (7 isolated radius fractures, 39 isolated ulna fractures, and 20 bothbone fractures). Average patient age was 25.2 years, and the average BMI of patients treated was 25.4. Most fractures were comminuted (78.7%) and resulted from blast injuries (79.4%). An ipsilateral vascular injury was present in 30.3%. A total of 62 patients underwent definitive treatment with open reduction internal fixation (93.9%), 2 with intramedullary nailing (3%), one with elbow fusion (1.5%), and one required early amputation (1.5%). Soft tissue coverage required skin

grafting in 28 patients (42.4%) and flap coverage in 26 patients (39.4%). Union was achieved in 83.8% of patients after primary treatment. Of the remaining nine patients, one required amputation after ORIF due to massive radial and ulnar artery thrombosis, and eight developed nonunions. Six of the nonunions healed after late bone grafting, one passed away prior to nonunion surgery, and one refused further intervention. The final union rate in this series was 93.9%. Complication rates were high, with heterotopic ossification developing in 21 patients (54.5%), and a radioulnar synostosis developing in eight patients (12.1%). Bone loss at the fracture site was a significant risk factor for development of a nonunion after initial treatment ($p=0.01$).

Conclusion: This cohort of high-energy open forearm fractures had a substantially lower union rate relative to previously published series. Complication rates were high, and bone loss at the fracture site predicted later nonunion.

48. Factors Associated with Removal of a Radial Head Prosthesis Placed for Acute Trauma

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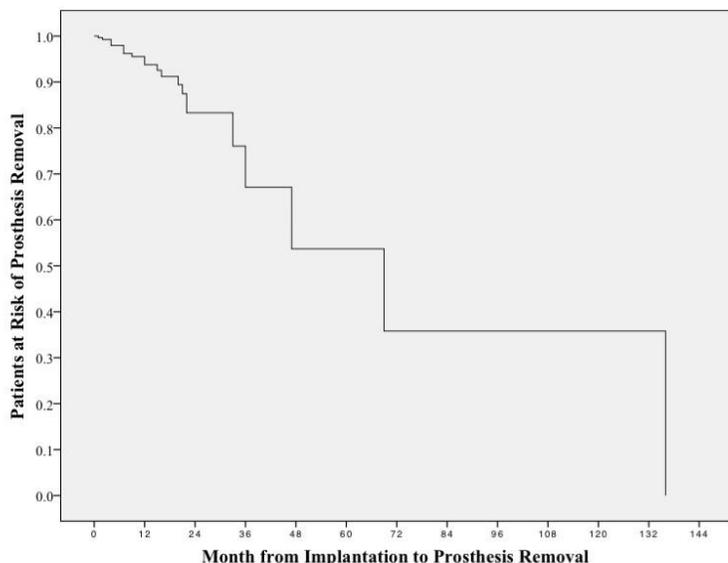
Introduction: Because there are many types of prostheses and differences in opinion about the role a prosthesis might play over the long term, removal of a prosthesis might be highly variable. This study tests the hypothesis that there are no factors associated with removal or revision of a radial head prosthesis. A secondary analysis addressed the time to removal or revision.

Methods: We reviewed the database of two large hospitals from 2000 to 2014 and identified 278 patients that had radial head replacement after an acute fracture or fracture dislocation of the elbow: 19 had removal and 3 had revision of the radial head implant within the study period. Explanatory variables including demographics, the type of injury, prosthesis type, surgeon, medical center, and associated injuries were evaluated in a Cox regression model. Survival analysis using Kaplan-Meier curves evaluated time to revision.

Results: In the multivariable analysis, only the hospital was the independent factor influencing the rate of removal or revision (OR=2.4, Confidence interval: 1.0-5.7, P value=0.046). The rate of removal/revision was 8%. The highest rate of removal was during the first year after implantation (50%) and decreased each year by half over the following second to

fourth years. The most common reason for removal of the prosthesis was to facilitate removal of heterotopic ossification (the majority with proximal radioulnar synostosis).

Conclusion: The most important finding is that there were differences by hospital, likely reflecting different opinions and preferences of the surgeons.



49. Variation in Admission and Transfer Volume at a Regional Hand Trauma Referral Center

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¹Curtis National Hand Center, Baltimore, MD; ²University of Maryland, Baltimore, MD

Hypotheses: A variety of factors may influence the transfer of hand trauma patients to regional hand centers. It is important to understand the factors that contribute to the variation in trauma admission and transfer volume. Our hypotheses were 1) transferred patients constitute a higher proportion of all patient encounters on holidays and weekends, 2) uninsured patients are more likely to be transferred than patients with private insurance, 3) replantation surgery is more likely to be done in transferred patients

Methods: Our institutional hand trauma registry was queried for a record of all encounters spanning a 5 year period between 2009-2014. Descriptive statistics were calculated including means and standard deviations for continuous variables and frequencies for categorical variables. Bivariate relationships between patient origin (primary versus transfer) and demographic covariates were evaluated. Multivariate logistic regression models were used to examine the independent effect of covariates including age, sex, insurance status, injury type, and replantation surgery on patient origin.

Results: The study included 8,260 hand trauma patients evaluated at our institution. Transferred patients accounted for 28.6% of our sample. Weekends and holidays were not associated with increased odds of being transferred (p-values ranged 0.16-0.29). Multivariate logistic regression showed a 93% increased odds of being transferred among patients undergoing replantation (95% CI 23-104%). Penetrating and sharp (slice or saw) injuries had increased odds of 1.58 (95% CI 1.33-1.88) and 1.49 (95% CI 1.32-1.67) for transfer, respectively, when compared to blunt and crush injuries. Additionally, underinsured patients with either medical assistance or self-pay status had an odds ratio of 1.26 (95% CI 1.14-1.39) for transfer. We also observed significantly increased odds of transfer for white patients (OR 1.47, 95% CI 1.33-1.63) compared to all other races, as well as male patients (OR 1.54, 95% CI 1.37-1.74).

Summary:

- Patients undergoing replantation or revascularization are more likely to be transferred than primarily admitted to a hand trauma center
- White, male, and underinsured patients are more likely to be transferred
- Penetrating and sharp hand injuries are more likely to be transferred compared to other injury types
- There is no difference in relative volume of primary admissions to transfers on weekends and holidays compared to other days of the year
- Factors that determine whether a patient is transferred to a hand trauma center are not well understood and may include socioeconomic considerations from the referring provider and hospital perspective

50. Skin Involvement in Dupuytren's Disease

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Introduction: Whether the palmar skin has a role in the development, propagation or recurrence of Dupuytren's disease remains unclear. Clinical assessment for skin involvement is difficult and its correlation with histology uncertain. Our study prospectively compared the histological characteristics of the palmar skin with clinical features of Dupuytren's disease and functional outcomes.

Methods: Over three years, we prospectively biopsied the palmar skin of all consecutive patients undergoing single digit fasciectomy (for primary Dupuytren's disease without clinically involved skin) or dermofasciectomy (for clinically involved skin as determined by the senior author or recurrent disease). We biopsied skin overlying a cord or nodule. Histological analysis was undertaken by an experienced dermatopathologist. Hand function was assessed by an independent Hand Therapist. Participants were grouped as fasciectomy or dermofasciectomy for between-group analyses.

Results: Overall, 103 patients were included in the study. We found dermal fibromatosis in 22 of 44 (50%) patients undergoing fasciectomy and 41 of 59 patients (69.5%) undergoing dermofasciectomy (p=0.041). Dermal fibromatosis was associated with greater pre-operative angular deformity (cumulative flexion contracture 63.5 vs. 117.5 degrees,

p<0.001). Dermofasciectomy conferred greater improvement in post-operative range of movement (49.5 vs. 90 degrees, p<0.001). There were no differences in the rate of complications between groups. There were no total graft losses. The presence of skin involvement was strongly associated with palmar nodules and occupations involving manual labour. Clinical assessment of the skin was unreliable (sensitivity 72.2% and specificity 63.6%).

Conclusion: This is the first study to show that dermal fibromatosis exists in the absence of clinical features of skin involvement, which may be an important piece of the puzzle in understanding the otherwise unpredictable nature of this disease. Skin involvement by Dupuytren's fibromatosis may have a greater role in the development and propagation of Dupuytren's disease than previously thought.

Figure 1. A flow diagram of patient attrition.

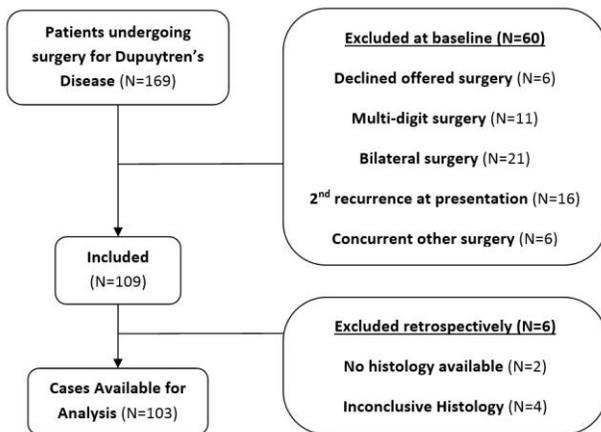


Figure 2. An H&E stained section of skin from a patient who underwent primary dermofasciectomy for clinically involved skin at increasing magnification. **Upper panel:** dermal fibromatosis distorting the normal architecture and adnexae. **Middle panel:** Dermal fibromatosis reaching the mid-reticular dermis. **Lower panel:** The active area of Dupuytren's disease.

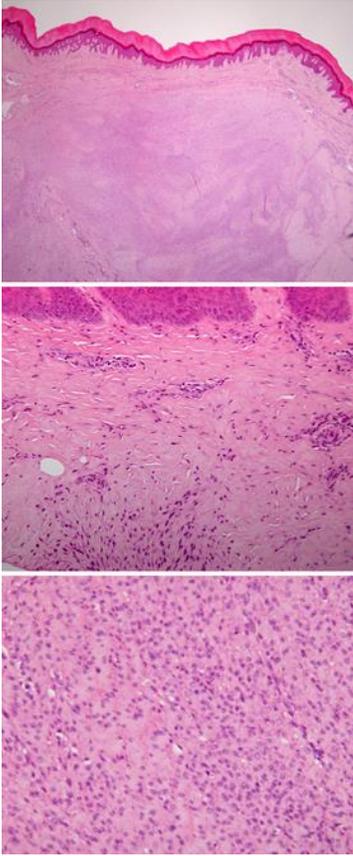


Figure 3. Upper row: Pre-operative photographs of a 68 year-old right-handed man with primary Dupuytren's disease involving the skin and PIPJ 57 degree flexion contracture. **Lower row:** 1-year post primary dermofasciectomy and full thickness skin grafting.



51. The Use of Psychosocial Services Post Hand and Upper Limb Injury and Trauma

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Purpose: The purpose of the study was to explore the use of psychosocial services by occupational therapists (OT's) and certified hand therapists (CHT's) who commonly work with patients sustaining a hand and upper limb injury.

Methods: A quantitative survey research design was implemented. A self-made questionnaire which consisted of questions in reference to hand and upper limb injuries or trauma, psychosocial services, psychological disorders, and the frequency of referral or use of psychosocial services was provided to 29 OTs and CHTs working in outpatient facilities in Pennsylvania, Maryland and New Jersey.

Results: The most frequently recorded frame of reference was the biomechanical. Only five of the 29 (17.2%) participants recorded utilizing psychosocial assessments. The most frequently reported psychosocial intervention used was massage (n = 21). The results revealed that 16 of the 29 participants referred to nine possible psychosocial services. However, the majority of the referrals were only 'occasionally' or 'sometimes'. Surgeons were reported as referred to the most by participants (M = 3.69, SD = 0.79) followed by family doctors (M = 2.81, SD = 1.05). OT's specialized in mental/behavioral health (M = 1.25, SD = 0.45), behavioral specialists (M = 1.31, SD = 0.48), and social workers (M = 2.31, SD = 1.30) were recorded with the least amount of referrals.

The most frequently reported barrier to providing referrals to psychosocial services was restraints presented by insurance companies (n = 14), followed by minimal awareness by therapists (n = 11). Limited resources (n = 9), physician referral (n = 8), and cost (n = 6) were among the remaining frequently reported barriers. A Spearman rank correlation which examined the relationship between referrals by therapists and years of experience as an OT or CHT revealed a weak but significant correlation of -.322 and -.351 at the $p < .05$ level respectively. This reflected an indirect correlation where the less experience a participant had; the more likely they were to refer to psychosocial services.

Discussion & Conclusion:

- Therapists appear to be biomechanically which may have an impact on outcomes.
- The results emphasized the lack of psychosocial assessments, interventions, and referral services provided by OT's and CHT's post injury.
- Psychosocial factors are not typically being addressed during the rehabilitation process and therefore have the potential to cause chronic psychosocial distress and dysfunction in occupational performance.
- The practice and referral of psychosocial services is an important contribution to the recovery process.

52. A Randomized, Double-Blinded, Placebo-Controlled Clinical Trial Assessing the Therapeutic Efficacy of Botulinum Toxin in Treating Scleroderma-Associated Raynaud's Phenomenon

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Introduction: Raynaud's phenomenon is a painful and often debilitating condition which can lead to digital ulcers, loss of function, and partial amputations. A promising new treatment option for Raynaud's phenomenon uses local injections with Botulinum Toxin Type-A (Btx-A) into the perivascular space of the affected digits and has been reported in case series to provide significant symptoms relief. However, researchers have noted anecdotally that this effect could not be demonstrated in patients with advanced scleroderma. As most patients with scleroderma (approximately 90%) suffer from Raynaud's phenomenon, we conducted a randomized, double-blinded, placebo-controlled clinical trial to assess the therapeutic efficacy of Btx-A in treating scleroderma-associated Raynaud's phenomenon.

Materials and Methods: Eligible patients are enrolled and their hands randomized to receive 7 injections each either with Btx-A (50 units in a total volume of 2.5 mL) or sterile saline (2.5 mL in total). Patients are followed-up 1 month and 4 months post-injection using laser Doppler imaging (LDI) of the hands to assess blood flow, patient-reported outcome questionnaires to assess quality-of-life, and a physical exam to assess digital ulcers. Paired t-test or paired signed rank test are used as appropriate to compare outcomes.

Results: Blinded analysis of 40 patients was performed using 1-month post-injection data. Twenty-three (57.5%) patients have limited scleroderma, 14 (35%) diffuse scleroderma, and 2 (5%) mixed connective tissue disease; 31 patients (79.5%) are female. Mean age is 52 years (range: 21-75) and the median time since diagnosis is 14 years (range: 1-35). Twenty eight patients (70%) are being treated with calcium channel blockers, 7 with phosphodiesterase-5 inhibitors (17.5%), 6 with fluoxetine (15%), and 5 with losartan (12.5%). Paired t-test using 1-month post-injection LDI data showed only weak statistical evidence for a change in blood flow on average (difference: -27.99, 95% CI: -59.12 to 3.15, p-value: 0.075), which did not achieve our level of significance set *a priori* (p=0.049). Differences in secondary outcomes were also not statistically significant (Table 1).

Conclusions: This study has found insufficient statistical evidence demonstrating the average efficacy of locally injected Botulinum toxin Type-A for scleroderma-associated Raynaud's phenomenon. Further ongoing analysis will reveal which patients with scleroderma may still benefit from this treatment and will occur after 4-month post-injection data collection is completed and unblinding has occurred (September 2015).

Table 1. Blinded results at 1-month post-injection comparing paired outcomes for hands injected with Botulinum toxin A or placebo.

Test	Baseline		1-month		Change in time		Difference (A-B)	95% CI	p-value
	Arm A	Arm B	Arm A	Arm B	Arm A	Arm B			
Blood flow (flux units)*	399.81	393.04	363.63	384.85	-36.18	-8.19	-27.99	-59.12 to 3.15**	0.075
QuickDASH score	27.56	30.76	26.96	29.11	-0.6	-2.54	2.16	-2.16 to 6.47	0.318
McCabe score	221.25	221.15	185.31	187.19	-35.94	-36.86	-2.56	-18.75 to 13.62	0.750
VAS Pain score	3.43	3.67	2.67	3.05	-0.76	-0.62	-0.14	-0.82 to 0.54	0.685
Oxygen saturation (%)	90.95	92.2	94.1	95.21	2.51	2.85	-0.33	-3.10 to 2.43	0.795
Number of ulcers	0.53	0.55	0.47	0.55	-0.08	-0.03	-0.05	-0.34 to 0.23	0.764

95% CI: 95% Confidence interval

* Measured with non-invasive Laser Doppler imaging (MoorLDI-IR)

** Confidence interval for this statistic was constructed at a 95.1% level to account for previously conducted interim analysis

53. Treatment of Failed Submuscular Ulnar Nerve Transposition

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Introduction: Root avulsions of the brachial plexus represent one of the most severe nerve injuries. Next to apparent sensorimotor functional deficits the avulsion injury often leads to unbearable pain, frequently referred to as deafferentation pain. In avulsion injuries of the inferior trunk the burden of pain is most intense and the hand function that can be expected by reconstructive, surgical approaches (intra-/extraplexual nerve transfers) is less than poor. We report of 5 patients with global plexopathies with avulsion of at least two nerve roots, who have approached our specialist center of extremity reconstruction in the years of 2010 to 2014. The impact of bionic extremity reconstruction on hand function, deafferentation pain and quality of life is presented.

Materials & Methods: In all 5 patients multiple selective nerve transfers (and muscle transfers in selected cases) were performed on the affected limb. Surgery was not able to restore motor function in the hand but thereby generated electromyographic signals could be used for the control of a prosthetic device. After intense rehabilitative training and consequent intuitive signal control the functionless hand was electively amputated and replaced by a functional prosthesis, defined as bionic reconstruction.

The patients were evaluated pre-interventionally (before bionic reconstruction), during the rehabilitative process and after amputation as well as prosthetic fitting. The pain state was assessed with the Visual Analogue Scale (VAS). Additionally pre- and post-interventional pain medication was documented and quality of life as well as general health state were assessed on a regular basis (Health Survey SF-36).

Results: In all 5 treated patients bionic reconstruction led to significant pain reduction compared against pre-interventional pain conditions. Pain medication intake was ceased in 3 patients after the prosthesis had been incorporated into the user's activities of daily living. Quality of life, subjectively perceived health state, and psychological role functioning also improved dramatically.

Conclusion: The functional and cognitive reintegration of the extremity into the patient's body image led to major pain relief as well as markedly improved quality of life in all so far treated patients. In some patients even a re-entry into working life was permitted by the functional gain of the prosthetic hand, which also came along with social and economic benefits.

54. Carpal Tunnel Syndrome and the Unmeasured Strength

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Introduction: Pinch and grip strength are commonly used measures of hand strength in evaluating the success of carpal tunnel release. These measures do not correlate well with activities of daily living. For example, many patients have difficulties with activities requiring both gripping strength and twisting strength, such as opening jars, opening doors, and turning keys. Our objective was to evaluate twisting strength in patients undergoing carpal tunnel release and compare this to standard pinch and grip testing.

Materials and Methods: 39 patients (27 females and 12 males) with carpal tunnel syndrome were prospectively enrolled prior to limited open carpal tunnel release by a single hand surgeon. Patients were evaluated pre-operatively and at 3, 6, and 12 months postoperatively for twisting strength. DASH, Visual analog score (VAS), standard pinch and grip testing were also obtained at each visit. Twisting strength was measured by turning a device with disks of 2.5 cm (pinch and twist) and 10 cm (grip and twist) diameter to simulate pinch and grip strength. The disk sizes were selected to simulate opening bottles and jars, respectively. ANOVA and Tukey pairwise comparisons were done for statistical analysis.

Results: Twisting strength with the 10 cm disk (grip and twist) was significantly improved at 12 months follow-up in both males and females 46.3 to 77.8 in lbs ($p < 0.001$). Twisting strength of the 2.5 cm disk (pinch and twist) improved from 9.1 to 12.3 in lbs ($p = 0.024$). VAS and DASH were significantly improved from 3.9 to 0.7 ($p < 0.001$) and 33.6 to 11.7 ($p < 0.001$) respectively. Standard pinch or grip testing levels remained at preoperative levels at all timepoints.

Conclusions: Twisting strength in both the 2.5 and 10 cm disk was significantly improved at 12 months in both males and females after carpal tunnel release. Historical studies evaluating pinch and grip strength have shown a return to preop levels around 3 months. Our patients demonstrated similar recovery of standard pinch and grip, as well as improved VAS and DASH scores with an improvement in twisting strength at 12 months after carpal tunnel decompression. Patients can be reassured that there should be no loss of grip strength following carpal tunnel release. Patients should also expect an improvement in the ability to open bottles and jars. As pain decreases after carpal tunnel release, patients gain improved ability to perform ADLs requiring twisting strength.

Concurrent Scientific Abstract Session IV

55. A Comparison of Three Diagnostic Tests for Diagnosis of Carpal Tunnel Syndrome Using Latent Class Analysis

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Introduction: The current reference standard for carpal tunnel syndrome is under debate. Recent studies have demonstrated similar diagnostic accuracy between ultrasound and nerve conduction studies. The purpose of this study is to determine sensitivity and specificity of ultrasound (US), nerve conduction studies (NCS), and CTS-6 for diagnosis of carpal tunnel syndrome (CTS) using latent class analysis.

