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Annual Meeting Posters
Abstract Book IV - Pediatrics/Congenital and Nerve

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AM Poster 367: Neural Perforasomes of the Upper Extremity

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Elbow and Forearm;Nerve
N/A - not a clinical study
Grant support received from: Piedmont Orthopaedic Foundation, and a 2017 AFSH Residents and Fellows Fast Track Grant.

Steven M. Koehler, MD
Andrew P. Matson, MD
David S. Ruch, MD
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Hypothesis

In the setting of the rapid advancement of integumentary vascular knowledge, we hypothesized that the extrinsic blood supply to the major peripheral nerves of the upper extremity could be categorized into discrete perforasomes.

Methods

Total limb perfusion of the arterial system was performed with gelatin-red lead oxide in cadaveric upper limbs. The perforating vessels to the radial, median and ulnar nerves were identified, confirmed with fluoroscopy and dissected. Distances to major anatomic landmarks of the upper extremity were measured. Additional cadaveric limbs' nerves were dissected and source arteries were selectively cannulated and injected to assess specific contribution to extrinsic nerve perfusion. The perfusion of each nerve was then calculated among all specimens.

Results

The radial, median and ulnar nerve perforators were mapped (FIGURE 1). The perforasomes of radial, median and ulnar nerves were mapped (FIGURE 2). The distal portions of the superficial radial nerve (SRN) and the posterior interosseous nerve (PIN) demonstrated a lack of staining (FIGURE 2). Similarly, at the carpal tunnel and at the proximal 25% of the median nerve (corresponding to the pronator teres), the nerve lacked vascular staining (FIGURE 2). At Guyon's canal and the flexor carpi ulnaris (FCU) the ulnar nerve demonstrated a lack of vascular staining (FIGURE 2).

Summary Points

- Peripheral nerves can be divided into perforasomes with limited overlap.
- The extrinsic perfusion of peripheral nerves is highly segmental.
- Absent staining within the nerves correspond to common sites of compression: carpal tunnel and pronator teres for the median nerve, supinator for the PIN, and Guyon's canal and the FCU for the ulnar nerve.

This research was supported by a Basic Science Grant from the American Foundation for Surgery of the Hand.

AM Poster 368: Outcomes of Elbow Flexion Reconstruction in Patients Over 50 with Traumatic Brachial Plexus Injury

Category: Pediatrics/Congenital and Nerve

Elbow and Forearm;Shoulder and Arm;Nerve
Level 4 Evidence

Joshua A. Gillis, MD

Hypothesis

There is controversy regarding the effectiveness of brachial plexus reconstruction and eventual elbow function in older patients as it is reported that outcomes are poor. The aim of this study is to determine the outcomes of elbow function in patients over the age of 50 and factors related to success.

Methods

Fifty-eight patients over the age of 50 underwent nerve grafting, nerve transfers or free functioning muscle transfer (FFMT) to improve elbow function after a traumatic brachial injury. Patients were evaluated pre- and post-operatively for elbow flexion strength and range of motion (ROM), Disability of the Arm, Shoulder, and Hand (DASH) scores, pain, age bracket, gender, body mass index (BMI), delay from injury to operation, concomitant trauma, severity of trauma, and type of reconstruction.

Results

The average age was 57.8 years (range 50-72) with an average follow-up of 24.0 months. The average modified BMRC (British Medical Research Council) elbow flexion grade improved significantly from 0.26 to 2.63. Thirty-three patients (60%) achieved functional elbow flexion =M3 post-operatively, compared to zero patients pre-operatively. There was no correlation between age or age range stratification and modified BMRC grade of those obtaining useful elbow flexion. Active elbow ROM improved significantly post-operatively, with no effect of age or age range on elbow flexion motion. More patients achieved =M3 elbow flexion with nerve transfers (69%) compared to FFMT (43%). Those patients who had FFMT using the spinal accessory nerve had better BMRC scores than the intercostal nerve donors. Patients had worse outcomes with high energy/velocity injuries. The mean DASH score decreased from 51.5 to 49.6 post-operatively and the average pain score decreased from 5.0 to 4.3.

Summary Points

- Brachial plexus reconstruction for elbow function in patients over the age of 50 can yield useful elbow function and age should not be used as an exclusion criterion for nerve transfer, grafting or FFMT reconstruction.
- Nerve transfers are preferred in the older patient population, if possible.
- If performing FFMT reconstruction, the spinal accessory nerve donor provides better outcomes in those over 50 years old.

AM Poster 369: The Pedicled Adiposal Perforator Flaps for the Treatment or Prevention of the Adhesive Neuritis in Upper Extremities

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Elbow and Forearm;Nerve
Level 4 Evidence

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Hiroshi Yajima, MD, PhD
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Shohei Omokawa, MD, PhD
Yasuhito Tanaka, MD, PhD
Kenji Kawamura, MD, PhD

Hypothesis

Management of adhesive neuritis can be challenging due to the recurrent adhesion after neurolysis. Especially, in the distal part of the upper extremities, the subcutaneous tissue is thin and adhesion between the nerve and the skin or the fascia can often occur. To avoid the recurrent nerve adhesion, an additional preventive measure is needed after neurolysis. We think wrapping the affected nerves with the pedicled adiposal perforator flaps (PAPF) can be useful for the prevention of the recurrent adhesive neuritis.

Methods

Between 2007 and 2017, we treated 14 patients of peripheral neuritis using the PAPF for preventing adhesion. Mean age of the patients was 54 years. Site of neuritis was the common digital nerve in 3, the proper digital nerve in 2, the palmar cutaneous branch of the median nerve in 1, the superficial sensory branch of the radial nerve in 2, the median nerve at the carpal tunnel in 3, and the ulnar nerve at the elbow in 1. Etiology was injury or adhesion of the nerve after the primary surgery in 12, hourglass-like constriction of the common digital nerve in 1, neurilemmoma in the carpal tunnel in 1. In the cases of hourglass-like constriction of the nerve and the neurilemmoma, the PAPF was used for prevention of adhesion. We used 3 digital artery perforator adiposal flaps, 2 hypothenar fat pad flaps, 4 radial artery perforator adiposal flaps, 3 ulnar artery perforator adiposal flaps and 1 ulnar recurrent artery adiposal flap. Patients were reviewed after a mean follow-up of 10 months (range, 6 to 21 mo.). Postoperative (final follow-up) pain was measured with a visual analog scale and compared with preoperative values. Sensory recovery was evaluated using the moving 2PD and Semmes-Weinstein's monofilament test. Statistical analysis was performed by Wilcoxon signed-rank test. Values of $P < .01$ were

considered statistically significant. Subjective symptoms and complications were assessed at the final follow-up.

