
PAPER 63
Clinical Paper Session 11: Trauma
Saturday, September 12 • 10:33—10:40 AM
Treatment, Surgical Technique, Basic Science, Hand and Wrist

Biomechanical Analysis of Reconstruction Methods for Peripheral Triangular Fibrocartilage Complex Tears
N/A - Not a clinical study

Amar Arun Patel, MD
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Loren Latta, PhD
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Hypothesis: Peripheral triangular fibrocartilage complex (TFCC) tears may be treated with several methods that have a high variability in outcomes. We believe that a combination of extensor capsulorrhaphy using the Herbert Sling (HS) and all-inside arthroscopic suture repair (SR) provides greater ulnocarpal joint (UCJ) and distal radioulnar joint (DRUJ) stability when compared to either procedure in isolation.

Methods: Twelve fresh-frozen, age-matched specimens intact from the proximal humerus to the fingertips were used for this study. Non-destructive testing was performed for each arm to assess the native UCJ and DRUJ stability. Each specimen was secured to a mechanical testing machine, and an actuator was then sinusoidally cycled dorsally and volarly until a neutral zone was displayed. The slope of the load-displacement curve at the maximal dorsal displacement was defined as “stiffness”.

An ulnar-sided, peripheral TFCC injury (Palmer 1b) was created in each specimen using an arthroscope, and mechanical testing was repeated. Six specimens were treated with SR, six were treated with HS, and testing was repeated. The six specimens treated with SR were then treated with HS, and testing was repeated again. Paired Student’s t-tests were used for statistical analysis within cohorts.

Results: All three reconstructions demonstrated improvements in UCJ and DRUJ stability. When combining all cohorts, there was a decrease in UCJ (P = 0.020) and DRUJ stiffness (P = 0.079) after the creation of a peripheral TFCC injury, and after repair there was a significant increase in UCJ (P = 0.0077) and DRUJ (P = 0.0056) stiffness. With regards to the UCJ stiffness, HS recovered 47% (P = 0.030), SR recovered 32% (P = 0.32), and SR+HS recovered 124% (P = 0.040) (Fig. 1). When comparing DRUJ stiffness, HS recovered 133% (P = 0.021), SR recovered 48% (P = 0.36) and SR+HS recovered 88% (P = 0.16) (Fig. 2).

Summary Points:
- All repair constructs increase both DRUJ and UCJ stability after the creation of a peripheral TFCC tear; however, SR demonstrates the least improvement with the most inconsistency in recovery.
- The addition of HS after SR provides greater improvement in both DRUJ and UCJ stability when compared to SR alone.

PAPER 64
Clinical Paper Session 12: Hand 2
Saturday, September 12 • 2:15—2:22 PM
Surgical Technique, Historical Information, Basic Science, Hand and Wrist, General Principles

Achieving the Optimal Epinephrine Effect with Local Anesthesia in Hand Surgery
Level 2 Evidence

Daniel Mckee, MD
Donald H. Lalonde, MD
Achilles Thoma, MD
Lisa Dickson, MD
Stuart Martin, MD

Hypothesis: In hand surgery, the optimal epinephrine effect from local anesthesia - producing maximal vasoconstriction and prime visualization- is achieved by waiting significantly longer than the traditionally quoted 7 minutes from the time of injection.1 2 3
Methods: In this prospective comparative study, healthy patients undergoing unilateral carpal tunnel surgery waited either 7 minutes versus 33 minutes - between the time of injection of 1% lidocaine with 1:100,000 epinephrine, and the time of incision. A standardized incision was made through dermis and into the subcutaneous tissue followed by exactly 60 seconds of measuring the quantity of blood loss using sterile micropipettes (Fig 1).

Results: There was a statistically significant reduction in the mean quantity of bleeding in the group that waited a mean of 33 minutes after injection and before incision compared to the group that waited only 7 minutes (95% Confidence intervals of 0.06 + -0.03 ml/cm of incision, compared to 0.17 + -0.08 ml/cm respectively) (P = 0.03).