Methods: Latent class analysis (LCA) is a statistical technique that can be used to estimate the accuracy of diagnosis when there is no universally accepted reference standard. This type of analysis is useful in the setting of CTS as their remains significant controversy with respect to the necessity of NCS and other confirmatory testing. CTS-6 is a validated clinical diagnostic tool for diagnosis of CTS-6 that has been shown to have a high sensitivity and specificity. Data from a database of 85 consecutive patients with NCS, CTS-6 and US was analyzed using classical latent class analysis, assuming that the three tests were imperfect and conditionally independent.

Results: The sensitivities of US, CTS-6, and NCS were 91% (95% CI 81-97), 94% (95% CI 86-99), and 91% (95% CI 81-97), respectively. The specificities of US, CTS-6, and NCS were 94% (95% CI 80-100), 91% (95% CI 74-99), and 83% (95% CI 66-95), respectively.

Conclusion: US, NCS, and CTS-6 have similar sensitivity and specificity for the diagnosis of carpal tunnel syndrome. The currently accepted reference standard (NCS) had the lowest sensitivity and specificity of the three tests. These findings support previous studies that suggest CTS-6 and US are highly accurate in the diagnosis of CTS and that NCS are not necessary in most cases.

56. Replantation and Revascularization Under Wide Awake Anesthesia

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Introduction: The use of local anesthesia with adrenaline for hand surgery is a new trend that is gaining popularity among hand surgeons worldwide. As with most new trends, appreciating the limits of its use can sometimes be difficult in circumstances where vascularity is already impaired. Like revascularization or replantation, the use of Wide-Awake hand surgery might be considered an absolute contraindication. However, we present a series of 12 cases that illustrate the use of the Wide-Awake technique for digital revascularization and replantation without detriment to the traumatized digit.

Materials and Methods: From 2013 to 2015, 12 patients (13 digits) received microsurgery under wide awake anesthesia. 5 digit revascularizations and 8 digit replantations were performed using 1% lidocaine and 1:100000 epinephrine digital blockade. The mean age of patients was 44.5 years (range 21-65). The ratio of clean cut to crush injuries was 5:8. Five of the twelve cases were smokers (42%) and three patients had significant co-morbidities (25%). The zone of injury was at the level of the distal phalanx in five cases (42%), the middle phalanx level in one case (8%) and proximal phalanx level in six cases (50%). Vein grafts from volar forearm were harvested in 5 digits. The average surgical time was 3.3 hours (range 1.3 to 5.6). The injection amount was 16.4 ml (range 6 to 55ml). A short-term (10-20 minutes) temporary tourniquet was used in three replantations only to aid in the identification and dissection of recipient structures. The adrenaline on replanting digits reduced local tissue blood perfusion but good spurting from the healthy artery stump was still checked. Therefore, safe anastomosis could be performed with reestablishment of flow.

Results: All the replantated or revascularized parts survived. Two revascularized and one replanted digits presented superficial necrosis. The wounds were healed by secondary intention and one local flap.

Discussion: The use of Wide-Awake anesthesia for hand microsurgery simplifies the organization of requirements for any particular operation thereby saving on resources and cost. But ultimately it requires the patient to be accommodating and surgeon to be completely familiar with the technique and confident with microsurgical anastomosis. We advocate this procedure in selected cases when urgent reestablishment of blood flow is required but resources are limited.

57. The Detrimental Effect of Patient Comorbidities on Digital Replantation Success in the United States

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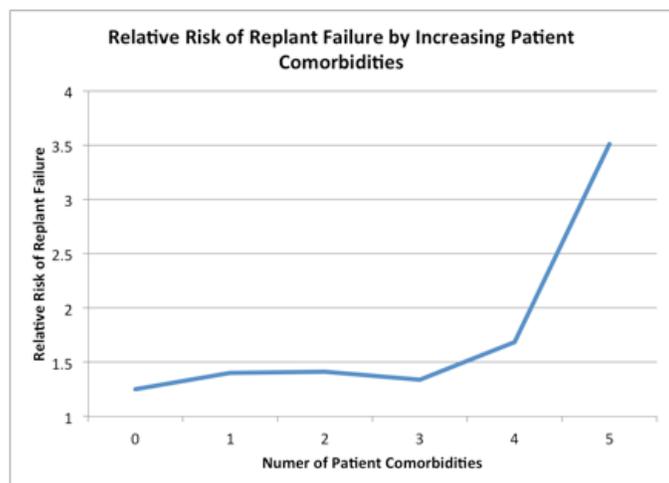
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Introduction: Recent reports suggest a decrease in success rates of digital replantation in the United States. We sought to determine the effect of patient comorbidities on digital replantation success in order to identify at risk populations for replantation failure.

Materials and Methods: All amputation injuries and digital replantations captured by the National Inpatient Sample during 1998-2012 were identified. Clinical Comorbidity Software was utilized to isolate preoperative patient comorbidities based on an Elixhauser Comorbidity Index. A successful procedure was defined as one in which a replantation occurred without a subsequent revision amputation. Patient comorbidities were tested for association with the success of the procedure.

Results: 15,822 replant procedures were identified. The overall rate of success of replants dropped from 74.5% during 2004-06 to 65.7% during 2010-12 (Relative Risk of replant failure [RR], 1.060; $p < 0.001$). Pediatric patients (RR, 0.909; $p = 0.004$), women (RR, 0.958; $p < 0.001$) and both Hispanics (RR compared to whites, 0.935; $p < 0.001$) and Asians (RR compared to whites, 0.852; $p < 0.001$) had increased relative risks of replant success. Patients with anemia deficiency (RR, 1.172; $p = 0.002$), depression (RR, 1.300; $p < 0.001$), electrolytes disturbances (RR, 1.100; $p = 0.047$), perivascular disease (RR, 1.261; $p < 0.001$), and those with tobacco abuse (RR, 1.041; $p = 0.035$) had decreased rates of replant success. Increasing cumulative number of comorbidities resulted in increasing risk of replant failure (RR, 1.252; $p < 0.001$).

Conclusions: These data suggest that increasing patient comorbidities increases the risk of digital replant failure. Patients with preoperative anemia, depression, perivascular disease, and tobacco use are at a particularly high risk of replant failure. Patients with multiple comorbidities must be carefully counseled prior to digital replantation due to significantly increased risks of failure.



58. Osteoporotic Distal Forearm Fractures - Stabilization With An Angle Stable Minimal Invasive Intramedullary Polymer

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Introduction: In progressed osteoporotic disease conventional operative treatment of distal forearm fractures often leads, especially in presence of long segment comminuted fractures in close proximity of the joint space, to unsatisfactory results.

Materials and Methods: Through a small incision using the Seldinger-technique a Dacron balloon catheter is inserted into the medullary canal after reaming with a flexible cannulated drill. The balloon is filled with a liquid non-toxic plastic monomer. After confirmation of the correct positioning of the intramedullary device curing of the monomer using blue light (wavelength 436 nm) through a fiberoptic cable is achieved within 300-600 seconds creating a customized intramedullary rod comparable in strength to steel or titanium. The balloon adapts to the often irregular shape of the medullary cavity. After the curing process and polymer formation an angle stable locking screw or a plate may be used in combination with the implant to increase stability.



Results: Nine female patients with distal forearm fractures with an average age of 77,6 years were treated from 09/2011 to 06/2014.

6 Patients suffered an A3-AO-Type Fracture of the distal Radius, 1 Patient a B2-AO-Type Fracture and 2 Patients a C2- respectively a C3-AO-Type Fracture. All ulnar fractures were A1.2- or A1.3-AO-Type Fractures.

3/9 distal radial fractures were treated with the Polymer in a retrograde fashion in combination with a locking screw. 1/9 patients was operated with a Hybrid-Osteosynthesis consisting out of the polymer and an angle stable palmar plate. 3/9 radial fractures obtained an extraarticular external fixator without the polymer. 2/9 patients were treated with palmar plate in combination with an external fixator.

6/9 distal ulnar fractures were stabilized with the polymer in combination with a distal locking screw. 2/9 got a Hybrid-Stabilization and 1/9 ulnar fracture was treated conservatively.

Mean follow up was 150,6 days (43-392 d). In all fractures (radius and ulna) bone healing was documented radiologically. The mean DASH-Score was 34,1.

Conclusion: Treatment of osteoporotic distal forearm fractures using an intramedullary polymer implant is suitable to manage long segment fractures. The radiolucent polymer allows radiological visualization of the entire bone and facilitates radiation therapy in select cases. Stability may be increased either with locking screws placed at any position of the implant as determined by anatomical safe zones or with plates.

59. Primary Surgical Release of Trigger Digits in Diabetics versus Nondiabetics: A Prospective Comparative Study

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Hypothesis: Stenosis tenosynovitis (i.e. the trigger finger) remains one of the most common problems treated by hand surgeons. Numerous studies have documented a lower success rate of corticosteroid injections in diabetics versus non-diabetics for the treatment of trigger fingers. Surprisingly, few studies have posed to investigate the comparative outcome, speed of improvement, and complication rate following surgical intervention between these two patient populations. We hypothesize that diabetic patients will report a lower success rate and higher complication rate for trigger finger release in comparison to nondiabetics.

Methods: A prospective comparative study of 42 patients undergoing surgical intervention for recalcitrant trigger fingers was performed. Preoperative evaluation as well as outcomes at 2, 6, and 12 weeks postoperatively were conducted. Success rate of surgery, speed of improvement, and complication rates were compared between diabetic to nondiabetic patients. Subgroup analysis of the impact of type I versus type II diabetes, preoperative Hemoglobin A1C, as well as insulin versus noninsulin dependent control were performed.

Results: Both diabetic and non-diabetic cohorts exhibited a similar pre-operative DASH score of 31.62 and 31.85, respectively. ($p > 0.05$) Both groups appreciated equally successful improvement from surgical intervention with final DASH scores of 0.53 in diabetic patients and 3.05 in non-diabetic patients at final assessment. ($p > 0.05$) The speed of improvement was similar for both diabetics and nondiabetics at all time points. There was a trend for diabetic patients with a HgA1C < 8 to express quicker improvement than those with a HgA1C > 8 . This trend approached but did not reach statistical significant. Approximately 35% of diabetics experience a post-operative complication compared to 10% of nondiabetics ($p < 0.05$). The risk for having a post operative complication was significantly higher in insulin dependent versus non-insulin dependent diabetics (approximately 50% versus 0%, respectively) ($p < 0.05$).

Summary:

- Diabetic and non-diabetic patients suffering from trigger fingers experience symptoms of similar severity.
- Surgical intervention can reliably provide equal success rate for both diabetics and non-diabetics.
- Diabetic patients experience a similar speed of improvement but a higher complication rate in comparison to non-diabetic patients.
- Insulin-dependency appears to be a significant risk factor for post operative complications.
- Diabetic patients should be appropriately counseled prior to undergoing surgical intervention for a recalcitrant trigger finger.

60. Management Trigger Finger: Maximizing Non-Operative Success Without Increasing Morbidity

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Introduction: Traditional non-operative management of trigger finger is limited to 1 long-acting steroid injection, followed by surgery in the case of failure. Recently, non-operative strategies have been extended to include 2-3 injections despite the absence of large prospective studies supporting this practice.

Materials & Methods: A prospective study was performed of all patients presenting with trigger finger to a single surgeon over a 22-year period. Patients with potentially confounding comorbidities were excluded. All patients received 1-3 injections of triamcinolone acetonide+local anesthetic into the tendon sheath. Data were analyzed by digit.

Results: 401 patients with 571 digits were included in the study. Average follow-up was 14.7 months. 472 digits (83%) demonstrated complete response within 1.0 ± 0.9 months of an initial injection and had been symptomatic for 4.7 ± 9.9 months prior to treatment. Of these 472, 347 (74%) achieved permanent remission without surgery after a total of 1-3 injections. In contrast, 99 digits (17%) demonstrated partial/no response to an initial injection and had been symptomatic for mean 8.6 ± 21 months ($p=0.04$). Of these 99 non-responders, 49 (49%) achieved permanent remission after 1-2 additional injections (2-3 total). Digits that were symptomatic for ≤ 3 months were more likely to demonstrate a complete response after 1 injection than those that were symptomatic for >3 months (OR 2.6, 95% CI 1.67-4.0, $p<0.01$). For the digits that failed to resolve after the 1st injection, those that were symptomatic ≤ 5 months prior to the first injection were more likely to respond to a 2nd injection than those that were symptomatic for >5 months (OR 9.4, 95% CI 3.0-29.7, $p<0.01$). There were no instances of tendon or pulley rupture, infection, or soft-tissue atrophy.

Conclusions: Trigger finger is more likely to respond to non-operative therapy when treated before 3 months. However, even when digits fail to improve after 1 injection, those symptomatic for ≤ 5 months prior to treatment are more likely to demonstrate a complete response following a 2nd injection than those symptomatic for longer. Digits whose symptoms fully resolve after 1 injection, even if only transiently, ~75% will achieve full remission with subsequent injections. It is both safe and reasonable to pursue non-operative management in the setting of initial treatment failure, as 2nd and 3rd doses increase the overall remission rate without increasing morbidity.

61. Diagnostic Performance of the ECU Synergy Test to Detect Sonographic Extensor Carpi Ulnaris Pathology in Chronic Dorsal Ulnar-sided Wrist Pain

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Introduction: The ECU synergy test is a simple and unique diagnostic maneuver for the evaluation of the chronic dorsal ulnar-sided wrist pain, using isolated tension to the ECU without greatly stressing other structures. This study aims to investigate the diagnostic performance of the ECU synergy test to detect ECU pathology with reference to ultrasonography.

Materials & Methods: During the 2-year period, consecutive patients who visited our clinic with dorsal ulnar-sided wrist pain continuing more than one month were enrolled in this study. A total of 40 affected wrists from 39 consecutive patients (22 men and 17 women; age, 14-79 years; mean age, 44.4 ± 19.4 years) were examined with the ECU synergy test and sonography. Sonographic evaluation was focused on the sixth dorsal compartment and on the distal of the compartment between the level of ulnar head and triquetrum. We considered the patient had ECU pathology if sonography showed more than one of the following abnormal findings: tendon sheath effusion, tenosynovitis, and tendinosis. The sensitivity, specificity, positive predictive value, and negative predictive value of the ECU synergy test to detect ECU pathology were calculated. We compared the results of the ECU synergy test between the group with and without ECU pathology, and also compared age, gender, and symptomatic duration of the patients between the group of a positive and negative ECU synergy test, and between the group with and without ECU pathology.

Results: The sensitivity, specificity, positive and negative predictive values were 73.7%, 85.7%, 82.4%, and 78.3%, respectively. There was significant difference in the result of ECU synergy test between the group with and without ECU pathology ($p < 0.01$). There was no significant difference in age, gender, and symptomatic duration of the patients between any two of the groups.

Discussion and Conclusion: The results of this prospective study may support the hypothesis that the ECU synergy test is a useful provocative maneuver to detect ECU pathology in chronic dorsal ulnar-sided wrist pain.

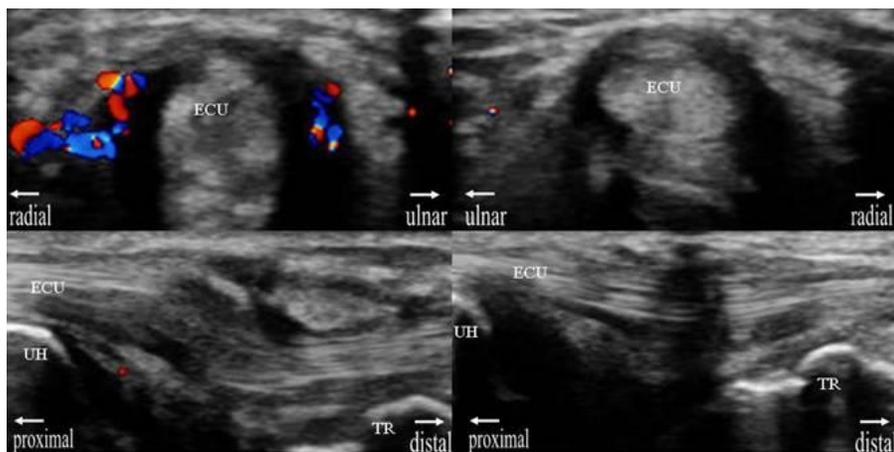


Figure 1. The comparison of sonographic images between affected left wrist (left image) and unaffected right wrist (right image) of 45 years-old woman with ECU tendon sheath effusion, tenosynovitis, and tendinosis including anatomical reference. The upper images exhibit the transverse image at the distal level of ulnar head. The lower images exhibit the longitudinal image between ulnar head and triquetrum. In the affected wrist, transverse image showed the enlarged ECU with intratendinous hypoechoic region, and longitudinal image showed irregular internal echotexture of ECU. Thickened tendon sheath encircled ECU either on transverse and longitudinal images. The Doppler flow inside the tendon sheath was also recognized. ECU: extensor carpi ulnaris, UH: ulnar head, TR: triquetrum.

Figure 2

Table 1 Age, gender, and symptomatic duration of the patients

	Age [years]	Gender [male/ female]	symptomatic duration [months]
Positive synergy test*	44.9 ± 19.0 (14-76)	8/8	3.9 ± 2.3 (1-9)
Negative synergy test**	44.1 ± 20.1 (16-79)	14/9	3.7 ± 3.8 (1-12)
The wrists with ECU pathology	46.4 ± 18.6 (22-76)	8/10	3.4 ± 2.5 (1-9)
The wrists without ECU pathology	42.8 ± 20.4 (14-79)	14/7	3.6 ± 3.3 (1-12)

A number of the patient is described in the box of gender. In the box of the other parameters, the mean value ± standard deviation is described in the upper box and value range is described in the parenthesis, respectively. *the wrists with positive ECU synergy test, **the wrists with negative ECU synergy test.

Table 2 Sonographic information of the wrists with ECU pathology

	Sonographic abnormality of the six dorsal compartment				
	TSE†	tenosynovitis	TSE & tenosynovitis	TSE & tendinosis	TSE & tenosynovitis & tendinosis
Positive synergy test* (N=14)	1	2	1	3	7
Negative synergy test** (N=5)	1	0	0	3	1

A number of the wrist showed corresponding ECU pathology is described in the box: †tendon sheath effusion, *the wrists with positive ECU synergy test, **the wrists with negative ECU synergy test.

Table 3 Correspondence between the ECU synergy test and ECU pathology

	ECU synergy test		Total
	Positive	Negative	
The wrists with ECU pathology	14	5	19
The wrists without ECU pathology	3	18	21
Total	17	23	40

A number of the corresponding wrist is described in the box.



Figure 3. The ECU synergy test.

The examiner grasps the patient's thumb and long finger with one hand and palpates the ECU tendon with the other hand, and then, has the patient radially deviate the thumb against resistance. Re-creation of pain induced along the dorsal ulnar aspect of the wrist is considered to be a positive.

62. Long-Term Results Of Articular Fractures Of The Base Of The Thumb Metacarpal Using Different Fixation Methods

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Long-term results of articular fractures of the base of the thumb metacarpal using different fixation methods
Introduction: Articular fractures of the base of the thumb metacarpal are classified in Bennett`s and Rolando`s fractures. In both fracture types a subluxation in the carpo-metacarpal joint due to traction of the abductor pollicis tendon occurs. Surgical treatment for these unstable fractures is mandatory. There are different options for fixation. The purpose of this study was to find out, which method of operative osteosynthesis can achieve the best functional outcome.
Methods: Between May 2002 and September 2013 75 patients (66 men, 9 women) with articular fractures of the base of the thumb metacarpal were treated operatively. In 55 cases a Bennett`s fracture was seen, in 20 cases a Rolando`s fracture. The average age of the patients was 36.4 years. All patients were evaluated retrospectively on the basis of the digital patient files and the existing x-rays. A functional assessment including range of motion of the thumb and pinch and grip strength was performed. Average follow-up was 44 months (12 ÷ 147 months).
Results: The Bennett`s fractures were treated in 25 cases using closed reduction and in 30 cases open reduction technique whereas the Rolando fractures were treated in 4 cases using closed reduction and in 16 cases using open reduction technique. In 23 operations a Kirschner-wire fixation were used, 4 plate osteosynthesis, 14 screw osteosynthesis and 14 screw- and K-wire osteosynthesis in Bennett fractures. Rolando fractures were treated in 6 cases using an external fixator. In 3 cases only K-wire were used and in 11 cases plate osteosynthesis. The mean range of motion for the palmar and radial abduction of the thumb was 85.5° (95% of the opposite side). Most of the patients were satisfied with their outcome (88%). The radiological evaluation showed in 44 cases an intraarticular step less than 1mm, in 17 cases between 1 - 2mm and in 14 cases more than 2mm.
Conclusion: The aim of treatment in articular fractures of the base of the thumb metacarpal is a stable osteosynthesis with anatomical reduction. This may lead to good functional outcome with the possibility of early rehabilitation. Different techniques of osteosynthesis can be used. It is difficult to restore the articular surface exactly in these injuries. Our data shows that a step-off up to 1mm obviously has no influence concerning the functional outcome.