Results

In all cases, Tinel's sign and spontaneous pain were significantly improved from early postoperative period. Sensory disturbance of an area supplied by a nerve remained but, sensory recovery achieved. In three cases with a large flap, convex shape and slight congestive discoloring of skin at the donor site were recognized for a couple of months postoperatively; they were improved completely.

Summary Points

In the treatment or prevention of the adhesive neuritis, the PAPF can provide reliable pain relief, satisfactory subjective results can be expected without serious complications at short term follow-up.

Bibliography

1: Koshima I, Moriguchi T, Etoh H, Tsuda K, Tanaka H. The radial artery perforator-based adipofascial flap for dorsal hand coverage. Ann Plast Surg. 1995 Nov;35(5):474-9.
2: Uemura T, Takamatsu K, Okada M, Ikeda M, Nakamura H. Radial artery perforator adiposal flap for coverage of the scarred median nerve. J Plast Reconstr Aesthet Surg. 2013 Jul;66(7):1019-21.
3: Plancher KD, Idler RS, Lourie GM, Strickland JW. Recalcitrant carpal tunnel. The hypothenar fat pad flap. Hand Clin. 1996 May;12(2):337-49.
4: Becker C, Gilbert A. [The ulnar flap]. Handchir Mikrochir Plast Chir. 1988 Jul;20(4):180-3.

AM Poster 370: Arthroscopic Treatment of Triangular Fibrocartilage Complex Injuries in Pediatric and Adolescent Patients

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems
Level 4 Evidence

Samir K. Trehan, MD
Gregory Schimizzi, BS
Tony Shen, MD
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Hypothesis

We hypothesized that arthroscopic treatment of triangular fibrocartilage complex injuries in pediatric and adolescent patients yielded favorable outcomes and patient/parents satisfaction.

Methods

Forty-nine patients (50 wrists) under the age of 18 years underwent arthroscopic surgery for TFCC tears between 2003 and 2016 by a single surgeon. Medical records were retrospectively reviewed for demographic, clinical, imaging, and operative data. Patients were then contacted by telephone to determine current wrist pain, limitations, and function; inquire about subsequent treatment(s); assess patient/parent satisfaction; and to complete the QuickDASH (Disabilities of the Arm, Shoulder and Hand) and PRWE (Patient Rated Wrist Evaluation) questionnaires.

Results

Seventy-one percent of patients were female. Preoperatively, 45% had additional diagnoses and the mean QuickDASH score was 46. The mean age at surgery was 15 years and time from symptom onset was 45 weeks. Intraoperatively, the majority of TFCC tears were Palmer 1B, 70% were amenable to repair, and 36% had additional concurrent procedures performed. Telephone response rate was 61% and mean telephone follow-up was 66 months. In those patients who could not be reached by telephone, mean clinical follow-up was 19 months. Twenty-two percent of patients had subsequent surgery (most commonly ulnar shortening osteotomy) and 4% had complications. At final follow-up, mean QuickDASH score was 5.5, PRWE 11.0, patient and parent satisfaction 8.4 and 8.6, respectively. Multiple surgeries (two or more) was negatively correlated with final outcome and was the only patient variable significantly associated with all outcome measures.

Summary Points

- Arthroscopic treatment of TFCC tears in pediatric and adolescent patients yielded favorable outcomes and patient/parent satisfaction at mid-term follow-up.
- This patient population was heterogeneous as evidenced by the substantial incidence of additional diagnoses, as well as previous/concurrent/subsequent surgeries.
- Concurrent ulnar shortening osteotomy should be considered in patients with preoperative physical examination/MRI findings consistent with ulnocarpal impaction and positive ulnar variance.

Bibliography

1: Terry CL, Waters PM. Triangular fibrocartilage injuries in pediatric and adolescent patients. J Hand Surg Am. 1998;23(4):626-634.

2: Farr S, Zechmann U, Ganger R, Girsch W. Clinical experience with arthroscopically-assisted repair of peripheral triangular fibrocartilage complex tears in adolescents--technique and results. Int Orthop. 2015;39(8):1571-1577.

AM Poster 371: The Outcomes of Double Antegrade Pinning for Fixation of the Pediatric Proximal Phalangeal Neck Fractures

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems
Level 4 Evidence

Kuan-Jung Chen, MD
Hui-Kuang Huang, MD
Jung-Pan Wang, MD, PhD

Hypothesis

Antegrade double K-wires pinning is at least the same, if not better than retrograde crossed K-wires in the fixation of displaced pediatric proximal phalangeal neck fractures.

Methods

Eight patients (7 boys, 1 girl) were identified in our retrospective review (Table 1). The average age was 11.5 years (range, 5-16). All fractures were classified as type IIa with the Al-Qattan's classification. Two K-wires with diameter of 1.0 mm were inserted antegradely from the base of proximal phalanx, 1-2mm lateral to the joint, into the medullary canal, and stop at the fracture site. Reduction of the displaced distal fragment was performed with gentle traction and flexion of the PIP joint. Then, the two K-wires were introduced across the fracture site and stopped at the subchondral level of the distal fragment for fixation (Fig. 1). The patients were encouraged to perform active ROM exercise immediately within the protection of volar thermoplastic short-arm splint. Both the K-wires and the splint were removed at 4 weeks postoperatively.