Summary Points:

- No studies to date have measured micro quantities of intraoperative bleeding in order to directly quantify the effects of local anesthetic and epinephrine on vasoconstriction in humans; previous studies have instead used indirect measurements such as laser doppler and near-infrared spectroscopy (4,5).
- Waiting roughly 33 minutes for the optimal epinephrine effect will result in less intraoperative bleeding than the traditionally quoted 7 minutes for all hand surgery procedures using wide awake local anesthesia & no tourniquet (WALANT). Achieving the optimal epinephrine effect is crucial in order to obtain hemostasis and visualization in WALANT hand surgery (6). The benefits of WALANT hand surgery include: intraoperative active movement examinations, as well as a reduction in the cost, waste, and complications which are associated with the main operating room and general anesthesia (7,8).

PAPER 65

Clinical Paper Session 12: Hand 2
Saturday, September 12 • 2:22–2:29 PM
Treatment, Surgical Technique, Prognosis/Outcomes, Shoulder and Arm, Congenital and Pediatric Problems, Nerve, General Principles

Denervated SBRN versus Sural Nerve Grafting: A Case-Control Analysis of 75 Patients
Level 3 Evidence

Eric Wagner, MD
Nina Suh, MD
Michelle Kircher, BS
Robert Spinner, MD
Allen Bishop, MD, PhD
Alexander Y. Shin, MD

Salary: Mayo Clinic (Shin)
Royalty: Trimed (Shin)
Contracted Research: Bacterin International (Shin)

Hypothsis: The purpose of our study was to perform a case-control analysis of two sources of nerve graft; the denervated superficial branch of the radial nerve (SBRN) in patients with ipsilateral brachial plexus injuries and the normal sural nerve in nerve grafting to restore function in the upper extremity.

Methods: Over a 10-year period, 25 patients underwent SBRN nerve grafting with a denervated ipsilateral nerve for brachial plexus injuries, which were T matched 2:1 with 50 patients who underwent sural nerve grafting by age, gender, and BMI (Comparisons are summarized in Table 1).

Results: The average follow-up for the use of ipsilateral denervated SBRN patients was 2.5 years (1-7) and for the sural patients was 2.8 years (1-9). In the denervated SBRN group, only 3 (12%) of patients experienced grade III or higher muscle function. All 3 of these patients underwent a grafting of the spinal accessory to triceps motor branch. This is in contrast to 20 (36%) of the patients who underwent sural nerve grafting achieving grade III or higher muscle recovery (P < 0.01), including C5, C6, or upper trunk to axillary (n=5) and musculocutaneous (n=7); or spinal accessory to axillary (n=1), musculocutaneous (n=2), and triceps motor branch (n=5). Only 12% of the denervated SBRN group had EMG signs of muscle recovery compared to 61% of the sural nerve group (P < 0.01). Smoking had a negative impact on muscle recovery, decreasing the rate of grade III or higher recovery in the denervated SBRN group (P < 0.01) and the sural group (P = 0.01). No other factors had an impact on muscle recovery. Overall, patients in both groups had significant improvements in their preoperative to postoperative pain and DASH scores (P < 0.04).

Summary Points:

- Use of ipsilateral denervated SBRN nerve grafts in patients with brachial plexus injuries has significantly poorer outcomes when compared to sural nerve grafts in the treatment of brachial plexus injuries in a matched series.
- The use of this denervated nerve should be saved for situations when no other nerves grafts are available and should be avoided when sural nerve grafts are available.
- Patients also should be counseled on the risks of smoking when choosing to undergo brachial plexus reconstruction.

REFERENCES
Benign Hand Tumors Have a Clear Indication for Surgery According to the Patient-rated Outcome Measures

Michiro Yamamoto, MD
Takanobu Nishizuka, MD
Katsuyuki Iwatsuki, MD, PhD
Shigeru Kurimoto, MD
Hitoshi Hirata, MD

Hypothesis: The purpose of this study was to report the patient-rated outcome measures (PROMs) using the Hand20 questionnaire (Suzuki et al. JBJS 2010) before and after surgery of the benign upper limb tumor. We hypothesized that benign upper limb tumors have a clear indication for surgery according to the PROMs.