63. Minimally Invasive Ultrasonic Tenotomy for Medial and Lateral Epicondylitis Allows for Early Recovery and Return to Work

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Introduction: The Tenex Health TX-1 (TX-1) device delivers ultrasonic energy to remove abnormal tendon in patients with tendinosis. TX-1 has been observed to result in early return to activity in some patients. Although mean pain results with 1-year follow-up are well established, detailed return to activity is lacking. The purpose of this study was to report the early results of treatment of medial and lateral epicondylitis with TX-1 in order to define early return to activity.

Materials & Methods: IRB approval and signed consents were obtained. Patients undergoing TX-1 treatment for tendinosis were prospectively enrolled. Surgery duration and incision length were recorded. Preoperative, intraoperative, and postoperative data (1, 2, 3, 6, and 12 weeks) were collected. Variables obtained include Patient Rated Tennis Elbow Evaluation (PRTEE) score, overall pain (0-10), grip strength, patient reported return to normal activity and full-duty work, and satisfaction (range 1-5; 5=very satisfied). Patients kept a daily pain diary for the first 14 days postoperatively.

Results: Forty-two patients underwent 48 TX-1 treatment procedures including 7 medial, 29 lateral, and 6 simultaneous medial and lateral. There were 18 females and 24 males with a mean age of 48 (range 32-66). The mean duration of preoperative symptoms was 12 months (range 3-42). Mean total duration of surgery was 12 minutes (range 5-33). Average size of incision was 5 mm (range 3-11). Preoperative and 12 week mean PRTEE scores were 47 and 17 respectively. Preoperative and 12-week mean grip scores were 17 kg and 24 kg respectively. Twenty-five percent of patients were back to normal activity within 9 days following surgery, 50% by 29 days, and 75% by 59 days. Twenty-five percent of patients returned to full-duty work by 8 days postoperatively, 50% by 27 days, and 75% by 70 days. Mean pain scores preoperatively and at each postoperative visit were 5.7, 3.6, 3.5, 3.2, 2.5, and 2.1 respectively. Mean satisfaction at 12-weeks was 4. There were no intraoperative or postoperative complications.

Conclusions: These data provide some guidance when discussing expectations of early postoperative recovery with patients. Twenty-five percent of patients return to normal activity by 2 weeks, and 50% by 1 month. Although biologic studies of tendon healing suggest a tendon should be protected for 6 to 12 weeks postoperatively, our data suggest that removing only the diseased tendon using TX-1, which leaves the normal tendon intact, allows for early return to activity without compromising healing. Follow-up is ongoing.

64. Prospective Evaluation of Opioid Use After Distal Radius Fracture Surgery: Determining What Effects Consumption

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Introduction: Postoperative pain management and opioid consumption following distal radius fracture repair surgery (DRF ORIF) may be influenced by a number of variables including fracture type, patient demographics, and anesthetic type. Over-prescribing postoperatively potentially introduces excess opioids vulnerable to diversion and abuse. In order to optimize postoperative opioid dosage and better understand opioid consumption following DRF ORIF, a prospective study was undertaken with the hypothesis that opioid consumption would be lower with regional anesthesia, but higher with worsening fracture classification and various patient demographics.

Methods: All patients undergoing DRF ORIF were consecutively enrolled over a six month period. Information collected included patient demographics, fracture type, surgical technique, anesthesia type, amount and type of narcotic prescribed, number of pills taken, reason for stopping, and adverse events. Statistical analysis was performed.

Results: A total of 98 patients were eligible for inclusion in the study (average age of 58 years), consisting of 79 females and 19 males. Prior to morphine equivalent conversion, average opioid pill consumption was 15 pills and the average amount prescribed was 29 pills. Anesthesia type consisted of 45 patients with general anesthesia (GEN) and 53 with regional anesthesia (REG) with a single shot peripheral nerve block. The mean amount of opioid consumption calculated via morphine equivalence was 58.5mg (range 0-280mg) for a mean of 4.8 days (range 0-16 days) after surgery. Opioid consumption in the GEN group was 59.2 compared to 58.5 in the REG group ($p>0.05$). Opioid consumption based on fracture classification consisted of mean morphine equivalence of 57.7, 60.3, and 62.0 for fractures with AO Class A, B, and C, respectively ($p>0.05$). Analysis of patient demographics found that there was an inverse relationship between age and opioid use ($p<0.05$). Similarly, there was a trend towards a higher opioid consumption among self-pay/Medicaid patients ($p>0.05$).

Conclusion: Patients following DRF ORIF were routinely over-prescribed opioids by approximately double than actually consumed post-operatively. Opioid consumption was equivalent irrespective of type of GEN or REG anesthesia. Worsening fracture classification demonstrated a trend towards increasing opioid consumption. In terms of patient demographics, opioid consumption decreased with increasing age. However, patients who were self-pay or had Medicaid were more likely to consume a greater amount of opioids. Surgeons should take these findings into account when prescribing postoperative opioids in order to avoid optimize prescribing.

65. Long-Term Outcomes Following Operative Management of Pediatric Scapholunate Ligament Injuries

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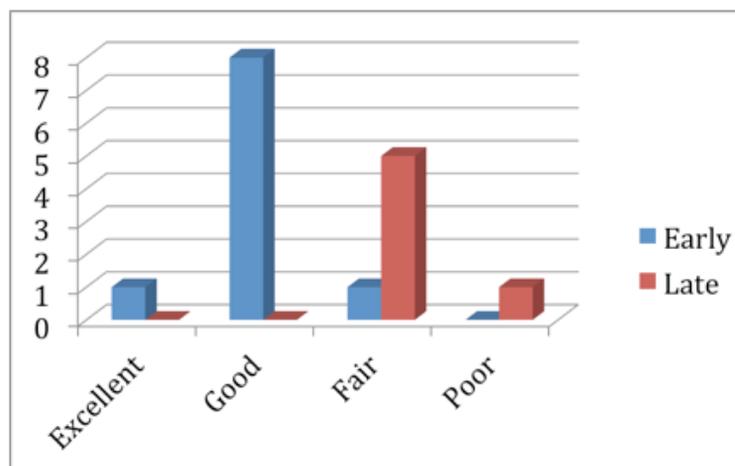
Purpose: Scapholunate injury is rarely diagnosed in children. The current study reports the outcomes of surgically treated scapholunate (SL) ligament injuries in patients less than 18 years of age with surgically documented SL injury.

Methods: An IRB approved retrospective review was performed on 21 pediatric patients with SL ligament injuries. Average subject age was 15 (range, 11-17). Records were reviewed for pre-operative and post-operative radiographic data, and intraoperative findings, classifications of interosseous ligament injury and post-operative course. Post-operative outcomes were evaluated with Mayo Wrist scores

Results: Fourteen females and 7 males sustained SL injuries which required operative intervention. Twenty patients presented with dorsal wrist pain. Seven patients had a positive Watson shift test. MRI was performed in 15 patients; the radiologist interpretation indicated an SL tear in 7. Arthroscopy was performed in 18 patients. The SL injury was classified as Geissler grade II in 1 patient, III in 12 patients, and grade IV in 5 patients. The average follow-up period was 28 months, after which, 8 patients were pain free, 3 described pain only with heavy activity, 7 had mild pain with daily activities, 2 had moderate pain, and 1 patient required daily pain medication. Based on the modified Mayo wrist score, 8 patients had excellent or good results while 8 demonstrated fair results. The mean wrist flexion-extension arc was 111 degrees while the mean grip strength was 81% of the unaffected side. Patients treated >1 year following injury had significantly decreased grip strength and Mayo wrist score. (Figure 1.)

Conclusion: SL dissociation is an uncommon injury but can also occur in the pediatric age group. Within this study worse results were seen in children who had a protracted course prior to diagnosis. A high index of suspicion is necessary to detect an SL injury in the younger age group. SL injury should be within the differential in all children with persistent dorsal wrist pain, localized tenderness over the dorsal SL joint and/or positive Watson's test. MRI may assist in diagnosis but is not always sensitive. Arthroscopy is valuable to determine the extent of injury.

Figure 1. X-axis= Mayo Wrist Score; Y-axis= Number of patients. Early = treated within 1 year of injury; Late= treated >1 year after injury. Difference in average Mayo wrist score was statistically significant at 69 in the late treatment group versus 83 in the earlier treatment group ($p= 0.004$).



66. Repeated Closed Reduction Attempts of Distal Radius Fractures in the Emergency Department – Are we Helping our Patients to Avoid Surgery?

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Background: Repeated attempts of closed reduction of distal radius fractures are often performed in the emergency department (ED) setting in order to optimize reduction, provide definitive treatment and thus potentially avoid surgical treatment. However, the additional manipulation of the fracture, especially in osteoporotic bones, may increase dorsal comminution and consequently compromise fracture stability. This may eventually lead to loss of reduction, and complicate the surgical treatment if needed. We hypothesized that repeated reductions of displaced distal radius fractures would not significantly change the need for surgical treatment, and may add complexity to the operation because of increased dorsal comminution and decreased fracture stability.

Methods: We reviewed the radiographs of 94 patients with distal radius fractures, who were treated in our ED between 2007-2010 and underwent two closed reduction attempts. Indications for surgical treatment were based on acceptable published criteria. Follow-up radiographs of patients, whose fracture alignment was deemed acceptable following the second reduction, were evaluated according to the above criteria. In addition, the amount of dorsal comminution was compared between radiographs taken after the first and second reduction attempts.

Results: A second reduction attempt improved mean radial height by 1.12 mm ($p=0.01$) and mean volar tilt by 4.16° ($p=0.01$) at the expense of increase in mean dorsal comminution length by 1.62 mm ($p<0.01$). Seventy-eight (82%) patients were classified as surgical candidates after the first reduction, and following the second reduction attempt 64 (82%) still had at least one parameter advocating surgery. Of the 14 patients with acceptable alignments following the two reduction attempts, follow up radiographs were identify for 10, showing loss of reduction in all but three (3.9%) cases.

Conclusions: A second close reduction attempt improved overall fracture alignment, but also worsen the dorsal comminution. Only 3.9% of patients who underwent two reduction attempts, healed in an acceptable alignment, and did not require surgery. Worst dorsal comminution compromise fracture stability and may increase the complexity of open reduction and internal fixation. Based on our results, we recommend avoiding repeated closed reduction attempts of distal radius fractures in the ED setting.

67. Obesity and Failure of Nonoperative Management of Pediatric Both-Bone Forearm Fractures

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Introduction: Obesity is a major health problem among children in the United States. In addition to being associated with numerous comorbidities, pediatric obesity is associated with a higher prevalence and increased risk of extremity fractures. In pediatric fractures treated nonoperatively, maintaining reduction can be difficult in obese children due to the larger soft tissue envelope. The purpose of this study was to investigate the relationship between obesity and failure of nonoperative management of pediatric both-bone forearm fractures.

Materials & Methods: We conducted a retrospective review of skeletally immature patients > 2 years old who received initial orthopaedic treatment for closed radius and ulna shaft fractures at a Level I pediatric trauma center between 2011 and 2014. 145 patients who were initially treated nonoperatively with splinting or casting were included in the study. Radiographic parameters from known literature were used to assess the quality of the reduction. The patients were divided into two groups: 1) normal weight children (BMI > 5th and < 85th percentile), and 2) overweight and obese children (BMI > 85th percentile). 59% (86/145) of patients were normal weight. 41% (59/145) patients were overweight and obese. The mean patient age was 8 years in both groups. The primary outcome measure was loss of reduction, defined as the need for repeat closed reduction or surgical intervention after initial closed treatment. Secondary outcome measures included time to healing and surgical complications. For statistical analyses, Chi-square and Fisher exact tests were used for categorical variables, and t test was used for continuous variables. Statistical significance was defined as $p < 0.05$.

Results: 16 % (14/86) of normal weight children experienced loss of reduction compared to 31% (18/59) of overweight and obese children ($p=0.04$). 29% (4/14) of normal weight children who lost reduction required surgery compared to 56% (10/18) of overweight and obese children ($p=.12$). One obese patient experienced a surgical complication. Time to healing averaged 6 weeks in normal weight children and 7 weeks in overweight and obese children ($p=0.03$).

Conclusion: Overweight and obese children have a significantly higher rate of loss of reduction in both-bone forearm fractures managed nonoperatively compared to normal weight children. These patients may benefit from closer clinical follow up and a lower threshold for surgical intervention.

68. Computed Tomography Analysis of Ulnar CMC Fractures Injuries Missed on Plain Film Radiographs and Significantly Changes Management

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Introduction: Intra-articular fractures of the ulnar carpometacarpal joints are most commonly assessed with plain film radiography. In a cadaver model, Viegas demonstrated that these injuries are often more complex than suggested by plain film evaluation alone. Plain film analysis is challenging due to overlapping bony architecture on lateral views. Inadequate restoration of articular congruity often leads to post-traumatic arthritis and poor functional outcomes. Computed tomography (CT) imaging is not routinely performed in pre-operative analysis, but does offer an accurate assessment of carpometacarpal (CMC) joint congruity, fracture displacement and subluxation. The purpose of this study is to identify significant differences in fracture analysis using computed tomography compared to plain films alone, and to identify any changes in proposed fracture management based upon different imaging modalities.

Materials & Methods: A retrospective chart review from a single surgeon's practice identified 15 patients with intra-articular ulnar CMC fractures. Two fellowship trained academic surgeons, two hand surgery fellows, and two senior residents independently assessed three standard radiographic views and as well as CT scan images. Evaluators assessed CT and plain film images separately in a blinded fashion and their assessments of each fracture were compared post-hoc. Images were reviewed in a standardized fashion for the following parameters: metacarpal injured, associated carpal fracture, and articular step > 2 mm. Based on each set of independently assessed plain films and CT images, reviewers chose a preferred method of fracture management.

Results: Inter-rater reliability for CT image analysis was 100% for all considered parameters (ICC = 1). On plain films, reviewers did not correctly identify which metacarpal was injured in 19% of patients. In addition, 70% of associated carpal fractures were missed. Reviewers failed to identify an intra-articular fracture in 23% of patients. A step deformity was incorrectly estimated in 50% of patients using plain film imaging. CT imaging changed fracture management in 49% of patients.

Conclusions: CT imaging leads to more accurate analysis of ulnar intra-articular CMC fractures. Plain film imaging misidentified the injured metacarpal with moderate frequency, and failed to reliably identify associated carpal fractures. Reviewers could not reliably determine whether the fractures were intra-articular using plain films alone, and plain film analysis lead to inaccurate estimation of articular step deformity when present. The information provided by CT imaging when compared with plain films lead to significant differences in management. Acquiring CT imaging during initial analysis of ulnar CMC fractures may significantly contribute to optimal management.

69. Using Hounsfield Units to Assess Osteoporotic Status on Wrist CT Scans: A Missed Opportunity?

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Background: The rates of evaluation and treatment for osteoporosis following distal radius fragility fractures remain low. Detecting osteoporosis from a diagnostic computed tomography (CT) scan at the time of injury would allow for a timely diagnosis and may prompt intervention to help prevent a subsequent fracture. The purpose of this study was to determine if Hounsfield unit (HU) measurements at the capitate correlated with bone mineral density (BMD) measurements of the hip, femoral neck, and lumbar spine, and to assess the ability of these HU measurements to detect osteoporosis of the hip.

Methods: The cohort included forty-five female patients with a distal radius fracture who underwent CT scan and dual x-ray absorptiometry (DXA) scan as part of the management of their wrist fracture. Bone density measurements were made using the regional cancellous bone HU value at the capitate and compared to values obtained by a DXA scan.

Results: HU values at the capitate correlated with bone mineral density (BMD) and t-scores at the femoral neck and hip ($p < 0.0001$). HU values at the capitate were also associated with BMD and t-scores at the lumbar spine ($p = 0.001$ and $p = 0.002$ respectively). A HU threshold of 307 in the capitate optimized sensitivity (86%) and specificity (94%) for discerning patients with osteoporosis from patients with a normal t-score with an odds ratio of 14.6 ($p = 0.0013$).

Conclusions: By demonstrating that capitate HU measurements from clinical CT scans are correlated with BMD and t-scores at the hip, femoral neck, and lumbar spine, our data suggests that clinical CT scans may have a role in detecting osteopenia and osteoporosis. Furthermore, our results suggest that intervention for osteoporosis should be considered in female patients with a Hounsfield unit measurement of 307 or less at the capitate.

Level of Evidence: Level II Diagnostic

70. Comparison of Dorsal Plate Fixation versus Intramedullary Headless Screw Fixation of Metacarpal Shaft Fractures: A Biomechanical Study

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Introduction: Operative metacarpal fractures are often treated with dorsal plate fixation. Recently, intramedullary headless screw (IMHS) fixation has shown promise as an alternative fixation strategy. The purpose of this study was to assess the biomechanical performance of IMHS versus dorsal plate fixation. We hypothesized that IMHS fixation provides equivalent fixation stability to dorsal plating.

Methods: Our hypothesis was tested in a transverse metacarpal fracture model using forty-four human metacarpals harvested from 8 fresh-frozen cadavers. The specimens were divided into 5 fixation groups: 1.5-mm non-locking plate; 1.5-mm locking plate; 2.0-mm non-locking plate; 2.0-mm locking plate; and 2.4-mm short cannulated IMHS. A 4-point bending model was used to assess load-to failure (LTF) and stiffness. Failure was defined as a marked change in the load versus displacement curve. Stiffness was determined from the slope of the elastic region of the load versus displacement curve. A one-way ANOVA test was used to identify statistically significant differences in LTF and stiffness among groups with a Wilcoxon test utilized for pairwise comparisons. The level of significance for all tests was $P < 0.05$.

Results: IMHS had significantly lower LTF ($P < 0.001$) than all of the dorsal plate fixation groups. Additionally, 2.0-mm non-locking plates ($P = 0.01$) and 2.0-mm locking plates ($P = 0.023$) demonstrated significantly greater LTF than 1.5-mm locking plates (Figure 1). There was a trend towards a significant difference for LTF between 1.5-mm non-locking plates and 1.5-mm locking plates ($P = 0.092$). No significant differences in LTF were found between 2.0-mm non-locking plates and 2.0-mm locking plates ($P = 0.144$). IMHS demonstrated the lowest stiffness in all groups, and was significantly less than 3 of the 4 dorsal plate groups (Figure 2). Bending stiffness in 2.0-mm locking plates was significantly greater than in the 2.0-mm non-locking plates ($P = 0.022$). No significant differences were found in stiffness between 1.5-mm locking plates and 1.5-mm non-locking plates ($P = 0.999$), or between 1.5-mm non-locking plates and 2.0-mm non-locking plates ($P = 0.835$).

Discussion and Conclusion: IMHS fixation of unstable metacarpal shaft fractures offers less stability compared to dorsal plate constructs when loaded in bending. The LTF and structural stiffness of IMHS versus dorsal plate fixation of metacarpal shaft fractures has not been previously quantified.

Figure 1. Chart displaying load to failure data. Values are displayed as mean and standard deviation.

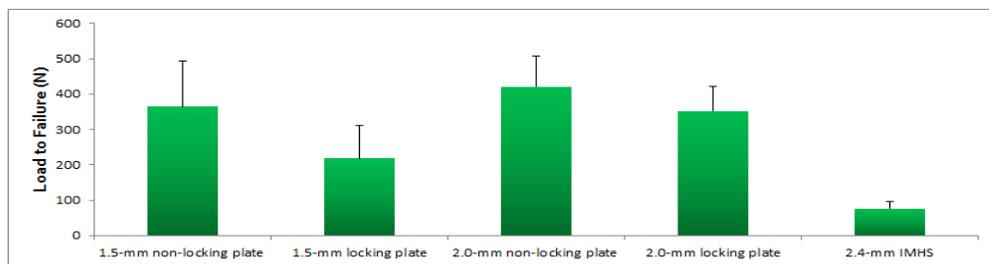
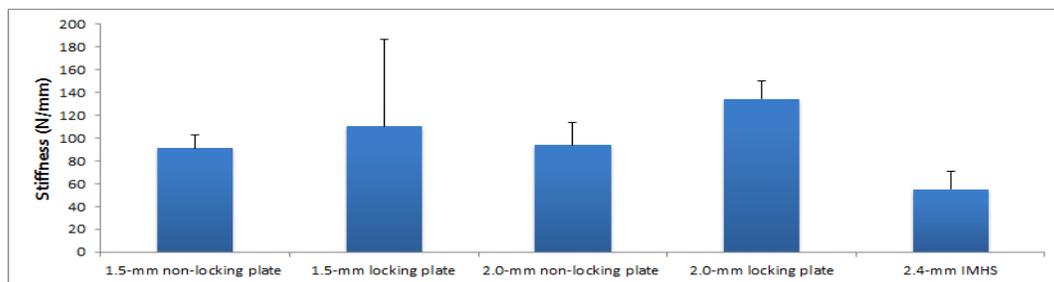


Figure 2. Chart displaying stiffness data. Values are displayed as mean and standard deviation.



71. Treating Scaphoid Nonunions with Plate Fixation and Cancellous Grafting: First Clinical Report

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Background: Scaphoid nonunions have traditionally been treated with headless screw or pin fixation with vascular or non-vascular corticocancellous graft to add structural integrity. Cancellous grafts have been proposed by many investigators as being physiologically superior to corticocancellous grafts. Vascularized grafts carry the added burden of increased costs and morbidity over non-vascularized grafts. It would seem advantageous to devise a technique that would allow for cancellous grafts to be used as opposed to the more invasive, expensive and perhaps less physiologic grafting options. Locked volar plating of scaphoids with segmental defects allows the physiologic superior cancellous graft to be used without concerns to structural compromise.