Results

The average follow-up time was 13.8 months (range, 10-24). The X-ray films showed fracture union at 8 weeks postoperatively. All patients achieved excellent ROM recovery with a average TAM of 284° (range, 261-305°). No phalangeal head osteonecrosis, malunion, or traumatic joint disease was found in the latest radiographs. Complication of superficial pin-tract infection occurred in one patient at 3 weeks postoperatively, which was managed with removal of K wire and a course of oral antibiotics. The patient had excellent recovery of union with full ROM in 8 weeks.

Summary Points

Antegrade double intramedullary pinning spares the PIP joint. Therefore, it speeds postoperative ROM rehabilitation, and minimize soft tissue scarring and stiffness. It is a reliable method to achieve reduction, fracture healing and excellent functional recovery.

Bibliography

1: Al-Qattan MM, Al-Qattan AM. A review of phalangeal neck fractures in children. Injury. 2015;46(6):935-44

2: Al-Qattan MM. Phalangeal neck fractures in children. Classification and outcome in 66 cases. J Hand Surg Br 2001;26(2):112–21.

3: Matzon JL, Cornwall R. A stepwise algorithm for surgical treatment of type II displaced pediatric phalangeal neck fractures. J Hand Surg Am2014;39(3):467–73.

4: Karl J, White NJ, Strauch RJ. Percutaneous reduction and fixation of displaced phalangeal neck fractures in children. J Pediatr Orthop 2012;32:156–61.

5: Ataker Y, Uludag S, Ece SC, Gudemez E. Early active motion after rigid internal fixation of unstable extra-articular fractures of the proximal phalanx. J Hand Surg Eur Vol. 2017 Oct;42(8):803-809.

AM Poster 372: Sonographic Assessment of Medial Elbow Injuries in Junior Baseball Players: High Incidence of Avulsion Injury of the Humeral Medial Epicondyle

Category: Pediatrics/Congenital and Nerve

Elbow and Forearm
Level 4 Evidence

Katsuhisa Tanabe, MD, PhD

Hypothesis

We hypothesized that sonography was useful to assess medial elbow lesion of junior baseball players.

Methods

We conducted a survey of 164 junior baseball players with an age of 10 to 12 years-old. We investigated players' backgrounds, such as height, body weight, grade when starting elbow, baseball history, elbow pain in the past, elbow pain in the latest year, an experience of a pitcher, stretching after a play. We also examined physical findings, such as 3rd internal rotation of the shoulder, internal rotation of the hip, straight leg raising test, finger floor distance, moving valgus stress test and tenderness at the medial epicondyle. With sonography, we examined morphology of the medial collateral ligament and the medial epicondyle. We studied which background or physical finding is related with medial side lesions of throwing elbows diagnosed by ultrasonography. We used chi-square test for binominal items and student t-test for numerical items to study statistically significant relationship.

Results

The players had experience of baseball with 1-7 years (median; 4, mean; 4.4). Sixty players (37%) had medial elbow lesions in ultrasonography. The younger grade when starting baseball, experience of pitchers, experience of the elbow pain since starting baseball, experience of the elbow pain in the past or in the last year is related with medial side lesions of throwing elbows with statistical significance ($p=0.03$, 0.02, 0.01, respectively). For physical findings, positive moving valgus stress test was significantly related with the presence of medial elbow lesion in ultrasonography ($p=0.02$).

Summary Points

- More than one-third of junior baseball players have medial elbow injuries with sonographic assessment.
- The younger age when starting baseball, elbow pain in the past or in the last year, and positive moving valgus stress test is significantly related with medial side lesions of a throwing elbow.
- We should keep in mind high frequency of medial elbow lesions in junior baseball players and take care for prevention of elbow injuries of pitchers or players with elbow pain.

Bibliography

1: Dines, J. S., Frank, J. B., Akerman, M. & Yocum, L. A. Glenohumeral Internal Rotation Deficits in Baseball Players With Ulnar Collateral Ligament Insufficiency. Am. J. Sports Med. 37, 566–570 (2009).
2: Shanley E, Rauh MJ, Michener LA, Ellenbecker TS, Garrison JC, Thigpen CA. Shoulder Range of Motion Measures as Risk Factors for Shoulder and Elbow Injuries in High School Softball and Baseball Players. Am. J. Sports Med. 39, 1997-2006 (2011).
3: Shanley, E. et al. Preseason shoulder range of motion screening as a predictor of injury among youth and adolescent baseball pitchers. J. Shoulder Elb. Surg. 24, 1005–1013 (2015).
4: Garrison, J. C. et al. Shoulder Range of Motion Deficits in Baseball Players with an Ulnar Collateral Ligament Tear. Am. J. Sports Med. 40, 2597–2603 (2012).
5: Sakata, J., Nakamura, E., Suzukawa, M., Akaike, A. & Shimizu, K. Physical Risk Factors for a Medial Elbow Injury in Junior Baseball Players. Am. J. Sports Med. 45, 135–143 (2017).

AM Poster 373: Two Stations on the Road to Surgery for CP of the Upper Extremity

Category: Pediatrics/Congenital and Nerve

Congenital and Pediatric Problems
Level 4 Evidence

Shai Luria, MD
Marilyn Cohen-Holzer
Sharon Eylon, MD

Hypothesis

The importance of a team approach to the care of children with cerebral palsy has been discussed. The aim of this study was to analyze the methods with which we can improve the decision making process behind the surgical care of upper extremity deformity in these patients.

Methods

During the past 10 years, we have gradually implemented a treatment program including a multidisciplinary clinic, team meetings and video evaluation for improving the care of upper extremity deformity.

Results

Using this protocol, we have treated more than 40 patients and found that the adherence to the protocol changes the surgical plan in the majority of these patients.

Summary Points

- One station is the team meeting where the social, phsycological and neurological factors are taken into consideration as well as the coordination with other planned interventions (such as concurrent lower extremity surgery).
- The second station is the clinic, where a detailed examination is better performed, close interaction between the surgeon, therapist and patients are innate and the technical planning of intervention is under the best conditions.