Methods: This study included 301 consecutive patients with histories of benign bone and soft tissue tumors of the upper limb, who had undergone surgery. There were 130 male and 171 female patients with a mean age of 45 years (range, 11–87 years). The diagnoses included 72 ganglions, 37 vascular tumors, 31 giant cell tumors of tendon sheath (GCTTS), 24 schwannomas, 21 lipomas, 21 enchondromas, 17 glomus tumors, 16 fibromas, 15 exostoses, 12 epidermoid cysts, 6 vascular leiomyomas, 6 granulomas, and 23 others.

The tumors were located on the finger in 147 cases, hand in 51 cases, wrist in 61 cases, forearm in 18 cases, elbow in 16 cases, and upper arm and axilla in 8 cases.

Tumor size was classified into 3 groups: smaller than 1 cm (45 cases), between 1 and 3 cm (157 cases), and larger than 3 cm (99 cases).

We have prospectively assessed PROMs using Hand20 questionnaire before and after surgery. The mean period from surgery to assessment was 21 months (range, 6–78 months).

Results: The mean Hand20 and pain scores significantly improved in patients with ganglions, vascular tumors, GCTTS, schwannomas, enchondromas and lipoma. The mean pain scores in patients with glomus tumors improved significantly, but the mean Hand20 scores improved without statistical significance. In patients with fibromas, exostoses, epidermoid cysts, granulomas, and vascular leiomyomas, both the mean Hand 20 and pain scores improved without statistical significance. (Figure 1 and 2).

Summary: Upper limb tumors are frequently encountered by hand surgeons. Surgery is indicated not only to sample the tumor tissue for definitive diagnosis, but also to improve the function and aesthetic outcome of the hand. According to the results of PROM, benign hand tumors located within the distal upper limb have a clear indication for surgery.

REFERENCE
Yuichiro Matsui, MD, PhD  
Shigeuki Kon, PhD  
Tadano Funakoshi, MD, PhD  
Tomoe Miyashita, Undergrad  
Tadashi Matsuda, PhD  
Norimasa Iwasaki, MD, PhD

Hypothesis: Although Dupuytren contracture is characterized by myofibroblast development and increased cytokines including transforming growth factor-β1 (TGF-β1) in the palmar fascia, the relationship between TGF-β1 and αv integrin, which is considered to be related to fibrosis, has not been clearly elucidated. We hypothesized that αv integrin would play an important role in the development of Dupuytren contracture.

Methods: Seven male patients whose mean age at the time of surgery was 70.7 years (range, 68 to 73) underwent partial fasciectomy as treatment for Dupuytren contracture. The nodule and cord were isolated from the palmar fascial tissues of the patients. Normal palmar fascia was obtained from seven control patients with carpal tunnel syndrome undergoing carpal tunnel release. These included two male and five female patients whose mean age at the time of surgery was 67.0 years (range, 36 to 88). Histologic and immunohistochemical analyses were performed to investigate the expression patterns of the myofibroblast and integrins. The expression of TGF-β1 and αv integrin and fibronectin in Dupuytren’s disease. Acta Histochem. 1995;97(3):229–233.

Results: The spreading and proliferation of fibroblasts were found in nodules, while few fibroblasts were detected in cords and normal palmar fascia. In immunohistochemical analysis, alpha-smooth-muscle-actin (α-SMA)-positive cells were mainly observed in nodules, while few α-SMA-positive cells were found in normal palmar fascia. Among the α-SMA and integrins, α-SMA and αv integrin were markedly induced and co-localized in nodules. Real-time PCR analysis confirmed that the expression of TGF-β1 and αv integrin genes were significantly increased in nodules, as compared to those in normal palmar fascia (P = 0.004 and P = 0.006, respectively) (Figure 1A and 1B).

Summary: Henderson et al. showed that αv integrin controls a core molecular pathway that regulates fibrosis in several organs. In fact, we found the expression of TGF-β1 and αv integrin were significantly increased in nodules, as compared to those in normal fascia. The obtained results indicate that αv integrin is a critical intrinsic regulator of the growth of fibrous tissue in Dupuytren contracture via regulating TGF-β1 expression. αv integrin will become a target molecule for the injection treatment of Dupuytren contracture.