Hypothesis: Scaphoid nonunions with segmental defects treated with volar locked plating and cancellous grafting will heal as fast, if not faster, than other more traditional techniques with comparable functional outcomes.

Methods: 14 consecutive patients with established scaphoid nonunions were treated with locked volar plating with cancellous graft from the distal radius and/or olecranon. All patients were screened with MRI to assess vascularity, but were not excluded if they demonstrated AVN. SNAC II-IV were excluded. Average age of patient was 33.2 years, and all were male. Operative time, complications and time to union was recorded. Bony union was confirmed with CT scan. Grip strengths, DASH and Mayo wrist scores were obtained.

Results: 5 patients presented with AVN of the proximal pole confirmed with MRI. All patients had segmental defects following intraoperative debridement. Average time from initial injury was 72 months (range: 14 weeks to 28 years). One patient had a previous surgery for the acute fracture with a headless screw which progressed to established nonunion. Average operative time was 40 minutes. Average time to union was 84.4 days (range: 46 to 196 days). At final follow up, grip strengths were 87% the contralateral side. DASH and Mayo wrist scores were better than previously reported values.

Conclusions: Locked volar plate fixation with cancellous graft compare favorably to previous reports of more traditional techniques that involve vascularized or non-vascularized corticocancellous grafting. Although randomized controlled trials are required, this technique may offer faster and more predictable union with less morbidity, expense, and expertise required.

72. Outcomes Following Scaphoid Non-union Reconstruction

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Introduction: Surgical reconstruction following scaphoid non-union is performed using various bone grafts depending on injury factors (such as fracture site location) and specific patient factors. The type of bone graft may influence the duration of postoperative immobilization and ultimately affect hand therapy referral and ultimately outcome. This study evaluated the outcomes following scaphoid reconstruction in patients who attended hand therapy.

Materials & Methods: Following institutional Research Ethics Board approval, we performed a retrospective chart review. Adult patients who underwent scaphoid reconstruction, attended hand therapy at our hospital and were discharged between January 2011 and December 2013 were eligible for inclusion. At initial and final assessment in hand therapy, each patient underwent an assessment which included range of motion, strength and self-report questionnaires. Statistical analyses were performed to evaluate the relationships between the dependent and the independent variables.

Results: There were 26 patients (25 men, 1 women) with a mean age of 25 ± 9 years. The mean duration of hand therapy treatment was 4.4 ± 3.2 months. There was a statistically significant improvement in active range of motion ($p < 0.001$) from initial (extension 33 ± 14.2 ; flexion 26 ± 14.6 degrees) to final (extension 50 ± 13.7 ; flexion 54 ± 16.1 degrees) post-operative assessment. In those patients ($n = 9$) who completed the Patient Rated Wrist Evaluation (PRWE), there was a significant improvement ($p = 0.007$) from initial PRWE (33 ± 19.3) to final PRWE (12 ± 7.2). There was a significant correlational relationship between time from surgery: and initial passive extension ($r = .79$, $p = 0.04$); final active flexion ($r = .57$, $p = 0.02$). There was no statistical relationship between range of motion and type of graft, dominant hand injured or PRWE scores.

Conclusions: In these patients after scaphoid reconstruction, there was a significant increase in range of motion following hand therapy independent of the bone graft source. We found significant improvement in the self-report questionnaires and range of motion but there was no significant association between those measures. The outcomes of more specific self-report functional gains may be related to the physical impairments and warrants further investigation.

Concurrent AAHS Scientific Abstract Session V

73. Pediatric Upper Extremity Fractures Associated with Sports Participation: Incidence, Etiology, and Prevention

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Introduction: Sports related injuries are extremely common in the pediatric and adolescent population. The purpose of this study was to evaluate the incidence of sport participation related upper extremity fractures as well as to assess which sports cause upper extremity fractures and whether protective equipment or formal training makes an impact on their occurrence.

Materials & Methods: A questionnaire was administered to all pediatric and adolescent patients (or their parents) who presented for evaluation of a sports-related injury. Data collected included patient demographics, the sport they were playing when the injury occurred, the injury location, the years of experience playing that sport, the amount of formal training in that sport, the competitive setting at the time of injury, and whether or not the appropriate protective equipment was utilized. The diagnoses were recorded and simple statistical analysis was performed.

Results: 339 patients were surveyed over a 12 month period. The majority of injuries involved the upper extremity 56% (191/339) with fractures accounting for 80% (153/191) of these cases. Football 48% (72/153) was the most common sport causing a patient to sustain a upper extremity fracture, followed by basketball 18% (27/153) and soccer 9% (14/153).

Among football related fractures, 64% (43/72) occurred in participants with 2 or more years of formal training. Furthermore, this group who had more training wore protective equipment 67% (29/43) of the time while participants with 1 or fewer years of training used protective gear only 3% (1/29) of the time.

The hand, 49% (75/153) was the most frequently fractured location followed by the wrist 26% (40/153)

and shoulder 9% (14/153). The setting where fractures occurred was unorganized play 46% (70/153) of the time, followed by organized recreational play 31% (47/153) of the time, with the remainder of fractures occurring at high school junior varsity, varsity, or official club/travel team games or practice.

Conclusions: Pediatric and adolescent patients frequently sustain fractures during sports participation with football causing three times as many fractures as the next most common sport (basketball) and accounting for nearly half of all pediatric sports related fractures. In football neither increased formal training nor the use of protective equipment seems to help reduce fracture incidence. Increased awareness and possible new protective equipment is needed for football to reduce the risk for fracture in the pediatric population.

74. Lateral versus Dorsal Plating for Metacarpal and Phalanx Fractures

Joshua W. Hustedt, MD, MHS¹; Michael Bonnelly, BA¹; Patricia Drace, MD²; Lloyd Champagne, MD³

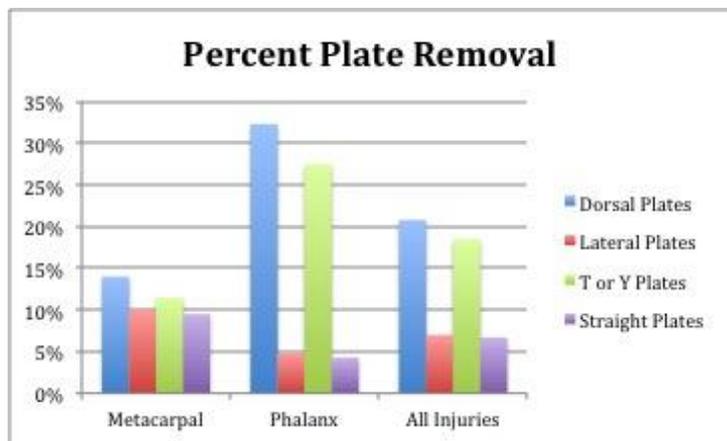
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Introduction: Recent technological advances in locked plating for phalanx and metacarpal fractures has improved fixation options for these common injuries. However, there is debate on proper plate placement between the dorsal and lateral positions. Our study exams the rate of plate removal and clinical outcomes to determine the difference between lateral and dorsal locked plating in the hand.

Materials and Methods: We conducted a retrospective review of prospectively collected patients treated with locked plates by a single surgeon for hand fractures between the years 2009 to 2011. Rates of plate removal, percent total arc of motion (%TAM), and patient and injury demographics were compared based on plating position in univariate and multivariate models.

Results: 186 patients were treated with locked plates; 90 patients had metacarpal fractures and 88 had phalanx fractures. 110 patients had dorsal plates versus 76 lateral plates. Dorsal plating resulted in less total arc of motion after surgery (212 vs 226 degrees, $p=0.04$) For metacarpal fractures there was no significant difference in plate removal in dorsal versus lateral plating ($p=0.746$). However, in phalanx fractures dorsal plating resulted in significantly higher rates of plate removal (OR 6.6, 95% CI 1.34-31.9) than lateral plating. Larger T or Y type plates resulted in greater rates of plate removal than straight plates ($p=0.005$) in phalanx fractures.

Conclusions: These data suggest that dorsal and larger T or Y type plating results in increased rates of plate removal in phalanx but not metacarpal fractures. Additionally, lateral plating results in increased postoperative total arc of motion. Biomechanical studies have shown the equivalency in strength of lateral and dorsal plating. Therefore, lateral plating provides equivalent fracture fixation, increased clinical results, and decreased need for plate removal in phalanx fractures of the hand.



75. Orthogonal Plating with Corrective Osteotomy for Treatment of Distal Radius Fracture Malunion

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Introduction: Substandard treatment of distal radius fractures (DRF) often results in malunions which typically have significantly debilitating effects on patients, including pain and loss of motion. The purpose of this study is to describe our institution's experience with corrective osteotomy of DRF malunions and other DR deformities, using orthogonal volar and radial plating.

Methods: We retrospectively reviewed the charts of all patients who underwent corrective osteotomy of the distal radius by one senior, fellowship-trained hand surgeons (RWC) from 2007 through 2014 using orthogonal ("90/90") plate fixation. Demographic data, injury history, prior treatment(s) and clinical exam values were recorded. Bivariate statistical analysis with independent t-test was utilized for comparison of pre- and post-operative wrist and forearm range of motion and grip strength. Secondary outcomes of complications and/or need for revision surgery were also recorded.

Results: Thirty-seven wrists in 37 (24 female, 13 male) patients satisfied inclusion in this study. Average age of all patients included was 53.0 +/- 12.3 years. Aside from two patients treated for Madelung's deformity, all other patients had sustained a prior fracture, of which 15 had been operated on previously, and 20 were initially treated non-operatively. Volar tilt was initially present in 8 patients (35.3 +/- 17.3 deg), with the remainder of patients presenting with dorsal tilt (26.5 +/- 12.3 deg). Twenty surgeries were performed on the non-dominant extremity. The mean interval from initial injury or prior intervention to surgery was 14.4 +/- 24.6 months. Significant improvement was seen in flexion/extension arc (86.6 +/- 25.4 deg pre-operatively vs. 102.3 +/- 24.9 deg post-operatively; $p = 0.016$) and grip strength measured by dynamometer (36.8 +/- 27.6 pre-operatively vs. 57.7 +/- 25.4 post-operatively; $p = 0.005$). No significant difference was observed between pre- and post-operative forearm rotation. Thirteen patients underwent a subsequent operation at mean 8.5 +/- 9.7 months from the index 90/90 fixation procedure: five patients had one or both plates removed due to symptomatic hardware, four patients underwent ulnar shortening osteotomies for persistent ulnar-sided wrist pain, two patients had tenolysis for tendon adhesions, two had revision carpal tunnel releases and two patients had irrigation and debridement with wound closure for persistent drainage, though no signs of overt infection were noted.

Conclusions: Orthogonal plating in conjunction with corrective osteotomy of distal radius malunions or deformities is an effective treatment option for added stability of the radial column and allows for improved motion, with acceptably low rate of revisions.

76. Age Matters

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Introduction: In addressing potential benefits of undergoing carpal tunnel release (CTR) surgery, several standardized tools have been developed. While valuable to the physician scientist, it may be more difficult for the individual patient to relate to these standardized measurement outcomes when assessing their decision for intervention. The goal of the current prospective study was to provide meaningful information to the physician who is regularly faced with the question, “how much will I get better if I decide to have surgery?”.

Materials and Methods: 890 consecutive patients undergoing open CTR by a single surgeon were prospectively enrolled. All patients agreed to participate and 91% of patients completed the study through final follow-up data at 6 months. Pre-operative frequency of daytime numbness, nighttime awakening, and duration of symptoms were recorded as part of the intake assessment tool in addition to height, weight, history of diabetes, history of thyroid disease and electrodiagnostic findings. After undergoing CTR, symptom frequency and severity was recorded at defined intervals including final report of symptoms at 6 months. Univariate and multivariate analysis was then performed.

Results: In patients up to age 50 there was a stable and high percentage of symptoms resolution with 70% of patients describing complete resolution of daytime numbness. At age 50 there was a break in the outcomes curve after which there was a linear .53% per year of age decline in daytime symptom resolution. 89% of patients reported complete resolution of nocturnal awakening at 6 months post-operatively. This also demonstrated a statistically significant linear decline after age 50. The study size and high study completion rate allowed age-stratified and whole-group multivariate analysis of factors including diabetes, thyroid disease, BMI, physical exam findings and duration of symptoms. No factor, besides age, was independently correlated with symptom resolution at 6 months.

Conclusions:

- Age at time of carpal tunnel surgery is a significant factor in predicting symptom resolution in patients with history, physical exam and electrodiagnostic evidence of carpal tunnel. For each year of age older than 50 at the time of surgery, there was a half percent decrease in resolution of daytime numbness post-operatively.
- All other factors including symptom duration, diabetes, thyroid disease, BMI, exam findings and EMG severity were non-predictive of symptom resolution.
- Univariate and multivariate analysis demonstrates that age is related to many of these other factors, however, age alone is the independent variable in predicting successful symptom resolution.
- Age matters.

77. Can a Stener Lesion be Created During Physical Examination?

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Introduction: The purpose of this study was to discover if a Stener lesion could be created by clinical examination in a thumb with nondisplaced transection of the distal components of the ulnar collateral ligament.

Materials and Methods: Six thawed fresh frozen hand and forearm specimens were used. Measurements of radial deviation of the metacarpophalangeal (MCP) joint were taken with the thumb in neutral rotation, pronation and supination, both in full extension and in 30 degrees of flexion of the MCP. Pronation and supination force was achieved through manual stress by one the investigators reproducing a clinical examination. Measurements were obtained using a hand-held goniometer.

The proper UCL and the accessory UCL were serially sectioned and radial deviation measurements were repeated. The adductor pollicis aponeurosis was initially left intact, and visual examination was performed to assess the presence of a Stener lesion. After measurements were obtained with both UCL components sectioned, an opening was made in the fascia connecting the proximal adductor tendon to the underlying joint capsule and thumb extensor mechanism. Testing was repeated to visualize if a Stener lesion could be created.

Results: A Stener lesion was not created by testing in neutral rotation or in pronation. After creating a defect in the fascia, a Stener lesion could be created in two thumbs. Clinical testing measurements were evaluated. Pronation provided more stability, and supination provided less stability, with one or both components cut, especially with testing at 30° of flexion. There was a statistically significant different in angulation when tested with the thumb supinated at 30 degrees of MCP joint flexion.

Conclusions: New findings in our study show that a Stener lesion can be created from a non-displaced complete UCL tear if the testing is done with the thumb supinated and flexed. Care needs to be taken during examination to prevent rotation of the thumb.

78. Surgical Treatment of Scaphoid Fractures - Does Delayed Treatment Affect Union Rate?

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Introduction: Diagnosis of scaphoid fractures is frequently delayed, which can alter the prognosis for union. Stable non-displaced fractures, if found late, take on average twice as long to heal in a cast as acute fractures. Unstable and displaced fractures have a lower likelihood of healing in a cast if treatment is belated. This has led to a trend in earlier operative fixation for subacute fractures. The purpose of this study was to determine if delayed surgical treatment of scaphoid fractures affects the union rate.

Materials & Methods: A retrospective chart and imaging review was conducted for adult patients who underwent operative scaphoid repair between 2000 and 2013. The time of presentation was divided into two categories: less than 6 weeks and 6 weeks or longer. Patients were typically evaluated post-operatively at 2 weeks, 6 weeks, and 3 months. Radiographs at follow-up visits were reviewed to determine fracture union. Analysis included comparing union rates with a group of patients who presented with acute scaphoid fractures.

Results: 94 patients matched the inclusion criteria (72 male, 22 female, mean age 30.7 ± 14.5 years). Among these patients, 82 (87.23%) of them had healed while 12 patients (12.77%) had nonunion. There was no association between the healing status and 1) gender ($p = 0.15$), 2) side of injury ($p = 0.19$), and 3) whether the injury is related to polytrauma ($p = 0.62$).

The healing status was significantly predicted by whether patients presented early or late. More specifically, the odds of having a scaphoid nonunion for a patient with delayed presentation were **5.13** times larger than the odds for a peer who underwent surgery less than 6 weeks of injury, with the **95% CI for the OR [1.05, 25.15]**. Tobacco use was not related to prediction of wrist healing status, OR = .30, 95% CI [.08, 1.09] and neither was fixation method, OR = .38, 95% CI [.04, 4.01]; nor approach, OR = 2.64, 95% CI [.74, 9.47].

Conclusions The results of this study demonstrate that there is suspicion for decreased union after surgical fixation of scaphoid fractures when diagnosis and treatment is delayed. It also provides evidence to emphasize early referral to specialists if any concern for scaphoid fracture is established.

79. Performance Outcomes After Metacarpal Fractures in National Basketball Association Players

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Introduction: To determine if players in the National Basketball Association (NBA) who sustain metacarpal fractures demonstrate decreased performance upon return to competition when compared with their performance before injury and that of their control-matched peers.

Methods: Data for 32 NBA players with metacarpal fractures incurred over 11 seasons (2002-2003 to 2012-2013) were obtained from injury reports, press releases, and player profiles (www.nba.com and www.basketballreference.com). Player age, body mass index (BMI), position, shooting hand, number of years in the league, and treatment (surgical vs non-surgical) were recorded. Individual season statistics for the two seasons immediately prior to injury and the two seasons after injury, including player efficiency rating (PER), were obtained. Thirty-two controls were identified, matched by player position, age, and performance statistics.

Results: Mean age at the time of injury was 27.3 years with an average player BMI of 24.37. Players had a mean 5.63 seasons of NBA experience prior to injury. There was no significant change in PER when pre-injury and post-injury performance was compared. Neither injury to their shooting hand nor operative management of the fracture led to a decrease in performance during the two seasons after injury. When compared with matched-controls, no significant decline in performance in PER the first season and second season after injury was found.

Conclusion: NBA players sustaining metacarpal fractures can reasonably expect to return to their pre-injury performance levels following appropriate treatment.

Table 1: Performance parameter comparison between NBA players who sustained metacarpal fractures of their shooting hand versus those who fractured their non-shooting hand.

Values expressed as mean difference between the pre-injury and post-injury metrics (standard deviation). Pre-injury refers to the season immediately prior to injury and post-injury refers to the season immediately after injury.

Parameter	Metacarpal Fracture of Shooting Hand (n = 15)	Metacarpal Fracture of Non-Shooting Hand (n = 17)	p Value
Minutes played per game	1.19 (8.15)	1.72 (8.34)	0.862
PER +/- 1 season	-0.88 (3.54)	0.65 (3.11)	0.231
PER +/- 2 seasons	-0.65 (4.33)	2.18 (3.01)	0.089
Points per game	-0.80 (1.93)	0.27 (2.66)	0.202
Steals per 36min played	-0.18 (0.33)	0.07 (0.40)	0.072
Rebounds per 36min played	-0.47 (1.50)	-0.08 (1.44)	0.480
Assists per 36min played	0.57 (1.17)	0.07 (1.00)	0.233
Blocks per 36 min played	0.12 (0.33)	0.01 (0.57)	0.508

Table 2: Performance parameter comparison between NBA players who underwent operative treatment for metacarpal fractures and those treated non-operatively.

Values expressed as mean difference between the pre-injury and post-injury metrics (standard deviation). Pre-injury refers to the season immediately prior to injury and post-injury refers to the season immediately after injury.

Parameter	Operative Treatment (n = 14)	Non-Operative Treatment (n = 18)	p Value
Minutes played per game	3.42 (7.97)	0.39 (8.23)	0.314
PER +/- 1 season	0.01 (2.56)	0.12 (3.75)	0.921
PER +/- 2 seasons	2.53 (3.58)	1.60 (3.09)	0.518
Points per game	-0.03 (2.23)	-0.20 (2.61)	0.854
Steals per 36min played	-0.06 (0.34)	0.00 (0.42)	0.671
Rebounds per 36min played	-0.56 (1.47)	-0.03 (1.44)	0.326
Assists per 36min played	0.50 (1.55)	0.11 (0.67)	0.422
Blocks per 36 min played	0.02 (0.23)	0.07 (0.60)	0.726

Table 3: Difference in performance variables for NBA players with metacarpal fractures based on pre-injury and post-injury seasons.

Values expressed as mean difference between the pre-injury and post-injury metrics (standard deviation). Pre-injury refers to the season immediately prior to injury and post-injury refers to the season immediately after injury.

Parameter	Fracture Cohort (n = 32)	p Value
Minutes played per game	1.52 (8.14)	0.526
PER (based on +/- 1 season)	0.08 (3.31)	0.949
PER (based on +/- 2 seasons)	1.66 (2.98)	0.295

Table 4: Demographic and pre-index season performance comparison between NBA players with metacarpal fractures and matched-controls.

Demographic data and performance values expressed as mean (standard deviation). The index season refers to the season in which a fracture cohort player sustained the metacarpal fracture and the representative season a control cohort player was age-matched to their corresponding fracture cohort player.