AM Poster 375: Scapholunate Interval Variability in the Pediatric Population

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems
N/A - not a clinical study

Julie E. Johnson, MD
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Tiffany Kadow, MD
John Fowler, MD

Hypothesis

Children are frequently referred for consultation regarding a widened scapholunate (SL) joint on radiograph. We hypothesize that the SL interval varies by age and gender in the pediatric population.

Methods

Our radiology department generated a consecutive list of pediatric patients who had wrist radiographs between 1/1/12 and 12/31/14. Exclusion criteria for this study were: poor quality radiograph, not a true PA view, presence of trauma or anomaly, and duplicate patients. For radiographs that met inclusion, the distance between the scaphoid bone and the lunate bone were measured at the midpoint on the standard PA view. The SL interval was measured digitally and recorded in millimeters. Other data recorded included age in years and gender. The average and standard deviation for SL interval were calculated for each gender and age at time of radiograph.

Results

A total of 4,661 pediatric wrist radiographs were reviewed. Of those, 1,009 met inclusion criteria and the SL interval was measured. There were 550 males (55%) and 459 females (45%) included in the study. SL interval and standard deviation for age and gender are shown in Chart 1.

Summary Points

- Measureable SL interval decreases with age until skeletal maturity.
- There is more variation in SL interval with younger age.
- On average, SL interval in the pediatric population is narrower in girls than boys.
- SL interval > 2mm in a child less than age 10 does not infer injury of the SL ligament.

AM Poster 376: Socioeconomic Disparities in the Receipt of Brachial Plexus Surgery: A National Database Analysis

Category: Pediatrics/Congenital and Nerve

Shoulder and Arm;Nerve;General Principles
Level 4 Evidence

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Hypothesis

Brachial plexus injuries can have devastating effects on upper extremity function, with significant pain, psychosocial stress, and reduced quality of life. Understanding factors that influence the timing of brachial plexus surgery after injury is important in providing optimal patient care. The aim of this paper was to ascertain whether there are disparities in the receipt of brachial plexus repair in the emergent verses elective setting.

Methods

A retrospective analysis of the Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) Database sponsored by the Agency for Healthcare Research (AHRQ) was performed for the years 2009-2014. The NIS includes over 8 million discharge abstracts annually, approximating a 20% sample of all discharges, including non-federal, short-term, general, and other specialty hospitals, including public hospitals and academic institutions.

Results

Over the study period, 6,618 cases of emergent brachial plexus injury were retrieved. 660 cases of brachial plexus repair were seen in both the emergency and elective setting. There were significant differences in gender ($p<0.01$), age ($p<0.001$), ethnicity ($p<0.001$), insurance ($p<0.001$), and household income ($p<0.001$).
Of these, 153 (2.3%) underwent nerve repair surgery during the admission, whereas significant differences in those requiring supported discharge were identified. Including: more likely to be male (65.6% vs. 34.4%, $p<0.001$), more likely aged over 55 years (41.8% vs. 19.0%, and white (64.7% vs. 57.0%, with government-based insurance (45.6% vs. 29.4%, $p<0.001$).
We reviewed the patient and hospital-level characteristics of those undergoing surgery in the emergency setting compared with the elective setting. Patients undergoing repair in the elective setting were relatively more likely to be white (64.0% vs. 45.1%) males (90.3% vs 80.4%) with

private insurance (55.8% vs. 32.0%). Patients treated in the emergency setting were more likely to be African American (19.6 vs. 9.7%) and in the lowest income quartile (39.2% vs. 21.9%).

Summary Points

- There are socioeconomic disparities in the timing of brachial plexus surgery
- Socioeconomically-advantaged individuals with private insurance in the higher income quartiles, are more likely to undergo surgery in the elective setting
- Patients undergoing brachial plexus surgery in the acute setting are more likely to require supported discharge
- The disparities relate to timing, rather than receipt of nerve repair

AM Poster 377: The Interaction Between Mesenchymal Stem Cells, Neoangiogenesis and Functional Outcomes in Peripheral Nerve Repair

Category: Pediatrics/Congenital and Nerve

Shoulder and Arm;Nerve;Diseases and Disorders
N/A - not a clinical study

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Mana Saffari
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Hypothesis

We hypothesized that seeding undifferentiated MSCs (uMSCs) and MSCs differentiated into Schwann-like cells (dMSCs) on a processed nerve allograft leads to enhanced angiogenesis in vivo. As MSCs and angiogenesis can provide neurotrophic growth factors to a regenerating nerve, we expected this interaction to result in improved functional outcomes.

Methods

10mm Sciatic nerve grafts were obtained from Sprague-Dawley Rats, decellularized and transplanted back into Lewis rats. Before transplantation, 5 nerve allografts per group were seeded for 12 hours with either nothing (group II), 1 million uMSCs (group III) or 1 million MSCs differentiated into Schwann cell-like cells (group IV). These groups were compared with nerve autografts (group I). After 16 weeks, ITF and CMAP were obtained before sacrifice. The vasculature of the nerve was preserved by aortic infusion of Microfil (figure 1 and 2). The nerve grafts were dissected and with micro-CT and conventional photography, respectively the volume and the surface area of the vasculature were measured. All outcomes were measured as a ratio of the untreated side and were analyzed blindly. The outcomes were compared using one way ANOVA analysis and multiple comparisons tests with Tukey-Kramer correction. The Pearson's correlation test was used to find correlations.

Results

In group IV the highest vascular volume ratio and surface area ratio were found, followed by group I, group III and group II. One way ANOVA and multiple comparisons analysis showed significant differences between group IV and the other groups for the mean vascular surface area ratio ($p<0.001$). A linear relation was observed between the volume- and the surface area-measurements (Pearson Correlation = 0.509; $p=0.022$). The mean CMAP was the highest in group III, followed closely by group IV. The ITF results of group III and IV lagged the results of group I, but were better than those of group II. One way ANOVA showed no significant

difference between groups for both outcome measures. No significant correlations were found between the functional outcomes and the vascularity measurements.

Summary Points

- We found a significant correlation between the vascular surface area ratio and the volume ratio, suggesting that our methods can be used trustfully.
- This significant correlation supports our finding that both cell-types, particularly dMSCs, enhance vascular ingrowth in the nerve allograft.
- Our results suggest that the addition of both uMSCs and dMSCs leads to better results of the nerve allograft.
- The amount of vascular ingrowth seems to positively influence the functional outcome of nerve allografts.