REFERENCES

PAPER 68
Clinical Paper Session 12: Hand 2
Saturday, September 12 • 2:43–2:50 PM
Treatment, Prognosis/Outcomes, Hand and Wrist

The Effect of Corticosteroid Concentration on Glycemic Control in Patients with Diabetes Mellitus
Level 4 Evidence

Amar Arun Patel, MD  
Nikola Lekic, MD  
Megan E. Fleming, MD  
David Chen, MD  
Patrick W. Owens, MD  
Morad Askari, MD

Hypothesis: Corticosteroid injections have proven to be less effective in diabetic patients and may result in transient elevations in blood glucose levels. We hypothesize that triamcinolone injected at a concentration of 10 cc/mg (T-10) is equally successful, safer, and more cost-effective than triamcinolone 40 cc/mg (T-40).

Methods: All patients with type II diabetes mellitus and presenting to a university-based hand surgery clinic were prospectively enrolled in this study if they were candidates for a corticosteroid injection. Either T-10 or T-40 was administered based on surgeon preference. Fasting glucose the morning of injection, QuickDash scores prior to injection, and location of pain were recorded. Blood glucose was recorded the evening of the injection, and the fasting glucose was recorded each morning until it normalized.
back to the pre-injection levels. QuickDash and VAS scores were recorded at 6 weeks. Statistical analysis was represented with means, standard deviations, and student’s T-test for comparisons when needed.

**Results:** Patients in both cohorts on average had improvements in their QuickDash and VAS scores after the injection, and there was no significant variation between cohorts. There was a significant elevation in blood glucose regardless of injection type ($p = 0.005$). The T-10 group had an average maximum glucose elevation of 53 (41%) points, which returned to baseline at 21 hours. In contrast, T-40 had a maximum glucose of 50 (40%) points returning in 54 hours to baseline. The difference in time to return to baseline trended towards statistical significance ($p = 0.07$). No patients in either cohort had glucose elevations that required adjunct insulin treatment or evaluation in the emergency room. T-10 was also 4 times cheaper ($2.40 versus $9.96 per cc) than T-40 per injection administered.

**Summary Points:**

- Both T-10 and T-40 are effective in relieving painful symptoms and improving patient functionality after injection.
- A lower concentration of triamcinolone steroid is associated with a quicker return of blood glucose to baseline.
- T-10 is a cheaper and more cost-effective alternative to T-40.

**REFERENCES**


**Hypothesis:** Readmission following surgery is a quality metric tracked by many institutions including Government agencies. The incidence of readmission following outpatient hand and elbow surgery is not reported. We utilized the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database to determine the incidence of unplanned thirty-day readmission and the associated perioperative characteristics of patients undergoing outpatient hand and elbow surgery.

**Methods:** The ACS-NSQIP database was queried to identify patients undergoing outpatient hand and elbow surgery between 2011 and 2013. The patients were identified using 407 hand-and-elbow-specific CPT codes. NSQIP captures 30-day readmissions that take place at the index hospital as well as any other hospital. Patients who underwent any other concomitant surgery were excluded from the analysis. Patients who required an unplanned readmission were compared with those who were not readmitted. Preoperative patient characteristics, intraoperative variables, days from procedure to discharge, 30-day complication rates, and mortality were compared between the cohorts. An $a = 0.001$ denoted statistical significance due to the large sample size.

**Results:** A total of 18,174 outpatient hand and elbow surgeries were identified between 2011 and 2013 of which 202 patients (1.1%) required an unplanned readmission. Patients who required readmission were significantly older (58 vs. 50 yr; $p < 0.001$) and experienced longer operative time (80 vs. 64 mins; $p < 0.001$). Pre-operative comorbidities including diabetes, hypertension, COPD, renal dialysis, and steroid use were more prevalent in the readmitted cohort ($P < 0.001$). Likewise, ASA class 3 and 4 were more prevalent in the readmitted cohort ($P < 0.001$). These patients had greater incidences of postoperative morbidity and mortality ($P < 0.001$).