Parameter	Fracture Cohort (n = 32)	Control Cohort (n = 32)	p Value
Age (years)	27.31 (3.72)	27.31 (3.72)	1.000
Height (in)	78.91 (4.55)	78.25 (3.85)	0.541
BMI (kg/m ²)	24.53 (1.74)	24.25 (1.60)	0.501
Number of Pre-index Seasons	5.63 (3.15)	5.75 (3.76)	0.886
PER 1 season prior to index season	14.68 (4.93)	14.93 (3.10)	0.812
PER 2 seasons prior to index season	15.36 (3.84)	14.59 (3.04)	0.414
Minutes played per game season prior to index season	25.24 (9.22)	25.89 (8.99)	0.775
Position Played			1.000
Forward	13	13	
Guard	13	13	
Center	6	6	

Table 5: Performance comparison between NBA players with metacarpal fractures and matched-controls.

Performance values expressed as mean difference between the pre-index and post-index metrics (standard deviation). Pre-index refers to the season immediately prior to injury and post-index refers to the season immediately after injury.

Parameter	Fracture Cohort (n = 32)	Control Cohort (n = 32)	p Value
Minutes played per game	1.52 (8.13)	0.15 (8.27)	0.51
PER +/- 1 season	0.08 (3.31)	1.02 (3.41)	0.267
PER +/- 2 seasons	1.66 (2.98)	0.91 (3.65)	0.421
Points per game	-0.13 (2.44)	1.07 (3.46)	0.115
Steals per 36 min played	-0.02 (0.39)	0.08 (0.34)	0.310
Rebounds per 36 min played	-0.225 (1.45)	0.23 (1.28)	0.190
Assists per 36 min played	0.26 (1.08)	-0.08 (1.17)	0.234
Blocks per 36 min played	0.05 (0.49)	0.15 (0.46)	0.392

Table 6: Performance comparison between NBA players who underwent operative treatment of their metacarpal fractures and matched-controls.

Performance values expressed as mean difference between the pre-index and post-index metrics (standard deviation). Pre-index refers to the season immediately prior to injury and post-index refers to the season immediately after injury. Note, the control cohort presented in this table was matched to the operatively treated fracture cohort.

Parameter	Operatively Treated Fracture Cohort (n = 14)	Control Cohort (n = 14)	p Value
Minutes played per game	0.01 (2.56)	-0.99 (3.52)	0.450
PER +/- 1 season	1.89 (1.98)	0.91 (3.05)	0.409
PER +/- 2 seasons	1.78 (2.96)	-0.84 (2.62)	0.083
Points per game	-0.06 (0.23)	-0.07 (0.23)	0.944
Steals per 36min played	-0.56 (1.06)	0.35 (1.06)	0.097
Rebounds per 36min played	0.50 (1.15)	-0.05 (1.15)	0.334
Assists per 36min played	0.02 (0.23)	-0.03 (0.25)	0.679
Blocks per 36 min played	-0.03 (4.06)	0.28 (4.06)	0.816

80. Efficacy of Surgical Approaches for Treatment of Pyogenic Flexor Tenosynovitis

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Introduction: Pyogenic flexor tenosynovitis accounts for a large percentage of admissions to the hand service. Common surgical treatment of pyogenic flexor tenosynovitis includes wide exposure, irrigation, and debridement or minimally invasive catheter based irrigation. The efficacy of these surgical approaches and their indications have not been adequately studied. This study aimed to assess the efficacy of open versus catheter-based surgical treatment for pyogenic flexor tenosynovitis.

Methods: This is a retrospective chart review of patients who presented to our institution with pyogenic flexor tenosynovitis and underwent surgical treatment by Plastic Surgery or Orthopedic Surgery from 2004 to 2014. Data collected included duration of symptoms, initial surgical approach, length of hospitalization, duration of intravenous antibiotics, number of failed surgical treatments, and time to complete healing. Statistical analysis was performed comparing each primary endpoint between the two surgical approaches.

Results: 123 charts were reviewed including 54 cases of open surgical treatment and 69 cases of catheter-based treatment for pyogenic flexor tenosynovitis. The mean age was 40 years in catheter-based and 43 years in open treatment group. There was no significant difference between the groups in regards to sex, hand dominance, involved hand, high risk, duration of symptoms, length of hospital stay, or duration of IV antibiotics. Failure rate, defined in our study, as unanticipated return to the operating room for failure to clear infection after the initial operation, was 20.3% in the catheter group and 9.3% in the open group which was statistically significant. Average time to complete healing for patient with successful initial treatment was 40.7 days for the catheter-based group and 45.4 days for the open group.

Conclusions: Minimally invasive catheter based treatment for pyogenic flexor tenosynovitis offers several advantages compared to traditional wide open incision and debridement. Due to its inherent disadvantages in being limited exposure; however, not all cases of flexor tenosynovitis should be treated with this surgical approach. Further prospective randomized controlled studies are needed to compare the two surgical approaches and guide clinical management for efficient patient care without compromising outcome.

81. Is Insurance Status Associated with Development of Nonunion Following Scaphoid Fracture?

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Introduction: Scaphoid nonunion is a common precursor to radiocarpal arthrosis. A number of factors have been associated with development of scaphoid nonunion, including delayed diagnosis, inadequate initial management, proximal location, and carpal instability. We hypothesized that insurance status would also be a risk factor for development of scaphoid nonunion.

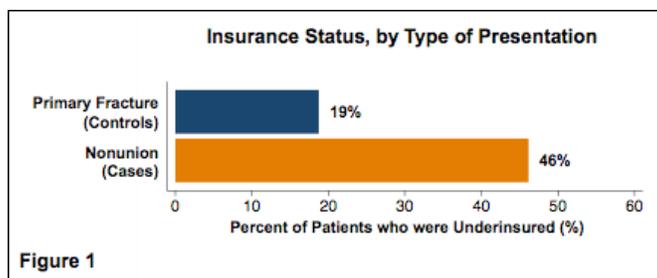
Materials & Methods: A case-control study was performed on patients who presented to a single surgeon at a tertiary referral center during 2006-2015. Cases were defined as patients presenting with nonunions. Controls were defined as patients presenting with primary fractures. Insurance status was characterized as underinsured if the patient lacked any type of insurance or if the patient was on Medicaid. Case/control status was tested for association with patient and fracture characteristics, including age, sex, fracture displacement, fracture location, laterality of fracture, and insurance status.

Results: A total of 71 patients were identified. Of these, 39 (55%) were nonunions (cases) and 32 (45%) were primary fractures (controls). Cases were more likely than controls to have had displaced fractures (72% versus 41%, $p=0.008$; Table 1). Cases were also more likely than controls to have fractures located at the proximal aspect (18% versus 0%) and less likely than controls to have fractures located at the distal aspect (0% versus 19%; $p<0.001$). Finally, cases were more likely than controls to be underinsured (46% versus 19%, odds ratio = 3.7, 95% confidence interval = 1.3-11.0, $p=0.015$, Figure 1).

Conclusion: Patients presenting with nonunions were more likely than patients presenting with primary fractures to be underinsured. This finding suggests that underinsurance is a risk factor for development of nonunion. Given that delay between fracture and intervention is a known risk factor for development of nonunion, it is likely that the association between nonunion and underinsurance is mediated through this delay. Increased attention should be turned to timely and standard of care management of primary fractures in those who lack adequate insurance.

Table 1. Characteristics of patients presenting with nonunions (cases) versus with primary fractures (controls).

	Primary fracture (controls; N=32)	Nonunion (cases; N=39)	P-value
Age (years ± standard deviation)	29.7±19.1	25.7±13.5	0.302
Sex			0.482
Male	25 (78%)	33 (85%)	
Female	7 (22%)	6 (15%)	
Fracture displacement			0.008
Nondisplaced	19 (59%)	11 (28%)	
Displaced	13 (41%)	28 (72%)	
Fracture location			<0.001
Proximal pole	0 (0%)	7 (18%)	
Mid/waist	26 (81%)	32 (82%)	
Distal pole	6 (19%)	0 (0%)	
Laterality			0.801
Left	13 (41%)	17 (44%)	
Right	19 (59%)	22 (56%)	
Insurance status			0.015
Adequately insured	26 (81%)	21 (54%)	
Underinsured	6 (19%)	18 (46%)	



82. What are the Indications for Transosseous Reinsertion of Ulnar Avulsion of the TFCC

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During the last years it has become evident, that the deep ulnar insertion of the TFCC is important for the stability of the distal radioulnar joint (DRUJ). A special type of avulsion involving only the deep part with the superficial fibers intact, which is difficult to detect during arthroscopy of the radiocarpal joint, does exist.

First results using an arthroscopically assisted technique of transosseous reinsertion of the deep part have been encouraging. An important step using this technique is a careful debridement of the fovea to cancellous bone making a groove to pull the TFCC in by two transosseous sutures. In the beginning the indication has been limited to moderate instability of the DRUJ. By expanding the indication to cases of more severe instability the results have been slightly less reliable.

The results using this technique in 80 patients (50 female, 30 male) from 2000 to 2009 are presented. In the first group of 39 patients operated until 2007 as well as in the other group of 41 patients operated from 2007 to 2009 pain on a numeric rating scale and function as measured by the MMW -Score and the DASH- Score improved significantly. The average DASH Score in the first group improved from 46 points pre - OP to 5 points post - OP, in the second group from 52 to 14 points pre – to post- OP.

Possibilities of conservative management are addressed.

Different factors which might be relevant for the result of operative treatment are discussed:

1. The degree of instability: moderate instability, which can be found only by careful examination using the ballotment test versus severe instability, which is clearly visible with positive piano key sign.
2. Quality of the ligamentous tissue employed for reattachment
3. Time from trauma to operation
4. Degenerative changes of the TFCC and ulnokarpal area e. g. ulna abutment
5. Residual malunion after distal radius fractures

Considering these points the questions are discussed, when to remain conservative, when to operate doing only a reinsertion of the TFCC, doing only a ulnar shortening or simultaneously doing both, or at least employing a ligamentoplasty technique.

83. A Novel Internal Joint Stabilizer for the Elbow

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Introduction: Treatment for elbow instability includes ligament repair/reconstruction and immobilization or external fixation. Consequently, the elbow is at risk for stiffness and instability. Ideally, after ligament repair/reconstruction patients should be able to immediately start range of motion. We describe and report findings in six patients treated with a novel internal joint stabilizer (NIJS).

Materials & Methods: This is a retrospective case series of six patients with posttraumatic instability treated with a NIJS created from bending and twisting a distal radius volar locking plate. The plate was fixed to the proximal ulna by locking screws and a partially threaded screw was placed through the axis of ulnohumeral rotation that allows for full range of motion.

Results: Six patients average age 44 (29-61) years, presented with posttraumatic elbow instability. Average follow-up was 15 (11-20) months. Two patients had acute, traumatic terrible triad elbow fracture dislocations. Three patients had chronic instability after the same injury and surgery at outside institutions. All elbows were clinically and radiographically stable intraoperatively and at last visit. During the index procedure, two elbows required tendon autograft for ligament reconstruction: one medial collateral ligament and one lateral ulnar collateral ligament. After the index procedure, the average arc range of motion was 67 ± 44 degrees. Patients underwent a staged arthroscopic contracture release without removal of the NIJS. After this release, the average arc range of motion was 129 ± 12 degrees. Two patients required a third procedure for removal of the NIJS due to hardware prominence. Three patients completed the DASH Questionnaire and the Mayo Elbow Performance Score (MEPS). The MEPS preoperatively were 30, 5, and 5. Postoperatively, the MEPS were 95, 85, and 50 respectively. The preoperative DASH scores were 94, 97, and 98. Postoperative DASH scores were 0, 6, and 73. Two patients achieved good or excellent results. One patient, who presented two years post injury after multiple surgeries continues to have poor overall scores although her function has improved greatly from baseline.

Discussion and Conclusion: Elbows with instability treated with an NIJS maintain stability and adequate range of motion at a mean follow up of 15 months. This device is easily made intraoperatively and permits immediate, postoperative range of motion while offering stability and protection of ligament repairs/reconstructions. Additional contracture release surgeries permit patients to quickly obtain full arc of motion without necessitating NIJS removal.



84. Does Attempted Reduction of Isolated Small Finger Metacarpal Neck Fractures Reduce the Measured Angular Deformity at Final Follow-up?

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Hypothesis: Current recommendations for the treatment of boxer's fractures are highly variable and reduction of these fractures is often performed in an effort to decrease the residual deformity upon healing. We hypothesize that attempted closed reduction of fifth metacarpal neck fractures does not result in decreased fracture angulation at final follow-up.

Methods: Retrospective chart review of all patients aged 18 and older managed for isolated boxer's fractures between 2004 and 2014. Subjects were separated into two groups; patients who underwent an attempted fracture reduction at the initial visit, and patients who did not undergo an attempted fracture reduction. The degree of fracture angulation was measured on oblique radiographs by two independent observers as per the procedures described by Lowdon et al. in which they determined the normal uninjured head/shaft angle at the fifth metacarpal neck as viewed on oblique radiographs to be approximately 26 degrees. To analyze interobserver reliability, the intraclass correlation coefficient was determined. Significance was measured using the paired t-test when comparing the initial, post-reduction, and final fracture angle measurements within the reduction and non-reduction groups, and the student's t-test was used when comparing the change in fracture angle between the two groups.

Results: Sixty-six patients meeting the inclusion criteria were managed for an isolated boxer's fracture during the study period. Twenty-three patients underwent attempted reduction and 43 patients did not. The average initial fracture angulation for all patients was 46.8 degrees. For patients who underwent an attempted fracture reduction at the initial visit there was a significant decrease in fracture angle following reduction (49.0 degrees vs. 39.6 degrees; $p < 0.05$), however the initial and last follow-up fracture angulation for patients undergoing a reduction attempt was not significantly different (49.0 degrees vs. 44.9 degrees; $p = 0.09$). For patients without a reduction attempt the average fracture angle was 45.5 degrees at the initial visit and 45.0 degrees at last follow-up ($p = 0.55$). When comparing the average change in fracture angle from the initial visit to final follow-up there was no difference between patients with and without a reduction attempt (4.1 degrees vs. 0.5 degrees; $p = 0.16$). Interobserver reliability was high for each set of radiographs measured.

Conclusion: The attempted reduction of fifth metacarpal neck fractures is not an effective means of achieving a significant improvement in fracture alignment upon healing. Therefore, closed reduction with pin fixation or open reduction with internal fixation should be utilized when maintenance of a significant reduction is desired.



Table 1: Average Fracture Angle Measurements

	Initial Radiographs	Reduction Radiographs	Final Radiographs
All Subjects (n=66)	46.8 (20-80)	N/A	45.0 (19-63)
Attempted Reduction (n=23)	49.0 (40-80)	39.6 (10-66)	44.9 (19-63)
No Reduction Attempt (n=43)	45.5 (20-60)	N/A	45.0 (25-61)

Data are presented as the mean in degrees with the range in parentheses

85. Functional and Radiological Outcome after Reduction-Association of the Scapholunate

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Purpose: Scapholunate dissociations being the most common type of carpal instability are challenging problems to address. Irreparable tears are common causes of mechanical wrist pain and many times the soft-tissue procedures are not able to reliably restore and preserve normal carpal alignment. The reduction-association of scapholunate (RASL) procedure to address patients without arthritis has been described previously with variable results. Thus, we sought to review the long-term outcome of patients undergoing RASL procedure to address chronic non-repairable scapholunate dissociation in our institution.

Method: A retrospective review of 12 patients undergoing RASL with an average of 24.06 months follow up (4-43 months) was performed. The visual analogue score (VAS), wrist range of motion, grip and pinch strength, postoperative complications, and radiographic parameters were recorded. Statistical analysis using SPSS 22.0 (IBMTM) was performed and $p < 0.05$ was considered statistically significant.

Results: All patients had Geissler stage III (2 patients; 16.7%) or stage IV (10 patients; 83.3%). The postoperative VAS has improved to 3.6 from 6.2. The grip and pinch strength had decreased to 28.6 ± 17.3 kg and 8.3 ± 6.4 kg from 34.8 ± 19.3 kg and 14.7 ± 12.2 kg, corresponding to 82.2% and 56.5% of preoperative values, respectively. The scapholunate (SL) interval at final follow up had decreased from 4.5 ± 2.1 mm to 2.67 ± 1.37 mm ($p = 0.007$). The SL angle was stable at final radiographs (53.97 ± 17.91 compared to 51.5 ± 13.9 at final follow up). Flexion and Extension had decreased from $63.28 \pm 12.92^\circ$ and $61.5^\circ \pm 14.2^\circ$ to $41.4^\circ \pm 20.46^\circ$ and $52.8^\circ \pm 17.3^\circ$, respectively ($p < 0.05$). Postoperative Disability of the Arm, Shoulder, and Hand scores were 15.3 ± 11.1 . All patients other than two had planned removal of their screws at average of 18.5 ± 15.2 months (2.4-43.2 months). Seven patients (58.3%) developed wrist arthritis (five SLAC stage II and three SLAC stage III). Two underwent partial wrist fusion. Age, sex, preoperative SL interval, SL angle, Geissler classification, preoperative range of motion or strengths did not affect the final outcomes.

Conclusion: RASL can substantially decrease the scapholunate diastasis; however it was not able to provide stability of the SL interval with many requiring secondary procedures for screw removal secondary to loosening, or partial wrist fusions. Majority of patients developed scapholunate advance collapse at final follow-up. Future long-term studies are recommended to assess and compare RASL to soft tissue reconstruction procedures to address chronic scapholunate instabilities.

86. Characteristics of Elbow Deformity After Mild Lateral Humeral Condylar Fracture

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Introduction: Lateral humeral condylar fractures heal with some residual elbow deformity, e.g., fishtail deformity, cubitus varus/valgus deformity. However, details of angulation or tilting angle of the lateral condyle after the fracture have not been evaluated so far. We hypothesized some angulation about cubitus varus as well as fishtail deformity at the distal end of humerus was arisen after the lateral condylar fractures.

Materials & Methods: Between 2005 and 2015, we treated 107 mild (Wadsworth types I and II) fractures of the lateral humeral condyle. 23 fractures were treated by open reduction and internal fixation (ORIF) with K-wires. 84 cases were treated with a long arm splint for 3 weeks. There were 81 male and 26 female patients. The average age of the patients at the time of the injury was 6.0 years (range, 2 to 11 years). The average follow-up period was 22.5 months (range, 7 to 62 months). The humerus-elbow-wrist angle (HEWA; angle between long axis of humeral shaft and midline of the forearm bones), Baumann's angle (BA; angle between long axis of humeral shaft and growth plate of lateral condyle on AP view), tilting angle (TA; angle between long axis of humeral shaft and axis of lateral condyle on lateral view), fishtail deformity were evaluated on the radiographs. The active ranges of motion (ROM) were clinically assessed at unaffected and affected sides at the final follow-up.

Results: No significant difference was detected between the sides in regard to BA, TA, or ROM at the final follow-up. However, HEWA showed more significant loss of correction ($p = 0.021$). There was 2.2 degrees at the affected side compared with 8.4 degrees at the unaffected side. Fishtail deformity was shown in 7 out of 107 cases. There were significant differences in HEWA or fishtail deformity at affected side between ORIF and splint groups.

Conclusions: Mild lateral humeral condylar fractures followed subclinical cubitus varus or fishtail deformity. There were significant lower HEWAs after the fractures. ORIF does not prevent the deformities. Overgrowths at the site of fracture can be developed at both of ORIF and splint groups. BA, TA, or ROM was not significantly changed compared with that at unaffected side. In summary, cubitus varus deformity after lateral humeral condylar fracture is not accompanied by a change of TA or BA, unlike the deformity after supracondylar or distal epiphyseal fracture of the humerus.

87. Smartphone Photography as a Tool to Measure Elbow Range of Motion

Megan Anne Conti Mica, MD; Eric Wagner, MD; Alex Shin, MD

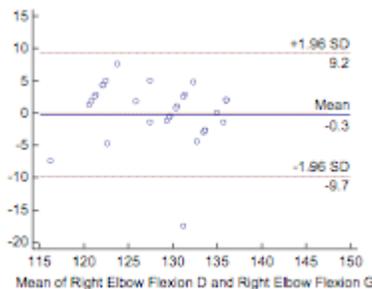
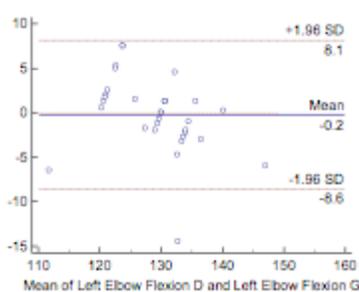
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Introduction: In the evolving digital world, the ability to utilize digital photography via smartphones could provide a very important tool to evaluate elbow range of motion (ROM) postoperatively. The purpose of this study was to determine if digital photography is as reliable as clinical goniometry in measuring elbow ROM.

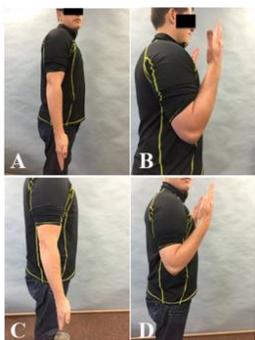
Methods: The validity and reliability of digital photography was examined using bilateral elbows of 32 normal participants (64 elbows). Digital photos were taken utilizing smartphones, measuring the angles at the extremes of flexion and extension with commercially available goniometry software. The photographs were obtained by another participant then by a researcher for comparison. Clinical goniometry measurements were taken after obtaining the digital photographs. Mean ROM, difference in ROM, then comparisons were performed utilizing T-test, a Bland Altman analysis, Pearson coefficient and interclass analysis of variance.