AM Poster 378: Variation Amongst Surgeons When Treating Fifth Metacarpal Neck Fractures in the Pediatric Population

Category: Pediatrics/Congenital and Nerve

Hand and Wrist
N/A - not a clinical study

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Alexandria L. Case
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Joshua M. Abzug, MD

Hypothesis

Fifth metacarpal neck fractures are common fractures affecting the pediatric population. However, no true standardization exists regarding their treatment. The purpose of this study was to determine if variation exists amongst surgeons when treating pediatric fifth metacarpal neck fractures and determine the factors regarding this variation.

Methods

Twenty-five sets of images of pediatric fifth metacarpal neck fractures with posteroanterior (PA), oblique, and lateral views were identified. Fracture angulation measurements were made for the lateral and oblique views, with half of the images unmarked to assess the effect of marked angulation on treatment decision. Five images were duplicated to assess variability of a surgeon's treatment choice. Each set of images was accompanied by the patient's sex and age. The images, along with a brief demographic questionnaire, were evaluated by 25 surgeons. A mixed effect model with the respondent as the random effect to determine which patient/radiographic factors were most associated with a decision to operate was performed.

Results

Age and angulation were the factors found to be significantly associated with a surgeon's decision to operate. Patient sex, cast status, and whether or not an image was marked had no association with a surgeon's decision to operate. Greater than 50% of surgeons would choose surgical intervention if the degrees of angulation in the PA and lateral views were =55° and =47°, respectively. Age alone was also identified as an independent factor for choosing operative intervention, with 42% of surgeon's operating on patients aged 17 years.

Summary Points

- Treatment of fifth metacarpal neck fractures in the pediatric population is not standardized.
- Worsening angulation above approximately 50 degrees and increasing age (adolescence) appear to be the most important factors when deciding to operate.
- Improved treatment algorithms based on outcomes studies are needed to determine the optimal treatment.

AM Poster 379: Variation Amongst Surgeons when Diagnosing and Treating Pediatric Phalangeal Neck Fractures

Category: Pediatrics/Congenital and Nerve

Hand and Wrist
N/A - not a clinical study

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Hypothesis

Phalangeal neck fractures are a common hand injury seen predominantly in the pediatric population. The indications for operative treatment are currently evolving. The purpose of this study was to determine the variation among surgeons in their practice habits when treating phalangeal neck fractures.

Methods

Twenty-five surgeons reviewed sets of posteroanterior (PA), oblique, and lateral finger radiographs of children less than 17 years of age. In each clinical vignette, the age and gender of the patient was included. Surgeons were provided with 12 clinical vignettes and were queried if they would; (1) treat the fracture with immobilization or intervention? (2) if operative intervention was chosen, would a CRPP or ORIF be performed? (3) and when the next follow-up visit would be if the fracture was nonoperatively treated. Additionally, surgeons were asked to complete a demographic questionnaire detailing their training and personal background. The analysis was completed using a mixed effect model with the respondent as the random effect.

Results

This study found that for each advancing year of age, the surgeons are 13.8% more likely to treat the fracture surgically which was determined to be a linear relationship ($P < 0.0001$). Additional results showed that females were 38% more likely to be treated surgically ($P < 0.0006$). There is a trend that indicates female surgeons are more likely to operate than their male counterparts and that surgeons were less likely to operate if they worked in a dedicated children's hospital.

Summary Points

- There is no consensus or standardization for treatment of phalangeal neck fractures in the pediatric population.
- Age and gender are the primary patient characteristics in determining if a phalangeal neck fracture is surgically treated.
- In order to provide the best outcomes with the least patient morbidity, more standardized treatment algorithms are needed.

AM Poster 380: A 15-Year Analysis of Pediatric Flexor Tendon Repair Outcomes

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems;Practice Management
Level 4 Evidence

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Amisha Agarwal, MSc
Claudia Malic, MD, FRCS

Hypothesis

There are no factors predictive of pediatric outcomes after flexor tendon repairs; regardless, the majority of patients will have good outcomes.

Methods

We reviewed the repair of pediatric flexor tendon injuries over a 15-year period (2000-2015). Data collection consisted of patient demographics, injury characteristics, anesthetic choice (local versus general), repair technique, rehabilitation regimen, ASSH Total Active Motion (TAM) scores, and complications. Wilcoxon rank sum and Pearson's chi-squared tests were used to analyze continuous and categorical variables, respectively.

Results

The mean age of our patient cohort (n=109) was 12±5 years with a total of 235 flexor tendons treated (92 FDS, 126 FDP, and 17 FPL) in 162 fingers (17 thumb, 22 index, 37 long, 38 ring, 48 little finger). The majority of patients (91%) were treated within 30 days of injury (mean=2±6 days), but nine patients had a delayed presentation >30 days. The most common mechanism of injury was from a knife (n=45), in zone two (digits=82), and was associated with a digital nerve injury (n=58). The modified Kessler was the predominant repair technique (66 repairs) with 2% (5 repairs) post-operative ruptures.

Excellent and good outcomes were found in 93% of patients using TAM scores (excellent n=17, good n=62, fair n=4, poor=1, lost to follow-up=24). The mean time for immobilization was 6±7 weeks using a splint (n=91) or cast (n=13).

Patients under nine years old were more likely to receive general (n=61) over local anesthetic (n=43, p 0.05).

Summary Points

- Pediatric tendon injuries have good outcomes and the most common complication reported was stiffness.
- Patient demographics, time of repair, and rehabilitation protocol were not predictive of outcomes or complications.