**Summary:** The incidence of unplanned readmission following outpatient hand and elbow surgery is low. Nevertheless, patients who were readmitted experienced higher incidences of postoperative complications and mortality. These data may be helpful for risk stratification of these patients prior to surgery.

Further analysis is warranted to characterize the independent predictors of readmission following outpatient hand and elbow surgery.

<p>| Table 1: Characteristics of Patients undergoing outpatient hand surgery: readmitted vs. non-readmitted |</p>
<table>
<thead>
<tr>
<th>Variable</th>
<th>Unplanned Readmission</th>
<th>No (n=1777)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), mean (SD)</td>
<td>57.97 (14.02)</td>
<td>59.31 (15.35)</td>
<td>0.076</td>
</tr>
<tr>
<td>Male (%)</td>
<td>45 (23.3)</td>
<td>50 (26.2)</td>
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<td>Race (%)</td>
<td>84 (44.0)</td>
<td>91 (45.6)</td>
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<td>Non-Hispanic White</td>
<td>135 (68.6)</td>
<td>148 (72.8)</td>
<td>0.257</td>
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<tr>
<td>Hispanic White</td>
<td>11 (6.4)</td>
<td>4 (2.0)</td>
<td>0.110</td>
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<td>Black</td>
<td>18 (9.5)</td>
<td>21 (10.5)</td>
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<td>Asian, Native Hawaiian or Other Hispanic</td>
<td>6 (3.0)</td>
<td>6 (3.0)</td>
<td>1.000</td>
</tr>
<tr>
<td>American Indian or Alaska Native</td>
<td>3 (1.6)</td>
<td>3 (1.5)</td>
<td>1.000</td>
</tr>
<tr>
<td>Other or Unknown</td>
<td>28 (13.4)</td>
<td>31 (15.6)</td>
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<td>BMI (kg/m2), mean (SD)</td>
<td>28.51 (3.79)</td>
<td>28.63 (3.71)</td>
<td>0.967</td>
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<td>Diabetes mellitus (%)</td>
<td>64 (31.5)</td>
<td>150 (73.7)</td>
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<tr>
<td>Hypertension (%)</td>
<td>80 (41.0)</td>
<td>134 (68.6)</td>
<td>0.001</td>
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<td>History of MI (%)</td>
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<td>0 (0.0)</td>
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<td>Previous cardiac surgery (%)</td>
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<td>19 (9.6)</td>
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<tr>
<td>Hypothyroidism (%)</td>
<td>10 (5.1)</td>
<td>19 (9.6)</td>
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<tr>
<td>Perioperative vascular disease (%)</td>
<td>3 (1.7)</td>
<td>7 (3.6)</td>
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<td>History of CVA (%)</td>
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<td>History of TIA (%)</td>
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<td>History of acute stroke (%)</td>
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<td>Renal failure (%)</td>
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<td>Renal transplant (%)</td>
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<td>Cancer (%)</td>
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<td>Malignant neoplasm (%)</td>
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<td>Open wound infection (%)</td>
<td>13 (6.4)</td>
<td>28 (13.4)</td>
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<td>Sore thumb (%)</td>
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<td>0 (0.0)</td>
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<td>Bleeding disorders (%)</td>
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<td>36 (18.2)</td>
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<td>Prophylactic Laboratory Values</td>
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**PAPER 69**

Clinical Paper Session 13: Elbow
Saturday, September 12 ● 2:15 – 2:22 PM
Prognosis/Outcomes, Hand and Wrist, Elbow and Forearm

Unplanned Readmissions Following Outpatient Hand and Elbow Surgery

N/A - Not a clinical study

Mohamed Noureldin, MD
Elizabeth B. Habermann, PhD
Daniel S. Ubl
Sanjeev Kakar, MD, MBA

Royalty: Skeletal Dynamics (Kakar)
Consulting Fee: Arthrex, Skeletal Dynamics (Kakar)
Contracted Research: Arthrex (Kakar)