Results: 32 patients (64 elbows) were measured, there was minimal difference in the overall mean in total arc of motion. Comparing measurements ascertained by smartphone base digital photography and the goniometer, there was no statistical difference between the groups ($p < .9$ on the left (L) and $p < .88$ on the right (R)) Examining the interclass correlation, the concordance coefficient for the left was 0.828 and 0.740 on the right. The Pearson coefficient was 0.845 on the left and 0.757 on the right. The Bland-Altman plots demonstrated 30 of 32 digital measurements were within the 95% confidence interval of the clinical measurements on the left, and 31 of 32 measurements were within the 95% confidence interval on the right. The measurements from the photography taken by the volunteer compared to the researcher showed no significant difference ($p < .66$ (L) and $p < .46$ (R)). The left concordance and Pearson coefficients of 0.955 and 0.962, respectively, and were 0.941 and 0.957 on the right. When estimating interobserver reliability, the difference between researchers was negligible ($< 1^\circ$), with concordance coefficients of 0.793 (left) and 0.767 (right) and Pearson coefficients of 0.811 (left) and 0.780 (right). (Table 1)(Figure 1)

Summary: The use of smartphone digital photography to measure elbow range of motion proved to be a reliable, reproducible and accurate when compared to goniometric measurements. There was no significant difference as to whether a laymen or a medical expert took the photograph (Figure 2). These findings validate the concept of having patients send in digital photography of their elbow range of motion in clinical and research follow-up.



	Interclass concordance coefficients	Pearson coefficient
Goniometer vs. Digital	0.828 (L) 0.740 (R)	0.845 (L) 0.757 (R)
Participant vs. Researcher	0.955 (L) 0.941 (R)	0.962 (L) 0.957 (R)
Interobserver	0.793 (L) 0.767 (R)	0.811 (L) 0.780 (R)



88. The Distribution of Specialist Hand Surgeons Across the United States

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 Brigham and Women's Hospital. Harvard Medical School & Harvard T.H. Chan School of Public Health, Boston, MA

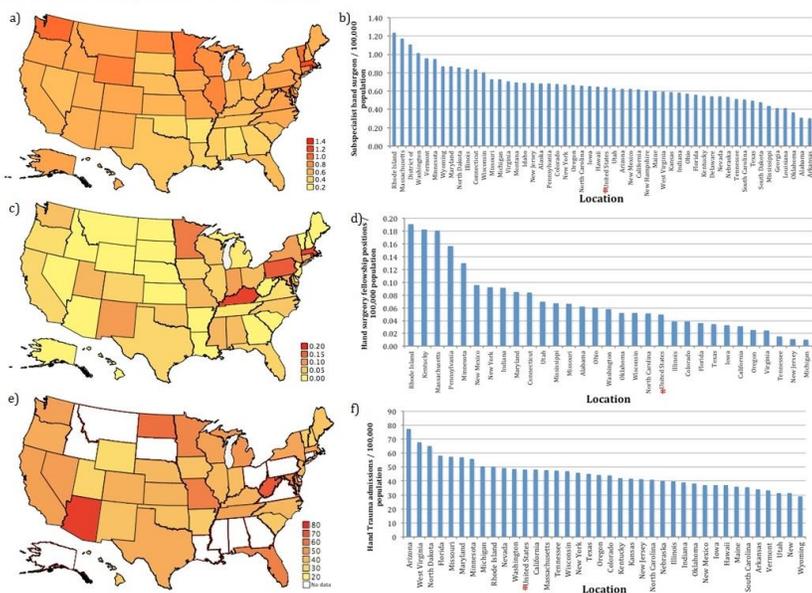
Background: Unequal access to hospital specialists for emergency care is an issue in the United States (US). The objective of this study was to describe the geographical distribution of surgeons with a Subspecialty Certificate in Surgery of the Hand (SCSH) and associated factors in the US.

Methods: Geographic distributions of surgeons holding a SCSH (2013) and hand surgery fellowship positions (2013) were identified from the American Board of Medical Specialties Database and the literature, respectively. State-level population (2012) and median per capita income (2009-2013) were ascertained using US census data. Variations in hand trauma admissions were determined using ICD-9-CM diagnosis codes in Healthcare Cost Utilization Project (HCUP) national/state inpatient databases (2012). Pearson correlations examined state-level associations between the density (per 100,000 population) of hand surgeons and fellowship positions, per capita income, and hand trauma admissions.

Results: Among 2,019 specialist hand surgeons identified; 72.1% were orthopedic (OS), 18.3% plastic (PS), and 9.6% general (GS) surgeons. There were 157 hand surgery fellowship positions nationwide; 82.8% run by OS, 12.1% PS, and 5.1% GS. There were 149,295 annual hand trauma admissions. The national hand surgeon density was 0.6 per 100,000 population and there were 47.6 hand trauma admissions per 100,000 population. At the state-level, the density of specialist hand surgeons and fellowship positions varied to a significantly greater extent than the density of hand trauma admissions (Figure 1). State-level variations in density correlated with the number of fellowship positions ($r^2=0.41$; $p=0.011$) and strongly with median per capita income ($r^2=0.66$; $p<0.001$). There was no correlation between density of subspecialist hand surgeons and the density of trauma-related admissions ($r^2=0.19$; $p=0.273$); and, per capita income and density of trauma-related admissions ($r^2=0.054$; $p=0.751$).

Conclusion: Specialist hand surgeons are distributed unevenly across the US. State-level analyses suggest that states with lower per-capita incomes may be particularly underserved, which may contribute to regional disparities in access to emergency hand trauma care.

Figure 1. Distribution by state of subspecialist hand surgeons per 100,000 population (a and b); hand surgery fellowship positions per 100,000 population (c and d); and hand trauma per 100,000 population in the United States (e and f).



89. Radiocarpal and Midcarpal Joint Malalignment with Distal Radius Malunion and Factors in Correction after Osteotomy

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Purpose: To evaluate the radiocarpal and midcarpal joints of the hand after treatment of distal radius malunion with corrective osteotomy and to evaluate if initial severity of injury and timing to osteotomy correlate with radiographic outcomes.

Methods: A retrospective review of all patients treated with a corrective osteotomy for distal radius dorsal bending malunion was performed. Data collected included patient demographics, pre-operative and post-operative radiographs, post-operative range of motion, and any complications or secondary procedures.

Results: Seventy-four patients were treated with a distal radius osteotomy from 2006-2015. Sixteen patients underwent osteotomy for other reasons and were not included. Fifty-nine fractures in 58 patients required osteotomy with plate fixation for a malunion subsequent to a distal radius bending fracture. Fourteen patients that had previous surgery, 5 that were skeletally immature, 6 that did not meet minimum follow-up requirements, 1 that had incomplete records, and 6 that had a volar bending distal radius fracture were excluded.

Twenty-seven radii in 26 patients with a mean age of 54 (19-79) years were included for final analysis. Mean follow-up of patients was 38 (12-170) weeks. Twenty-five were right-hand-dominant and 15 had an injury to the right arm. Twenty-five patients sustained injury via a fall.

The mean time from initial injury to distal radius corrective osteotomy was 49 (3-303) weeks. Mean time to union after corrective osteotomy was 15 (4-61) weeks. Mean correction of radial height 4.9 mm (3.9 mm to 8.8 mm), inclination 10.2° (11.6° to 21.8°), ulnar variance 2.3 mm (3.9 mm to 1.6 mm positive), and tilt 23.6° (23.1° dorsal to 0.47° volar) ($P < 0.0001$). Mean correction of radiolunate angle 9.3° (17.5° to 8.2°), radioscapoid angle 7.2° (48.1° to 55.3°), and effective radiolunate flexion (ERLF) 13.4° (20.9° to 7.5°) ($P < 0.0001$). Mean correction of capitulate angle 2.4° (9° to 11.4°) ($P < 0.11$).

Initial severity of injury correlated with ability to correct ERLF ($P = 0.04$). Time from initial injury to corrective osteotomy correlated with ability to correct the radiolunate angle ($P = 0.01$). It was more difficult to correct the radiolunate angle with increased time from injury to osteotomy, especially beyond 40 weeks ($P = 0.06$). Post-operative ERLF was more difficult to correct for the radiocarpal malalignment pattern versus the midcarpal pattern ($P = 0.001$).

Conclusions: Severity of initial fracture and time from injury to corrective osteotomy correlates with ability to correct radiographic parameters. Early correction of distal radius malunions is thus recommended, especially in patients with radiocarpal malalignment patterns.

90. Treatment of Acute Osteomyelitis Using Oral Antibiotics in the Pediatric Population

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Introduction: In our institution, we have treated a substantial number of pediatric patients with acute osteomyelitis of the hand. While treatment may initially require IV antibiotic therapy or minimal surgical debridement, the bulk of therapy in these patients has relied on oral antibiotic use. We present a retrospective cohort study to evaluate the modalities for treating osteomyelitis in the pediatric population.

Materials and Methods: A retrospective chart review was performed of all pediatric patients treated for acute osteomyelitis of the hand over a 4-year period. We collected pre-treatment information including demographic data (age, gender, and hand dominance), mechanism of injury, anatomical site, imaging studies, and relevant laboratory values. Outcomes data included type and duration of antibiotic therapy, need for surgical debridement, time to normalization of radiographic imaging, and length of follow-up. Resolution of osteomyelitis was confirmed with radiographic evidence of improved ossification at previous sites of lucency, accompanied by resolution of infection on clinical and laboratory exam.

Results: Twenty-eight pediatric patients with osteomyelitis (median age 8 years, range 1-16) involving 29 sites on the hand were included in the study. Male:female ratio was 1.6:1, and the most commonly involved digit was the index finger. In cases where cultures were available (39%), the most commonly identified pathogens were MRSA (n=4), mixed flora (n=4), MSSA (n=2), and coagulase negative Staphylococcus (n=2). 19 of 28 patients (68%) were treated with antibiotics alone, with a mean total duration of treatment of 6.4 weeks (SD=1.6). All patients in this group were successfully treated with either oral (PO) only (n=18) or PO+IV (n=1) antibiotics. 9 of 28 patients were treated with antibiotics and surgery, with a mean total duration of treatment of 10.1 weeks (SD=6.0). This group included pre-operative and post-operative (4/9), and post-operative only (5/9) antibiotic treatment.

Conclusion: In a majority of pediatric patients with acute osteomyelitis of the hand, the infection can be treated adequately with oral antibiotics only without surgery. Careful surveillance and clinical experience is necessary to identify patients who fail antibiotic-only treatment or who require surgical debridement at the time of diagnosis.

Concurrent AAHS/ASPN Scientific Abstract Session VI

91. Nerveregeneration after Reconstruction with Processed Human, Decellularized Allografts – First German Experiences in the Use of the Avance® Nerve Graft

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Introduction: Peripheral nerve injuries occur very often in traumatic injury. In cases in which direct, tension-free repair is not possible, processed human allografts promise good results in nerveregeneration. The morbidities in the donor side such as sensory loss, neuroma formation or prolonged operation time while using an autograft are not seen. Since November 2013 nerve allografts have been available in Germany.

Materials & Methods: In two German hand surgery departments 15 reconstructions of peripheral nerves were performed with Avance® nerve graft (Axo Gen, Inc., FL) by four experienced handsurgeons for different indications until June 2015. In two cases the median nerve was reconstructed up to a defect length of 7 cm. 13 digital nerves were repaired with an allograft. The static and moving 2PD, Semmes-Weinstein Monofilament Testing and in two cases nerve conduction velocity were measured. The follow-ups were performed 6-12 months after surgery depending on the expected axon regeneration time.

Results: During this conference the first German experiences in the use of the Avance® Nerve Graft will be presented. Overall meaningful recovery for all repairs was reported in over 85%. All patients with defect length up to 5 cm reported sensory improvement. No signs of rejection or infection were reported.

Conclusions: The processed nerve allografts seem to be safe and effective in sensory improvement up to a defect length of 5 cm. A sufficient sample size to perform a comparative analysis is still lacking. The outcomes so far represent actual results from literature. More clinical data need to be collected

92. The Effects of Carpal Tunnel Syndrome and its Release on Sleep

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Introduction: Carpal Tunnel Syndrome (CTS) is the most common compressive neuropathy of the upper extremity. Many patients with CTS complain of nocturnal symptoms, primarily waking with numbness and pain, which affects their sleep quality. Surgeons have recognized that patients' sleep complaints resolve after carpal tunnel release. The rate of nocturnal symptom resolution along with subjective and objective sleep quality outcomes have not been scrutinously evaluated.

Materials & Methods: A prospective study was conducted including 100 patients undergoing carpal tunnel release. The Pittsburg Sleep Quality Index (PSQI) and a carpal tunnel survey were administered preoperatively, 2 weeks postoperatively, and 6 months postoperatively to evaluate time to resolution of nocturnal symptoms and improvement of sleep quality.

Results: Nocturnal symptoms were present in 87% of patients and 50% of patients sought care because of these symptoms. Preoperative PSQI scores averaged 8, (>5 indicates poor sleep quality) with 80% of patients with a PSQI >5. The two week average PSQI had improved to a mean of 5, with 53% of patients with a PSQI score >5. Subjectively 60% of patients reported immediate resolution of their nocturnal symptoms and at two weeks postoperatively 93% reported complete resolution. At 6 months, only 1 patient complained of persistent numbness, however he reported improved sleep quality postoperatively.

Conclusions: Sleep quality is negatively affected by CTS. Most patients can expect resolution of their nocturnal symptoms in the immediate postoperative period, with 60% obtaining immediate resolution, and 93% obtaining resolution by two weeks postoperatively.

93. When Are Static/Moving Two Point Discrimination and Semmes-Weinstein Monofilament Tests Reliable in Children?

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Introduction: Objective sensory testing is a critical component of the physical examination, especially when lacerations occur. This is especially true in children as they may be unable to communicate that numbness is present. The purpose of this study was to determine at what age objective sensory tests can be reliably performed.

Materials and Methods: Normal, uninjured patients aged 2-17 years were enrolled in the study. Monofilament and static/moving two-point discrimination tests were performed bilaterally assessing the median, ulnar, and radial nerves. Three trials were performed for each test in each nerve distribution and the child was considered to be able to perform the test if they answered correctly all three times. Statistical analysis was performed utilizing univariable linear regression, Welch's t-test, and one-way ANOVA.

Results: 139 hands were tested utilizing monofilaments and 127 hands utilizing the two-point discrimination tests. The ulnar and median nerve distributions are more sensitive than the radial nerve during monofilament testing ($p < 0.0001$). For both static and moving two-point discrimination, children display the best discrimination ability in the median nerve distribution, followed by the ulnar nerve, and then the radial nerve ($p < 0.000001$). For all nerve distributions, children can better discriminate moving points compared to static points ($p < 0.0001$). Hand dominance generally does not affect monofilament or two-point discrimination scores, except for monofilament testing on the radial nerve, which indicates better sensitivity on the dominant hand ($p = 0.04$). All children 5 and older in our cohort were capable of performing the monofilament test in comparison to children ages 3 and 4 years (33% and 50%, respectively). The percentage of 5 year olds capable of testing is significantly greater than the percentage of 3 and 4 year olds combined ($p = 0.006$). All children 7 and older were capable of performing the two-point discrimination tests, which is a significantly greater percentage than for 6 year olds, of whom only 73% were capable ($p = 0.04$).

Conclusion: Objective testing of sensation can be reliably performed in children. Threshold testing utilizing a monofilament can be performed uniformly in children as young as 5 years, and sometimes as young as 3-4 years. Density testing utilizing two-point discrimination can be performed uniformly in children as young as 7 years with decreasing reliability in younger children.

94. Interhemispheric Plasticity in Response to Peripheral Nerve Injury

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Objective: Recovery from peripheral nerve injury in adults results in profound abnormalities in sensory perception despite improved microsurgical technique. It is of great importance to increase the understanding of cortical changes in response to peripheral nerve injury to improve the rehabilitation of these patients. We have previously described a transient increase in the contralateral primary somatosensory cortical activation area (fMRI) following nerve damage and repair (Hansson, Brismar 2003). In addition, there is growing evidence of interhemispheric plasticity. Studies of rats with a denervated paw show a transfer of activity from the contralateral to the ipsilateral hemisphere. Our objective was to study the ipsilateral cortical activation pattern in patients with median nerve injury.

Methods: Eleven healthy volunteers (mean age 24) and four patients (mean age 39) with median nerve injury at the wrist, repaired with epineural suture at least two years prior to the examination, were included in the study. 3T Functional MRI (fMRI) was used to measure brain activity while the median- and ulnar nerve innervated fingers of both hands respectively were given tactile stimulation by an air-driven brush. The static two point discrimination (2pd) test was used to evaluate sensory function. Data analysis was performed using SPM12 and the laterality index (LI) was calculated to evaluate redistribution of hemispheric dominance.

Results: All patients showed abnormal 2pd in the injured median nerve innervation area (2pd 8->15mm). The patients had normal 2pd (2pd <5mm) in the healthy hand and in the ulnar fingers of the injured hand. All healthy volunteers had normal 2pd. fMRI showed a higher degree of ipsilateral activity in the parietal lobe of the patients than in the group of healthy volunteers and there was a significant difference in LI between the two groups (mean patients 0.21, mean healthy volunteers 0.60, $p < 0.05$).

Conclusions: Our study showed that patients with median nerve injury have a lower LI, meaning a more bilateral activation pattern in the somatosensory cortex compared to a group of healthy individuals. Healthy individuals display a greater degree of contralateral dominance to unilateral median nerve stimulation. The relative increase in the ipsilateral contribution may compensate for the disorganised contralateral somatosensory cortex i.e. it may be a part of the interhemispheric plasticity in response to peripheral nerve injury.

95. Validity of the DASH Questionnaire in Upper Extremity Nerve Injury

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Introduction: Self-report questionnaires such as the Disabilities of the Arm, Shoulder and Hand (DASH) are used to assess upper extremity disability as a single construct score. The purpose of this study was to evaluate the validity of the factor structure and individual item completion of the DASH questionnaire in patients with upper extremity nerve injury.

Materials & Methods: Data from a previous cross-sectional study which evaluated patients with an upper extremity nerve injury were used. Institutional Research Ethics Board approval was obtained for secondary analyses of these data. Descriptive and factor analyses were performed.

Results: Patients (n = 242; 170 men, 72 women) with upper extremity nerve injury who completed the DASH were included in this study; diagnoses included distal nerve injury (n = 131) and brachial plexus or single proximal nerve injury (n = 111). Most patients (n = 227, 94%) completed all questionnaire items with a mean DASH score 47.3 ± 22 and mean QuickDASH score 50.4 ± 22 . Using mean item scores for replacement of missing items, the mean DASH score was 46.9 ± 22 . The highest scored item (indicating increased difficulty) was related to recreational activities and the lowest scored item was related to transportation needs.

The internal consistency was high for the DASH ($\alpha = 0.96$) and QuickDASH ($\alpha = 0.90$). For the DASH, a 3-factor structure had the highest variance (60.7%) and no overlap between factors. The 3-factor structure revealed domains related to: 1) light effort tasks; 2) greater effort tasks and; 3) limitations in social/work activities and pain. For the QuickDASH, a 2-factor structure had the highest variance (62%) and the item regarding limitation in activity was the only item with overlap between factors.

Conclusions: The DASH completion rate and internal consistency of all questionnaire items was high. In this sample of patients with nerve injury, the confirmatory factor analysis of the DASH and QuickDASH indicated a multi-factor construct. These multi-factor domains should be considered when utilizing the DASH as a single construct score of upper extremity disability.

96. Level I Evidence: How Much Volume of Local and How Long Should You Wait for an Effective Median Nerve Block?

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Introduction: There is little high level evidence to guide us to the ideal volume of local anesthesia we should inject to perform the ideal median nerve block at the wrist. There is a similar lack of high evidence for how long we should wait after injection before we operate. This study provides level I evidence in the comparison of 5cc vs. 10 cc of buffered lidocaine with epinephrine for the efficacy of median nerve blocks. It also provides a surprising answer to the question of how long does it take after injection for the nerve to reach peak anesthesia.

Materials & Methods: This was a prospective double-blinded randomized control trial in which each participant acted as his/her own control. All 14 volunteers underwent blinded randomized bilateral median nerve blocks of 5cc on one side and 10cc of 1% lidocaine HCl with 1:100,000 epinephrine and 1cc 8.4% bicarbonate in the other wrist. One surgeon performed all 28 blocks over 1 minute at 5mm proximal to the wrist crease and 5mm ulnar to the median nerve. He wrapped all wrists with bandages to blind injectees and data collectors. After injections, the blinded data collectors asked participants in 5-minute intervals whether the level of anesthesia had increased in the last 5 minutes. When the level had not increased for 15 consecutive minutes (3 consecutive negative responses), we determined the last increase to be the time to peak anesthesia. After each reported negative response, the data collectors poked the fingertips with a sterile 30-gauge needle to determine where pain sensation remained intact.