Bibliography

1: Nietosvaara Y, Lindfors NC, Palmu S, Rautakorpi S, Ristaniemi N. Flexor tendon injuries in pediatric patients. J Hand Surg Am. 2007;32(10):1549-1557.
2: Cooper L, Khor W, Burr N, Sivakumar B. Flexor tendon repairs in children: Outcomes from a specialist tertiary centre. J Plast Reconstr Aesthet Surg. 2015;68(5):717-723.
3: Singer G, Zwetti T, Amann R, Castellani C, Till H, Schmidt B. Long-term outcome of paediatric flexor tendon injuries of the hand. J Plast Reconstr Aesthet Surg. 2017;70(7):908-913.
4: Sikora S, Lai M, Arneja JS. Pediatric flexor tendon injuries: A 10-year outcome analysis. Can J Plast Surg. 2013;21(3):181-185.
5: Grobbelaar AO, Hudson DA. Flexor tendon injuries in children. J Hand Surg Br. 1994;19(6):696-698.

AM Poster 381: Radial Longitudinal Deficiency: Severity Differences between American and Japanese Populations

Category: Pediatrics/Congenital and Nerve

Congenital and Pediatric Problems;Diseases and Disorders
Level 3 Evidence

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Hypothesis

There are few population studies describing the presentation of radial longitudinal deficiency (RLD). In a study comparing patients in the United States (US) and Japan, we hypothesized that there would be a similar presentation of forearm deficiency severity, thumb hypoplasia severity, and associated syndromes.

Methods

Patients with RLD were identified via a comprehensive chart review at two pediatric hospitals, one in the United States and one Japan, capturing patients presenting over 15 years. We assessed RLD and thumb hypoplasia severity via the Bayne and Klug and the modified Blauth classifications. The relationship between these two diagnoses, and the presence of common medical conditions were evaluated via Chi-Squared analysis and correlated via Kendall rank correlation coefficient.

Results

A total of 194 Japanese patients with 290 involved limbs were compared with 109 US patients with 174 involved limbs. The US patients had a significantly more severe RLD (Table 1), and higher bilaterality rates (63% versus 50%, respectively). The US population had more severe thumb hypoplasia (Table 2) as well. A total of 131 (68%) Japanese patients and 41 (38%) US patients had associated medical syndromes/associations, most frequently VACTERL (46 Japanese, 14 US), Holt-Oram (44 Japanese, 5 US), and thrombocytopenia absent radius syndrome (0 Japanese, 13 US). Correlation analysis showed increased RLD severity was associated with increased thumb hypoplasia severity in both populations.

Summary Points

- There are significant differences in the presentation of RLD between US and Japanese cohorts.
- US patients have higher severity of RLD and thumb hypoplasia, and are more likely to have bilateral involvement.
- Japanese patients are more likely to be affected by a medical syndrome/ association
- RLD and thumb hypoplasia severity were highly correlated for both US and Japan populations.

AM Poster 382: Adverse Childhood Experiences Do Not Influence Patient Reported Outcome Measures in Patients with Musculoskeletal Illness

Category: Pediatrics/Congenital and Nerve

Congenital and Pediatric Problems;Diseases and Disorders;General Principles
Level 4 Evidence

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Hypothesis

Adverse childhood experiences (ACEs) affect adult mental health, contributing on average to greater symptoms of depression and more frequent suicide attempts. This study tested the hypotheses that ACE scores do not independently account for variation in (1) PROMIS PF CAT scores and (2) pain intensity, and we tested inter-questionnaire correlations.

Methods

We prospectively enrolled 143 adult patients visiting one of seven participating orthopaedic surgeons. We recorded their demographics and measured ACEs (using a 10-item binary questionnaire that measures physical, emotional and sexual abuse in the first 18 years of life), magnitude of physical limitations, pain intensity, symptoms of depression, catastrophic thinking, and health anxiety. We created two backwards stepwise regression models to identify independent factors associated with (1) the magnitude of physical limitations and (2) pain intensity.

Results

Greater physical limitations were independently associated with greater health anxiety, greater catastrophic thinking, being unemployed, presenting with other symptoms than arm/shoulder, older age, greater BMI, and completing 2-years of college, (Adjusted $R2 = 0.55$). Greater pain intensity was independently associated with female sex, and less health anxiety (Adjusted $R2 = 0.34$).

Summary Points

- Adverse childhood experiences are not independently associated with pain intensity or magnitude of limitations among adults seeing an orthopaedic surgeon.
- This suggests that ACEs may impact musculoskeletal health, but perhaps only when ACEs lead to greater symptoms of depression, anxiety, or greater catastrophic thinking.
- This suggests that attention is best directed towards stress, distress, and less effective coping strategies regardless of their potential origin to improve musculoskeletal health in the biopsychosocial paradigm.

Bibliography

1: Cheong E Von, Sinnott C, Dahly D, Kearney PM. Adverse childhood experiences (ACEs) and later-life depression: perceived social support as a potential protective factor. BMJ Open. 2017;7(9):e013228. doi:10.1136/bmjopen-2016-013228.

2: Dube SR, Felitti VJ, Dong M, Giles WH, Anda RF. The impact of adverse childhood experiences on health problems: Evidence from four birth cohorts dating back to 1900. Prev Med (Baltim). 2003;37(3):268-277. doi:10.1016/S0091-7435(03)00123-3.

3: Das De S, Vranceanu A-M, Ring DC. Contribution of kinesophobia and catastrophic thinking to upper-extremity-specific disability. J Bone Joint Surg Am. 2013;95(1):76-81. doi:10.2106/JBJS.L.00064.

4: Anda RF, Tietjen G, Schulman E, Felitti V, Croft J. Adverse Childhood Experiences and Frequent Headaches in Adults. Headache J Head Face Pain. 2010;50(9):1473-1481. doi:10.1111/j.1526-4610.2010.01756.x.

5: Vranceanu AM, Barsky A, Ring D. Psychosocial Aspects of Disabling Musculoskeletal Pain. J Bone Joint Surg. Am. 2009;91(8):2014-2018. doi:10.2106/JBJS.H.01512.

AM Poster 383: Nitric Oxide Releasing Silica Nanoparticle Promotes Angiogenesis and Functional Recovery after Peripheral Nerve Injury

Category: Pediatrics/Congenital and Nerve

Nerve
N/A - not a clinical study
Grant received from: National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIT) (NRF-2015R1C1A1A02036830)

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Hypothesis

We hypothesized that nitric oxide (NO)-releasing nanoparticle promotes re-vascularization and functional recovery in rat sciatic nerve crushing model.