Results: Following the median nerve blocks, 7 participants in the 5cc group and 1 participants in the 10cc group failed to reach complete numbness to pin prick in the median nerve distribution. On average, participants reached maximal numbness at 117.86 minutes with 5 cc and required less time to reach maximal numbness with 10 cc (106.07 minutes). A statistically significant difference was demonstrated between the survival curves for 5 cc and 10 cc, $\chi^2(1) = 4.04$, $p < .05$.

Conclusions: We recommend using a minimum of 10 cc of 1% lidocaine HCl with 1:100,000 epinephrine and 1cc 8.4% bicarbonate for non-ultrasound guided wrist blocks. We also recommend waiting a minimum of 40-45 minutes after injecting the median block to allow nerve penetration by the local anesthetic before making an incision in that nerve distribution.

97. Demographics and Outcomes of Radial Tunnel Syndrome Release: A Single Surgeon's Experience of 97 Cases

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Introduction: Compression of the radial nerve in the proximal forearm can cause two distinct syndromes, termed radial tunnel syndrome (RTS) and posterior interosseous nerve (PIN) syndrome. While patients with PIN syndrome have distinct motor symptoms, radial tunnel syndrome is a clinical diagnosis of pain over the radial tunnel in the dorsal forearm. Radial tunnel syndrome can be a repetitive use injury or can occur idiopathically. Patients often have multiple medical comorbidities and concomitant upper extremity compression neuropathies. The treatment of RTS is surgical release of the radial nerve.

Materials and Methods: After IRB approval, a retrospective chart review was conducted of all patients undergoing radial tunnel release (RTR) between 2008-2014. Charts were analyzed for patient demographics, comorbidities, concomitant compression neuropathies, preoperative symptoms, nerve conduction study findings, anatomic sites of release, as well as surgical outcomes and complications.

Results: In total 81 patients (66 female, 15 male) who underwent 97 radial tunnel releases were included in the study. Overall 86% of patients undergoing RTR also underwent a concomitant nerve decompression surgery. Medical comorbidities occurring most often in RTS patients included depression/anxiety (60%), obesity (48%) and diabetes (17%). 53% of patients were smokers. Preoperatively 98% of patients had pain with palpation over the radial tunnel while only 15% had muscle weakness and 7% had numbness. Preoperative nerve conduction studies were positive for RTS in 22% of patients. The most common anatomic site of compression was the arcade of Frohse which required release in 96% of patients, while secondary sites of compression included the extensor carpi radialis brevis (68%) and the vascular leash of Henry (67%). We experienced a 12% complication rate, which included patients with persistent pain, dysethesias, and weakness. Our recurrence rate was 3% and 98% of patients went on to recover fully.

Conclusions: Careful physical examination is required to diagnose radial tunnel syndrome as patients often present with multiple compression neuropathies. The most reliable diagnostic sign is pain with palpation of the dorsal forearm overlying the radial tunnel. While the most conspicuous site of compression is the arcade of Frohse, it is necessary to release all sites of compression including the vascular leash of Henry, the ECRB, and the distal supinator. To our knowledge this is the largest reported single surgeon series in the literature demonstrating that radial tunnel release is a safe, effective procedure that can provide dramatic relief of symptoms for affected patients.

98. Tendon Transfers for Radial Nerve Palsy in Brachial Plexus Injuries

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Introduction: Every year more than 1 million people suffer from peripheral nerve injuries. In this study, we sought to determine the outcome of tendon transfers in our patient population with brachial plexus injury undergoing radial nerve palsy tendon transfers and to further compare the results with patients undergoing similar transfer for non-brachial plexus type injuries.

Methods: A retrospective chart review analysis of patients undergoing tendon transfers to address radial nerve deficits treated at our institution from September 2001 to October 2014 with minimum of six months follow up was performed. DASH scores were recorded in patients with brachial plexus injuries and compared with the postoperative values. A paired t-test analysis was performed between the preoperative DASH scores and postoperative values.

Results: A total of 71 patients underwent tendon transfers for radial nerve palsy. Forty two patients (59.2%) were due to brachial plexus injuries and 29 patients (40.8%) were secondary to isolated radial nerve palsies. Twenty seven patients had the traditional Starr transfers. Out of these 27 patients, 15 (55.6%) had palsy secondary to plexus injuries and the remaining 12 (44.4%) had palsies secondary to isolated radial nerve palsies. There were no complications in perioperative period. The DASH score for patients with brachial plexus injury improved from 51.5 ± 24.09 to 27.98 ± 10.95 ($p=0.0026$). All patients in group 1 achieved full finger extension, wrist extension of $42.5^\circ \pm 8.4^\circ$ from $-26.5^\circ \pm 6.8^\circ$, and a postoperative wrist flexion of $20.9^\circ \pm 6.9^\circ$. Patients in group 2 all achieved full finger extension other than two patients. The average postoperative wrist extension in this group was $42.5^\circ \pm 6.89^\circ$ and $50^\circ \pm 11.18^\circ$ of wrist flexion. All patients other than the two with suboptimal outcomes had British Medical Research Council System (BMRC) score of 5. The two patients in group 2 with weak extension had preoperative BMRC scores of 4. Not considering the two patients with BMRC scores of less than 5, there was no difference between the two groups in postoperative wrist extension ($p=0.80$), finger extension ($p=0.90$). However the wrist flexion at final follow up was significantly better in group 2 ($50^\circ \pm 11.18^\circ$) compared to group 1 ($20.9^\circ \pm 6.9^\circ$) ($p>0.05$).

Conclusion: Starr transfer is an effective method in patients with both isolated radial nerve and combined radial nerve palsies in brachial plexus patients. Both groups of patients achieved similar improvements provided they had similar muscle strength preoperatively. Only a subgroup of patients with BMRC of less than 5 had less than optimal range of motion after these transfers.

99. The Nerve of Henle: An Anatomic and Sympathetic Study of the Ulnar Innervation

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Introduction: Initially described by Bourguery, the Nerve of Henle(NH) is described as a branch of the ulnar nerve(UN) in the forearm. Studies on the NH are few. Balogh et al, reported the presence sympathetic nerve fibers, but only found the NH in less than 60% of cases. This study will present data on the presence of the nerve and frequency of sympathetic fibers in relation to the ulnar nerve and its branches in the forearm. The data will be analyzed to determine if the absence of the NH influences the number of the sympathetic fibers of the posterior interosseous nerve (PIN).

Materials and Methods: The UN was dissected in 15 fresh cadaveric forearms from the medial epicondyle to the pisiform under 3.5X magnification. The origin of the nerve of the NH was measured from the medial epicondyle and the pisiform. The NH was identified and dissected in its course with the ulnar artery(UA) through out the forearm. The ulnar innervation was divided in 3 segments. 2 cm nerve samples where obtained from each segment. An additional PIN sample was obtained in each specimen. The nerve samples were fixed in 10% formalin and paraffin embedded. The tissue was stained for sympathetic fibers using Tyrosine hydroxylase antibody (ABCAM catalog #ab62111) and anti-rabbit Ig-HRP (Life Technologies, cat# 65-6120). The number of sympathetic fibers per fascicle where quantified using Motic images Plus (www.motic.com).

Results: The NH was present in 100% of the cases. In 80% had a *typical* presentation (McCabe and Kleinert). In the *typical* presentation the NH divided from the UN on average 10.51 cm distal to the medial epicondyle and 15.88 proximal to the pisiform. In the *atypical* presentation the NH's origin was 17.6 cm distal to the medial epicondyle and 8.8 cm proximal to the pisiform. The dorsal sensory branch divided from the UN on average 7.78 cm proximal to the pisiform. Sympathetic nerve fibers were found in all nerve samples. However the NH had a higher number of sympathetic fibers per mm² of fascicle area, compared to the UN and Dorsal Sensory Nerve.

Conclusion: Data collected to date on freshly embalmed specimens revealed the presence of the Nerve of Henle in all forearms. A higher concentration of sympathetic nerve fibers and migration of the nerve into the ulnar artery suggests the NH may be a good target in the treatment of vasospastic disorders in the hand.

100. Predictors of Return to Work After Carpal Tunnel Release in a Workers' Compensation Population

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Purpose: Workers' compensation (WC) patients take longer to return to work after surgery than non-compensated patients for a variety of reasons. We hypothesized that psychosocial factors could be a predominant factor of time to return to work (RTW) in the WC population.

Methods: This retrospective review examined all WC patients who underwent open carpal tunnel release surgery over a five-year period by one of three fellowship-trained hand surgeons at a single institution. One-hundred and sixty wrists in 115 patients (70 unilateral, 45 bilateral) satisfied inclusion criteria. Demographic, medical and surgical data were obtained from patient records. Univariate and multivariate analyses were performed to assess predictors of RTW.

Results: Average age at the time of surgery was 49.5 +/- 8.7 years. Females comprised 61% of the patients. Eighty-nine percent of all patients returned back to full duty. Average return to work in all wrists was 12.53 weeks (SD +/- 11.29), compared to 3 weeks in historical controls. There was no significant difference in RTW between unilateral and bilateral surgery (p=0.60). Predictors of delayed RTW in multivariate analyses were depression with or without anxiety (p<0.001), chronic pain and/or fibromyalgia (p=0.003), history of opioid use (p=0.001), and pre-operative work status (full-duty versus not full-duty) (p<0.001). In a multivariate regression model, these factors accounted for 68% of the variance in RTW in the WC population. Neither pre-operative motor nerve conduction velocity nor job type was predictive of RTW.

Conclusions: In this study, patients with a WC claim took longer to return to work after carpal tunnel release surgery than patients without such a claim. A psychiatric diagnosis of depression and anxiety was the most predictive factor of RTW, followed by opioid use, chronic pain conditions, and pre-operative work status. These factors explained nearly 70% of the variation in RTW. Disease severity and job type did not necessarily delay RTW. The aforementioned factors can help prognosticate which WC patients will have a protracted post-operative recovery and perhaps target additional therapeutic intervention to facilitate a more rapid return to work and finally, to inform employers of which patients could be expected to return to work in delayed fashion.

101. Comparison of Ulnar Intrinsic Function following Supercharged End-to-Side AIN Transfer to Ulnar Motor Nerve: A Matched Cohort of Study High Ulnar Nerve Injury Patients

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Purpose: To review our experience with high ulnar nerve injury patients that underwent a supercharged end-to-side anterior interosseous to ulnar motor nerve (SETS) transfer along with conventional surgical treatment. These patients were compared with a matched cohort of patients that did not have a SETS transfer to assess return of intrinsic function

Methods: A retrospective matched-cohort study identified all patients that underwent the SETS transfer between 2000-2014 and a second cohort of ulnar nerve injury patients that did not have the transfer, matched based on age, level and mechanism of injury (transection, compressive). The primary outcome was ulnar intrinsic function improvement, which included evidence of reinnervation on clinical examination and/or EMG. Dichotomous and continuous variables were compared with Fisher's exact and Student T-tests, respectively.

Results: Thirteen SETS patients with appropriate follow-up were identified. The average age at surgery for SETS patients and the matched cohort was 35 (+/- 14) and 35 (+/- 16) years, respectively. Transection of the ulnar nerve at or above the proximal third of the forearm represented 50% of patients, the remainder of injuries were compressive in nature. All patients presented with clinical or electrodiagnostic evidence of ulnar intrinsic denervation. Eleven SETS transfer patients (84%) had clinical evidence of recovery of intrinsic function compared with five (38%) of patients that did not have the SETS transfer ($p < 0.05$). Following ulnar nerve transection, greater intrinsic function return was demonstrated following the SETS transfer (85% vs. 14%, $p = 0.03$), while compressive injuries had comparable intrinsic function return between groups (67%). Where documented, the average time to first evidence of recovery was 2.9 months (+/-1.4) and 3.8 months (+/- 4.5) with and without the SETS transfer, respectively ($p > 0.05$). Nerve transection repairs augmented with a SETS transfer demonstrated ulnar intrinsic recovery on average at 3.4 months (+/-1.7), while recovery occurred closer to a year or not at all with repair alone.

Conclusions: This matched cohort study demonstrates that the SETS transfer results in increased ulnar intrinsic reinnervation following high ulnar nerve injury. From both a frequency and timing of recovery standpoint, this finding appears to be most relevant among patients with transection compared to compressive type injuries.

102. Virally Mediated Brachial Plexus Neuritis: A Case Series and Surgical Algorithm

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Introduction: Virally mediated brachial plexus neuritis can cause acute flaccid paralysis of the upper extremity. It involves the proximal musculature with no sensory deficits. Recently, there has been an outbreak in our region with several patients referred to our center for treatment. Review of the literature and CDC reports suggest that late recovery is not expected. While there have been proposed surgical strategies, there is currently no established surgical algorithm. Following our early experience with the contralateral-C7 (cC7) transfer for brachial plexus birth palsy, we have developed a treatment algorithm for this patient population.

Materials & Methods: We retrospectively reviewed our database for all children diagnosed with suspected virally mediated brachial plexus neuritis over the past 12 months. Demographics, clinical course, Mallet scores, magnetic resonance imaging (MRIs), and electromyography (EMG) results were reviewed. A surgical algorithm was created based on our experience.

Results: We had a total of four patients in our series, all with a preceding viral-like upper respiratory illness. Average age at diagnosis was 4.5 years. All patients presented with a flaccid shoulder and elbow with shoulder subluxation and some useful hand and wrist function. A viral work-up was performed on three patients but no causative species was identified. Three patients had abnormal findings on cervical spine MRI. Because of poor recovery, all patients have been scheduled for surgery within 9 months of presentation. Our algorithm is based on early intervention in cases where there is no clinical improvement seen within 6-9 months from onset of paralysis. Nerve transfers for shoulder function include spinal accessory to suprascapular nerve. Radial to axillary nerve transfer is generally not available because of poor or absent triceps function. Nerve transfers for elbow function include intercostals to the musculocutaneous nerve or the cC7 to the upper trunk. Although our patients had some recovery of hand function, this was incomplete in all children, thus an Oberlin or double fascicular transfer is not recommended. In the case of severe hand deficit, we only recommend using cC7 to the lower trunk if the patient is under 2 years old.

Conclusions: Brachial neuritis must be considered in the differential of an acute, painless, flaccid extremity. Work up includes EMG, MRI, and viral serologies. Our proposed algorithm is based on early intervention after determining that adequate recovery is not likely, usually within 6-9 months post-injury.

103. Risk Factors for Revision After In-Situ Ulnar Nerve Decompression with or without Medial Epicondylectomy in Patients with Idiopathic Cubital Tunnel Syndrome

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Purpose: To compare revision rates after ulnar nerve in-situ decompression alone or with medial epicondylectomy (ME) for idiopathic cubital tunnel syndrome (CuTS) and identify patient risk factors for revision.

Methods: We conducted a retrospective chart review of all patients treated at one institution with an open in-situ ulnar nerve decompression with or without ME for idiopathic CuTS from 2001 through 2010. Revision rates were determined by identifying patients who underwent additional surgeries for recurrent or persistent ulnar nerve symptoms. Bivariate analysis was performed to determine which variables had a significant influence on the need for revision surgery and used to develop a binary logical regression model.

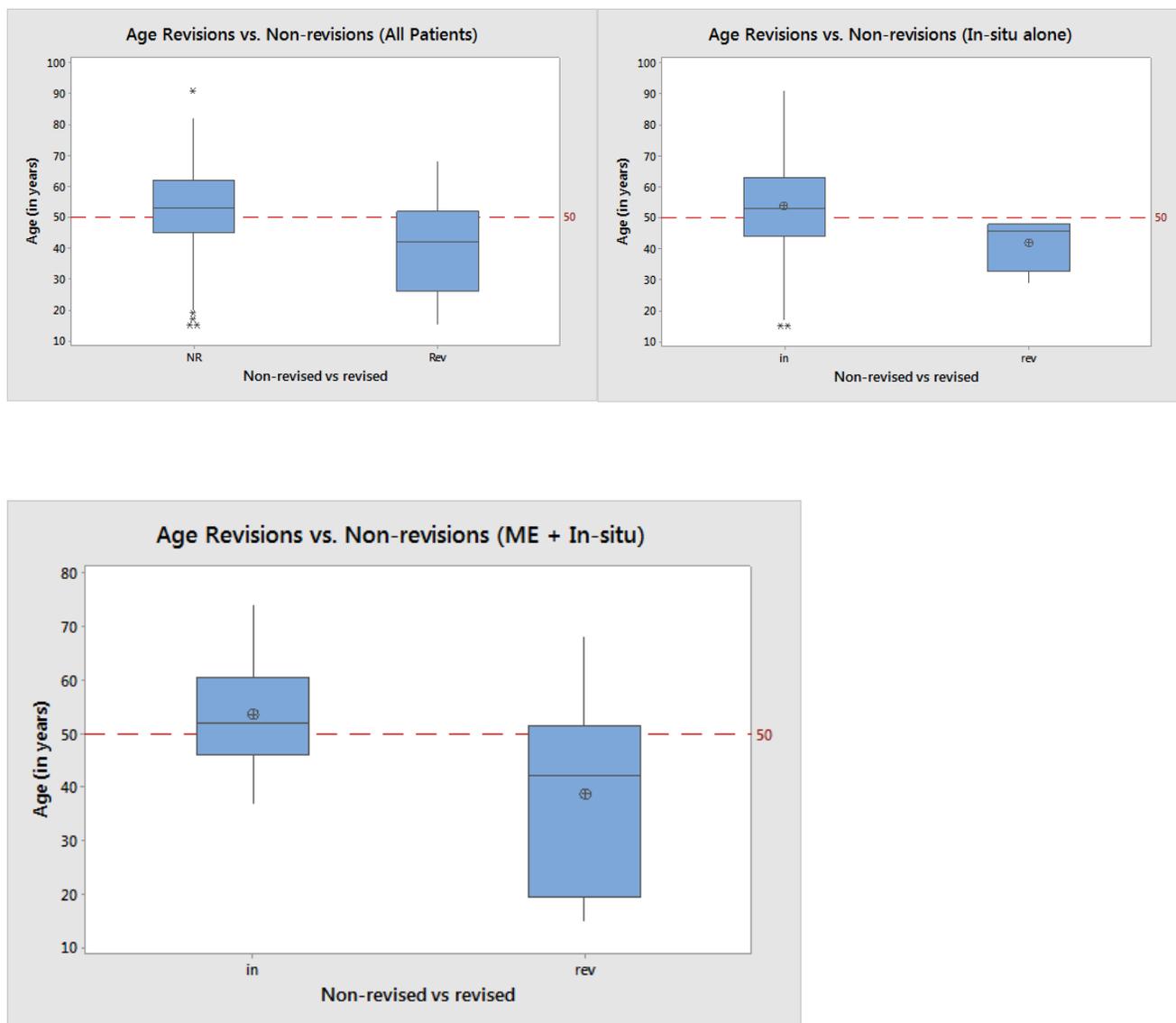
Results: Revision surgery was required in 4.4% (13 of 293) of all surgeries, with a significantly higher rate performed following in-situ ulnar nerve decompression with ME (15.5%) versus decompression alone (1.7%; $p < 0.0001$). Predictors of

revision surgery included initial age of less than 50 years (Relative Risk = 4.72; see Figures 1-3) and an associated Workers' Compensation claim (RR 2.51).

Conclusions: For patients with idiopathic cubital tunnel syndrome, the risk of revision surgery was significantly greater following in-situ decompression with ME versus decompression alone. Patients younger than 50 years of age are at a higher risk for needing revision, as are patients with associated Workers' Compensation claims. Patient specific factors, including gender, medical and smoking history, symptom(s) and McGowan staging do not appear to have any significant impact on the likelihood of revision cubital tunnel surgery.

Level of Evidence: Prognostic Level III

Figure 1: Age distribution of cases (patients requiring revision surgery) versus controls. Note the proportion of patients in both groups relative to the age of 50 years.



104. Recovering Extension Function Using a Modified Contralateral C7 Neurotization in BPAI Patients

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Backgrounds: In brachial plexus injuries with nerve root avulsions, the options for nerve reconstruction are limited. More and more emphasis has been put on the extension function of the paralyzed limb. Contralateral C7(CC7)transfer has gained international acceptance in treating brachial plexus avulsion injuries, however the results has not been satisfactory when neurotizing median nerve for flexion function recovery, mainly because of a long nerve regeneration process and irreversible muscle atrophy. It is of interest to know how it works when transferring to recover extension function, this report presents our results of extension function recovery using a new procedure involving contralateral C7 nerve transfer directly to the injured middle trunk in patients with BPAI.

Methods: Five male patients were treated from December 2012 to March 2014. Their ages ranged from 22 to 35 years (average, 28 yr). The interval between trauma and surgery ranged from 2 to 6 months(mean, 4 mo). All patients had total brachial plexus avulsion, which were confirmed during the operation. The contralateral C7 nerve root was sacrificed totally and its distal end was transferred to the proximal end of the middle trunk supraclavicularly behind the musclic sternocleidomastoideus, with the sural nerve grafting. One month aRecovery of elbow, wrist and finger extension was evaluated with use of the modified British Medical Research Council muscle grading system. Electromyography studies were also included.

Results: The length of the harvested contralateral C7 nerve root was 4.5 ± 0.5 cm. The nerve graft was 9.5 ± 2.5 cm long. Transient contralateral sensory symptoms were reported in all patients, weakness of elbow extension were also monitored in 2 patients, which recovered within 3 months postsurgery. The mean follow-up period (and standard deviation) was 24 ± 5 months (range, ninteen to twenty-nine months). Compound muscle action potentials(CMAP) could be recorded 9 ± 2 months postsurgery on the triceps long head, and 15 ± 4 months postsurgery on the ECRL. Motor function with a grade of M3+ or greater was attained in all the patients for elbow extension, 80% of the patients for wrist extension, 60% of the patients for finger and thumb extension.

Conclusion: This modified procedure of transferring contralateral C7 nerve root directly to the injured middle trunk favors successful nerve regeneration and functional recovery extension, which might provide new option for treatment of total BPAI.

105. Functional Outcomes of Nerve Grafting and Triple Nerve Transfers For Upper Trunk Obstetrical Brachial Plexus Injuries

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Purpose: Upper trunk obstetrical brachial plexus injury (OBPI) can cause profound shoulder and elbow dysfunction. Neuroma excision with interpositional sural nerve grafting is the current gold standard surgical treatment. However, distal nerve transfers have potential advantages including reduced distance to reinnervation, motor-to-motor coaptation, and shorter recovery time. The goal of this study was to compare the clinical outcomes and healthcare costs between nerve grafting and distal nerve transfers in children with upper trunk OBPI.

Methods: In this prospective cohort study, children who received the triple nerve transfer procedure (spinal accessory to suprascapular nerve, radial to axillary nerve and ulnar to musculocutaneous nerve) were evaluated with the Active movement scale (AMS) at regular intervals for a minimum of 2 years. Their outcomes were compared to children who underwent nerve graft reconstruction. To evaluate healthcare utilization, a direct cost analysis was also performed.

Results: Twelve patients who underwent nerve grafting were compared to 14 patients who underwent triple nerve transfers. Both groups had similar baseline characteristics and showed improved shoulder and elbow function following surgery, with the nerve transfer group displaying significantly better shoulder external rotation (AMS 2 years post-op= 4.3+0.5 (mean+SD) for transfers vs. 2.9+0.6 for graft, $p<0.05$), elbow flexion (6.1+0.5 for transfers vs. 5.5+0.2 for graft, $p<0.05$) and forearm supination (5.6+1.0 for transfers vs. 4.4+0.6 for graft, $p<0.05$) 2 years post-surgery. Nerve transfer donors had no loss of strength post-operatively. The operative time (2h19m+25m vs. 8h15m+1h31m), length of hospital stay (1.1+0.4 vs. 3.4+0.5 days) were significantly lower and overall cost was ~50% less in the nerve transfer group.

Conclusions: Triple nerve transfers for upper trunk OBPI is a feasible option with functional outcomes at least equivalent to that of traditional nerve grafting for shoulder flexion and abduction and faster recovery and better outcomes for shoulder external rotation, elbow flexion and forearm supination. Furthermore, nerve transfers are significantly less expensive than nerve graft reconstruction in this patient population.

106. Assessment of the Psychometric Properties of the Brachial Assessment Tool (BrAT) a New Patient-reported Outcome Measure for Adult Traumatic Brachial Plexus Injury

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Introduction: People with Brachial Plexus Injury (BPI) form a very heterogeneous group, with a wide spectrum of ability to use their affected limb. While a number of patient-reported outcome measures have been used to assess outcome following adult traumatic BPI, none has been psychometrically evaluated for this population. This paper outlines the development of a new BPI specific patient-reported outcome measure, the BrAT, based on the International Classification of Functioning, Disability and Health (ICF) definition of activity.

Method: The development of the BrAT followed a number of steps including:

- Item generation - involving adults with BPI and clinical experts
- Item reduction - using a consensus based approach
- Pilot testing of a 51 item pro-forma by adults with traumatic BPI
- Rasch analysis to determine content validity and unidimensionality. Items were removed in a series of iterations based on misfit to the model, local dependency, targeting to ability, importance and difficulty as determined by people with BPI.
- Classical test theory to determine the psychometric properties of test retest, construct validity and responsiveness

Results: One hundred and six adults with a traumatic BPI completed a 51-item BrAT proforma. Participants mean age was 40 years (range 18-82) and mean time post injury was 121 weeks (range 10 - 740 weeks). Injury severity ranged from pan plexus to those with infraclavicular injury. Items retained represented 16 of the 29 ICF Comprehensive Core Set for Hand Conditions (CCS-HC) activity categories.

Conclusion: Preliminary analysis shows the BrAT to be a unidimensional; targeted patient reported measure of the upper limb following adult traumatic BPI that assess a cross section of day-to-day activity as defined by the CCS-HC.

AAHS/ASP/ASRM Joint Outstanding Paper Session

AAHS #1 Proximal Interphalangeal Arthroplasty for Osteoarthritis; a Comparison of Silicone, Pyrocarbon and Surface Replacing Arthroplasty

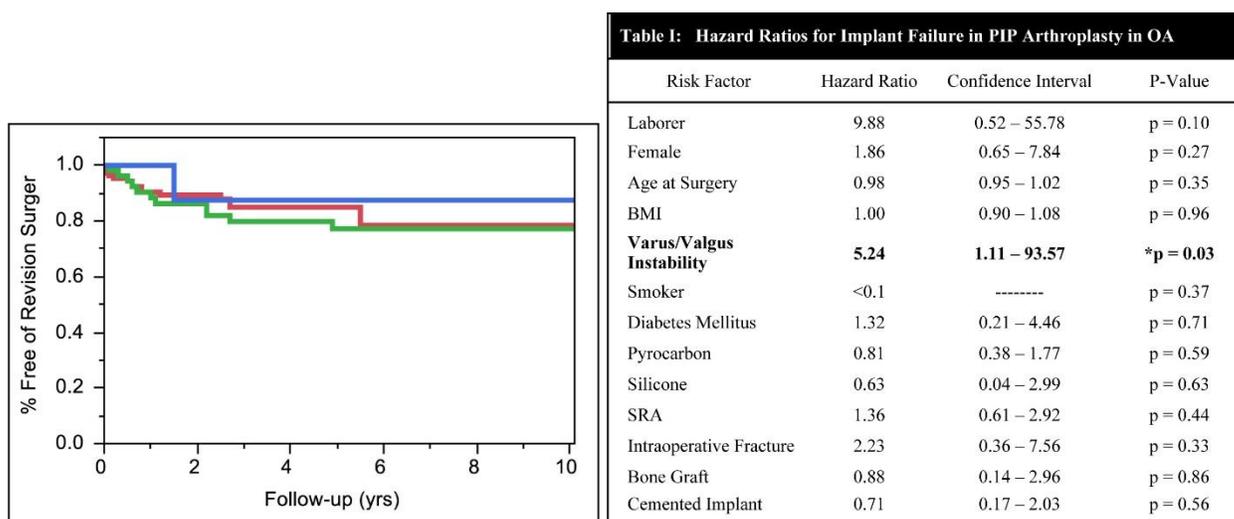
Eric Wagner, MD; John Weston, MD; Matthew Houdek, MD; Steven L. Moran, MD; Marco Rizzo, MD
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Hypothesis: Despite the increasing prevalence osteoarthritis (OA), the surgical treatment options for proximal interphalangeal (PIP) joint OA remain arthroplasty and arthrodesis. The purpose of this investigation was to evaluate the results PIP arthroplasty in patients with OA, comparing the outcomes of 3 different implants examining survivorship, patient-related factors and clinical outcomes.

Methods: We performed a review of 169 primary PIP arthroplasties by 8 surgeons in 103 patients for osteoarthritis at our institution from 1998 to 2012. The mean age at surgery was 65 years, BMI 26, with 51% involving the dominant extremity, 84% females, 5% smokers, 2% laborers, and 6% with diabetes mellitus (DM). Implants utilized included 108 pyrocarbon, 53 surface replacing arthroplasties (SRA), and 8 silicone. Patient characteristics were similar between the pyrocarbon, SRA, and silicone groups: age (65, 65, 66), females (84%, 83%, 88%), and DM (4%, 8%, 25%), respectively.

Results: There were 26 revision surgeries performed at a mean 1.3 years postoperatively. The 2, 5 and 10 year survival rates were 88%, 82%, and 80%, respectively. The 5-year survival rates for the pyrocarbon, SRA, and silicone implants were 85%, 77%, and 88% (p=0.69), respectively (**Figure 1, Table 1** silicone (blue), pyrocarbon (red) and SRA (green)). There were 8 intraoperative fractures that complicated the primary arthroplasty. Postoperatively, there were 2 periprosthetic fractures, 4 dislocations, 10 heterotopic ossification, and 7 infections. Silicone implants were associated with an increased infection rate (p=0.03). In those unrevised patients, at a mean 5.3 years (2-11) follow-up, pain levels improved from preoperatively to postoperatively (p<0.01). PIP total arc of motion did not significantly change from preoperatively (47°) to postoperatively (44°) (p=0.67). There also was no significant change in grip (p=0.34) or pinch strength (p=0.32). There were no significant differences according to implant type regarding pain (p=0.44), as well as grip or pinch strength (p>0.21). The total arc of PIP motion in the pyrocarbon, SRA, and silicone groups was 42°, 57°, and 42° (p=0.29), respectively.

Summary Points: Arthroplasty in the treatment of osteoarthritis with PIP provides predictable pain relief, with preservation of PIP motion, and reasonable medium-term implant survival There were no differences between 3 different types of implants with regards to survival, complications, pain relief or PIP motion.



AAHS #2 Are Surgeons Price-Sensitive? A Randomized Controlled Study on Factors Driving Surgeon Implant Selection

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Introduction: Surgical costs are under scrutiny by the public, and healthcare providers are increasingly being held accountable for containing medical costs. Surgical implants are often the largest component of total procedure cost, yet previous studies have revealed that surgeons' knowledge of implant prices is poor. Our study aims to (1) understand the drivers behind implant choice, and (2) assess whether educating surgeons about implant costs affects their implant choices.

Methods: We surveyed 226 orthopaedic surgeons across 6 continents. The survey presented 8 clinical cases of upper extremity fractures with history and radiographs, followed by surgical implant options. Surgeons were randomized to receive either a version that included each implant's average selling price ("price-aware" group), or a version without any mention of price ("price-naïve" group). Surgeons were asked to select a surgical implant and to rank factors affecting implant choice. Six cases offered different classes of implants (eg, Kirschner wires, volar locking plate, or spanning external fixator for a distal radius fracture). Two cases offered different implant models within the same class (eg, volar locking plate implants with fixed or variable angle screws). Descriptive statistics and univariate analyses were performed.

Results: Cost-effectiveness was ranked as the most important factor in implant selection by 19% of price-aware vs 6% of price-naïve respondents. Familiarity with the implant was the most common reason for choosing an implant in both groups (35 vs 46%). Implant selection was similar between price-aware and price-naïve surgeons for cases comparing different classes of implants ($p=0.26$), but it differed significantly for cases comparing models within the same implant class. When offered different models of distal radius volar locking plates, 25% of price-naïve surgeons selected the most expensive plate vs only 7% of price-aware surgeons ($p<0.001$). Similarly, the most expensive distal humerus plate was selected by 25% of price-naïve surgeons vs only 13% of price-aware surgeons ($p=0.01$). On average, price-aware surgeons selected implants that were 9-11% cheaper than price-naïve surgeons.

Conclusions: Although price does not alter a surgeon's decision to use a certain class of implant (eg, locking plate vs external fixator), price awareness does significantly influence surgeons' choice of a specific implant model within a general class (eg, volar locking plates with different features). Merely including prices with a list of implant options increases surgeons' perception that price is important. This implies that a real, untapped opportunity exists to reduce surgical expenditures simply by enhancing surgeons' awareness of implant costs.

ASPN #1 Electrical Stimulation Enhances Axon Regeneration And Functional Recovery Following Cubital Tunnel Surgery In Humans - A Randomized Controlled Trial

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Introduction: Brief post-surgical electrical stimulation (ES) enhances motor and sensory axonal regeneration in animal models following axotomy and crush injury. Although improved physiological outcomes with ES have also been shown in humans following carpal tunnel release, there was no significant difference in functional recovery compared to those who underwent surgery alone. The underlying reason is that thenar muscle strength only plays a small role in hand dexterity. In contrast, the ulnar nerve innervates the majority of hand muscles and makes a vital contribution to hand strength. In this study, we investigated the hypothesis that ES following cubital tunnel surgery in patients with severe ulnar neuropathy would result in better muscle reinnervation and functional recovery compared to surgery alone.

Methods: Patients with severe axonal loss from ulnar nerve compression at the elbow (McGowan grade III) were randomly assigned to the treatment or control group in a 2:1 ratio. Those in the control group received cubital tunnel surgery alone, while patients in the treatment group received 1 hour of 20Hz ES following surgery. Stimulation was delivered via two stainless electrodes placed adjacent to the ulnar nerve intraoperatively. Patients were followed yearly for 3 years. At each visit, axonal regeneration was quantified using motor unit number estimation (MUNE) and functional recovery was evaluated using grip strength and key pinch strength. Statistical analysis was performed using non-parametric tests, with statistical significance set at $p < 0.05$.

Results: Twenty-four patients were enrolled in the study: 8 received surgery alone and 16 received surgery and ES. There was no significant difference in demographics between the two groups. At three years following surgery, MUNE was significantly higher in the treatment group (182 ± 25 , mean \pm SE) compared to controls (93 ± 14 , $p < 0.05$). In terms of functional recovery, grip strength was significantly improved in the treatment group (43 ± 3 kg) at 3 years post-operatively compared to controls (39 ± 3 kg, $p < 0.05$). Key pinch strength was also significantly better in the treatment group (5.2 ± 0.5 kg) compared to controls (4.4 ± 0.8 kg, $p < 0.05$).

Conclusions: Our results suggest that post-surgical ES enhances axonal regeneration, muscle reinnervation and functional recovery following cubital tunnel surgery in humans. We propose that ES may be a clinically useful adjunct to surgical decompression for severe ulnar neuropathy, where functional recovery with conventional treatment is poor.

ASPN #2 Neurolysis Outcomes in Leprosy Patients: Prospective Study of Sensory and Motor Changes Following “Double CRUSH” Decompressions

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Purpose: Since the mid-1950s, for “leprosy,” retrospective case series reported outcomes following decompression of single anatomic sites of compression, and, more recently studies comparing efficacy of steroid versus single surgical site decompression have been reported. The purpose of the present study is to apply, prospectively, concepts developed from the successful treatment of diabetics with neuropathy and multiple sites of chronic nerve compression to patients with leprosy neuropathy.

Methods: Working in the indigenous leprosy area in Guayaquil, Ecuador, a protocol was developed that could be applied prospectively to a cohort of 20 patients with leprosy neuropathy who had been medically treated for infection but who had not received steroid treatment for neuropathy. An IRB-approved protocol was established in which each patient received surgery upon one leg and one arm simultaneously, with the goal of decompressing nerves at multiple anatomic sites of known compression, e.g., median and ulnar nerve at the wrist and elbow, peroneal nerve at knee and lower leg, tibial nerve at the four medial ankle tunnels. A total of 88 nerves were decompressed. Outcomes measured were changes in one and two-point static-touch, muscle strength change by manual motor testing and grip strength, comparison between operated and non operated side, and changes in score of validated “instruments” to measure quality of life, disability and pain (Rand36, Q Dash, and VAS, respectively). Outcome measurements were obtained by someone other than the surgeon at 12 and 24 months post-operatively.

Results: Eighteen of 20 patients returned for post-operative sensory evaluation. There were no post-operative complications. 72% of patients have sensory improvement demonstrated by PSSD testing. 65% of patients returned for motor testing, and 100% reported motor improvement and demonstrated motor testing score of > 4/5. 64% of decompressed nerves improved in sensibility: 78% of 18 median nerves, 53% of 17 ulnar nerves, 63% of 16 radial nerves, 71% of 14 common peroneal nerves, and 56% of 16 tibial nerves. Among those patients with completed outcome instruments, quality of life improved, hand disability decreased and pain scores decreased significantly, $p < .05$.

Conclusions: Application of double crush concept to decompression of multiple peripheral nerves is feasible in the population with leprosy neuropathy, and, in this small cohort of patients, gave improvement in sensory and motor function in the majority of patients.

ASRM #1 Correlation between Indocyanine Green (ICG) Patterns and Real-time Elastography Images in Lower Extremity Lymphedema Patients

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Background: ICG lymphography is becoming a popular modality with clear visualization of superficial lymph flows, but unfortunately not available in all institutions. Elastography is a relatively new ultrasonographic technique to evaluate tissue elasticity, which visualize fluid retention as a red region in lymphedema patients. The aim of this study was to evaluate the correlation between elastography and ICG lymphology.

Methods: The study was a retrospective observational study. Thirty-six legs in 18 patients with secondary lower extremities lymphedema (LEL) and 20 legs in 10 healthy volunteers were examined with elastography. Thirty-six legs in 18 secondary LEL patients were examined with ICG lymphography. Elastography was performed on both legs at the following 3 sites: medial thigh (MT), medial leg (ML), and anterior ankle (AA). The area of red region in the subcutaneous tissue demonstrated by elastography was calculated with Image J software (National Institute of Health, Bethesda, MD). ICG lymphography findings were classified into the following 4 patterns: linear (ICG1), splash (ICG2), stardust (ICG3), and diffuse (ICG4) patterns.

Results: As ICG pattern progressed, red region area was likely to increase. There was correlation between ICG patterns and red region area according to the severity at bilateral MT ($r_s = 0.665$), ML ($r_s = 0.623$), AA ($r_s = 0.668$). Significant difference was demonstrated among group means of red region area by analysis of variance (healthy vs. ICG1 vs. ICG2 vs. ICG3 vs. ICG4: 14.4 ± 5.7 vs. 15.1 ± 10.3 vs. 25.2 ± 6.2 vs. 30.8 ± 9.4 vs. 35.0 ± 2.8 ; $P < 0.001$).

Conclusions: The area of red region in the subcutaneous tissue shown with elastography, which represents fluid, increases with aggravation of lymphedema demonstrated by ICG patterns. Since elastography is performed by ultrasonography which is available in most institutions, elastography could be a useful alternative evaluation for lymphedema severity when ICG lymphography is not available.

Fig.1

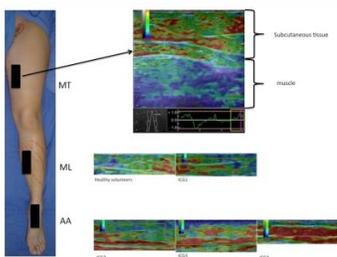
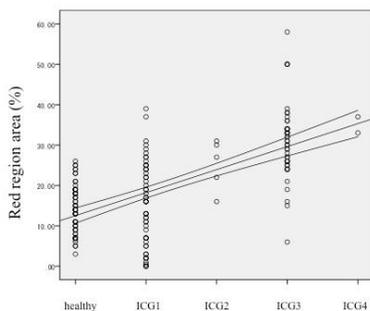


Fig.2



ASRM #2 A Single Institution Experience with 116 Consecutive Free-Flap and Pedicled Phalloplasties

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Introduction: Numerous phalloplasty techniques have been described for the female-to-male transgender population. Three of the most common flaps used today are the radial forearm flap, the anterolateral thigh flap, and the musculocutaneous latissimus dorsi flap. While there has been a large series of radial forearm flaps published in the past, there has not been a large series published in the United States. Also, no large series has been published comparing outcomes of these three flaps.

Materials and Methods: A retrospective review of all female-to-male phalloplasties from April 2013 to June 2015 was done. Complications including total flap loss, partial flap loss, flap take-back, hematomas, urethral strictures, fistulas, and meatal stenosis were reviewed. Outcomes measured included flap survival, sensory return, the ability to urinate through the phallus, and patient satisfaction.

Results: In total, 116 phalloplasties were performed at our institution. These included 71 radial forearm flaps (61%), 43 anterolateral thigh flaps (37%), and 2 musculocutaneous latissimus dorsi flaps (2%). There were no flap losses (0%) and four partial flap losses (3%). None of the partial losses exceeded 30% of the flap. Five flaps (4%) were re-explored for vascular compromise (three for arterial compromise, two for venous compromise) and all flaps were salvaged. The take-back rate for the first 16 flaps was 19%; the take-back rate for the remaining 100 flaps was 2%. The hematoma rate was 6% (n=7; three donor site hematomas, four groin hematomas). Of the 73 radial forearm flaps, the common femoral or superficial femoral artery were used as recipient vessels (end-to-side) in 71 cases (97%); a side branch was used in two cases (3%). The saphenous vein or a branch off the sapheno-femoral junction was used for all venous anastomoses. Urethral fistula and stenosis rates were 16% and 20% respectively. The rate of meatal stenosis was 5%. Of the radial forearm and ALT flaps that have reached an end-point of nerve regeneration, 99% have had return of tactile sensation; 85% have had return of erogenous sensation. There were no significant differences between the two groups. Neither latissimus musculocutaneous flap patients had return of tactile or erogenous sensation.

Conclusions: To our knowledge, this is the largest presented series of phalloplasties in the United States. This series shows that both the radial forearm and the anterolateral thigh flap (in select patients) can be viable options for an aesthetic and functional phalloplasty with good sensation and low fistula rates compared to other published series.