Methods

A total of 48 Lewis rats were randomly divided into two groups of 24 rats each. A standard calibrated crushed (6 mm width, 20 seconds) sciatic nerve of group I was augmented in fibrin glue. The crushed sciatic nerve of group II was treated with NO-releasing silica nanoparticle in fibrin glue carrier. We conducted the microangiography using a colored microangiographic polymer (Microfil®) in four rats from each group at 3 days after sugery. Sciatic functional index (SFI) using the walking tract test and compound muscle action potential (CMAP) of tibialis anterior (TA) were weekly measured to evaluate serial recovery of functional motor nerve. We checked the in-vivo isometric tetanic contraction force of TA, wet weight of posterior calf muscles, and nerve histomorphometry at 3 and 6 weeks after sugery. All results of TA contraction force and wet muscle weight were normalized to the contralateral side.

Results

Microangiography showed that the mean neural vascular density in crushing site of group II were higher than group I. The mean SFI and CMAP of group II was higher than group I until 4 weeks after treatment, but each groups had similar at 5 and 6 weeks. The mean TA contraction force of group II at 6 weeks was higher than group I (90.6% vs 68%) and the mean wet muscle weight of group II at 3 weeks was higher than group I (50.4% vs 44.1%). Nerve histomorphometry showed

that the number of myelinated axons was higher, axon diameter and myelin sheath were greater in group II at 3 and 6 weeks.

Summary Points

- Recently, biomaterial advances introduce NO-releasing silica nanoparticle, which may offer the controlled and sustained delivery of NO to the targeted tissues.
- NO-releasing silica nanoparticle treatment of an acute sciatic nerve crush injury promotes early re-vascularization of crushing sciatic nerve.
- NO-releasing silica nanoparticle treatment of an acute sciatic nerve crush injury promotes nerve regeneration of crushing sciatic nerve and functional recovery.

Bibliography

1: Shin JH, Metzger SK, Schoenfisch MH. Synthesis of nitric oxide-releasing silica nanoparticles. J Am Chem Soc. 2007 Apr 18;129(15):4612-9.
2: Shin JH, Schoenfisch MH. Inorganic/Organic Hybrid Silica Nanoparticles as a Nitric Oxide Delivery Scaffold. Chem Mater. 2008 Jan 1;20(1):239-249
3: Giusti G, Lee JY, Kremer T, Friedrich P, Bishop AT, Shin AY. The influence of vascularization of transplanted processed allograft nerve on return of motor function in rats. Microsurgery. 2016 Feb;36(2):134-43
4: Sundem L, Chris Tseng KC1 Li H, Ketz J, Noble M, Elfar J. Erythropoietin Enhanced Recovery After Traumatic Nerve Injury: Myelination and Localized Effects. J Hand Surg Am. 2016 Oct;41(10):999-1010
5: Keilhoff G, Wolf G, Fansa H. NOS-mediated differences in peripheral nerve graft revascularization and regeneration. Neuroreport. 2002 Aug 7;13(11):1463-8

AM Poster 384: Mid-Term Outcome after Selective Neurotization of the Infraspinatus Muscle in Patients with Brachial Plexus Birth Injury

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems;Nerve
Level 4 Evidence

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Hypothesis

Selective neurotization of the infraspinatus nerve using the spinal accessory nerve in patients with brachial plexus birth injury (BPBI) improves active shoulder external rotation (ER).

Methods

14 consecutive BPBI patients with active external rotation in adduction of less than 10 degrees and active shoulder elevation above 90 degrees were operated at mean age of 2.6 years (range 1.4-4.7 years) between 2012 and 2016. Pre-operatively all patients had congruent shoulders without internal rotation contracture and 8/14 patients had winging of the scapula. Clinical follow-up with range of motion measurements was scheduled at 3, 6, 12, 24 and 36 months post-operatively. Position of the scapula was assessed and scar treatment with Mepiform® was started if signs of scar hypertrophy was noted. Parents' satisfaction of the functional and cosmetic result was also obtained.

Results

Mean follow-up time was 2.8 years (range 1.1-4.4 years). 12/14 patients showed improvement of ER in adduction 43° (range -15° to 70°) and 13/14 in abduction 45° (range -5°-90°) (Figure 1). Lack of gain in active ER in adduction (2 patients) associated with development of passive internal rotation contracture. Three patients developed winging of the scapula post-operatively. However, during follow-up both pre- and post-operative scapular winging decreased. Hypertrophic scars were observed in seven patients. All but one patient's parents were satisfied.

Summary Points

Functionally significant active external rotation can be restored and maintained by direct neurotization of the infraspinatus muscle in BPBI patients. Possibility of hypertrophic scar formation and winging of scapula should be discussed with parents in advance.

AM Poster 385: Treatment of Pediatric Supracondylar Fracture of the Humerus with Median Nerve Palsy

Category: Pediatrics/Congenital and Nerve

Elbow and Forearm;Congenital and Pediatric Problems;Nerve
Level 4 Evidence

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Hypothesis

It is still controversial whether the median nerve should be explored in median nerve palsy caused by pediatric supracondylar fracture. We hypothesize that the median nerve should be explored in cases of pediatric supracondylar fractures of the humerus with median nerve palsy.

Methods

The study included 11 patients, 7 boys and 4 girls, with a mean age of 8 years (range 3–12 years) at the time of operation. All patients were classified as having Gartland type III fracture and developed median nerve palsy immediately after injury. Radial pulses were absent in 5 patients, while 1 patient had a pulseless pink hand.

Results

In 4 patients with radial pulselessness and ischemia, the nerves and arteries were explored before reduction. The median nerves were either pressed or pulled by the bone fragment. The brachial arteries were pressed against the bone fragment without visible damage, and the median nerve palsy improved 4 months after surgery. In the patient with a pulseless pink hand, the nerve and the artery were explored 2 weeks after closed reduction. Since the median nerve was severely constricted by scar tissue, neurolysis was performed, and the median nerve palsy improved 2 months after surgery.
Radial pulses were normal in 6 patients. In 5 patients who underwent nerve exploration prior to reduction, there was no median nerve damage. The median nerve palsy improved a few days after surgery in 3 patients and 3 months after surgery in 2 other patients. In the other patient with a normal pulse, who underwent nerve exploration 3 months after closed reduction, the median nerve was caught between bone fragments, thereby requiring neurectomy and

neurorrhaphy. About 1 year and a half after reoperation, the muscle weakness and the mild paresthesia persisted.

Summary Points

- In the cases with ischemia, all the median nerves were either pressed or pulled by bone fragments. Thus, there is a risk for median nerve injury by employing blind reduction in such cases.
- Among the cases without ischemia, we encountered a remarkable case of a patient whose median nerve should have been explored since it was caught between bone fragments.
- Regardless of the presence or absence of ischemia, it is better to explore the median nerve before reduction in cases of median nerve palsy.

Bibliography

1: Lewine E1, Kim JM, Miller PE, Waters PM, et al. Closed Versus Open Supracondylar Fractures of the Humerus in Children: A Comparison of Clinical and Radiographic Presentation and Results. J Pediatr Othop 2018;38:77-81

AM Poster 386: Exploring the Axillary Nerve through the Deltopectoral and Axillary Approaches: Is There a "Blind Spot"?

Category: Pediatrics/Congenital and Nerve

Shoulder and Arm;Nerve
N/A - not a clinical study

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Background

The axillary nerve is at risk of iatrogenic injury during arthroscopic shoulder procedures that use anchors or sutures in the anteroinferior or inferior margin of the glenoid (6-o'clock position). This injury most frequently occurs in a so-called "blind spot" that is located between the surgical exposure limits of the medial deltopectoral approach and the posterior approach to the axillary nerve(1,2). The aim of this study was to evaluate the feasibility of exploring the 6-o'clock position using a lateral deltopectoral approach, extended as needed with an anterior axillary approach(3).

Hypothesis

We hypothesized that 1) the lateral deltopectoral approach allows neurolysis of the axillary nerve at the 6 o'clock position, and 2) that an axillary extension of this approach enables sufficient exposure for axillary repair, graft or transfer(3) of these injuries.

Methods

Three axillary nerves were dissected combining the deltopectoral approach-medial to conjoint tendon (A), the deltopectoral approach lateral to conjoint tendon (B) and the axillary approach (C) in three sequences: A-B-C, B-A-C and C-B-A.
After the first approach was completed the proximal and distal margins were marked (Fig. 1).Additional exposure with second and third approach and the 6-o'clock position were also marked. The amount of exposed nerve with the first and additional approaches was

Results

Visualization of the 6 o'clock position and percentages of axillary nerve exposed by single or combination exposures is detailed in table 1.
A deltopectoral approach lateral to the conjoint tendon and the axillary approach were the two approaches that enabled neurolysis of the axillary nerve at the 6 o'clock position. Visualization

of the origin of the axillary nerve from the posterior cord required addition of the deltopectoral approach medial to the conjoint tendon. Visualization of the distal branches of the axillary nerve and sufficient exposure of the nerve for grafting or transfer demanded an extension of the deltopectoral into the axillary approach.

Summary Points

- The deltopectoral approach medial to the conjoint tendon does not allow visualization or neurolysis of the axillary nerve at the 6-o'clock position.
- An extension of the deltopectoral approaches by an axillary approach exposed 83-94% of the total length of the nerve, and enabled sufficient exposure for repair, graft or transfer for an injury at the 6-o'clock position
- Iatrogenic or traumatic injuries to the axillary nerve in the inferior recess can be visualized, repaired or reconstructed using anterior and axillary approaches without repositioning the patient for a posterior approach.

Bibliography

1: Maldonado AA, Howe BM, Lawton R, Bishop AT, Shin AY, Spinner RJ. Anatomical Study of the Axillary Nerve: Description of a Surgical Blind Zone. Plast Reconstr Surg. 2016 Aug;138(2):419–26.
2: Maldonado AA, Spinner RJ, Elhassan BT. Effectiveness of the extended surgical approach to visualize the axillary nerve in the blind zone in an arthroscopic axillary nerve injury model. J Plast Reconstr Aesthetic Surg. 2016;69(12):1697–703.
3: Bertelli JA, Kechele PR, Santos MA, Duarte H, Ghizoni MF. Axillary nerve repair by triceps motor branch transfer through an axillary access: anatomical basis and clinical results. J Neurosurg. 2007;107(2):370–7.

AM Poster 387: Anatomic and Microscopic Study of the Distal Posterior Interosseous Nerve

Category: Pediatrics/Congenital and Nerve

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

Marion Goutard
Charles Dacheux
Thomas Gregory, MD, PhD

Hypothesis

A precise anatomic description of the posterior interosseous nerve's distal arborization is important to explain some wrist pain syndrome. The goal of our cadaveric study was to thoroughly describe the anatomy of the PIN, and mostly its distal branches and terminal arborization at the wrist's dorsal joint.

Methods

The PIN was dissected in 10 adult specimens (8 fresh and 2 embalmed) under 2.5x magnification. All of our dissections started from the last motor branch of the PIN, innervating the extensor indicis proprius, and proceeded from proximal to distal.

Results

In the distal third of the forearm, the PIN is located on the dorsal surface of the interosseous membrane; it runs next to the posterior branch of anterior interosseous artery which location with respect to the PIN was variable. No collateral bundle was dissected in this part. In the fourth compartment of the extensors, the PIN was always embedded in a fibro-fatty sheath, completely stuck to the radial wall of the compartment and the distal radial surface. Collateral branches were constantly found dissecting this sturdy fascia. 6 of the 10 specimens had branches to the distal radioulnar joint. Branches to the distal radial periosteum were constant. The PIN is divided in three terminal levels in the dorsal wrist joint. Every specimen had branches to the radiocarpal joint; nine out of ten had a mid carpal innervation. Terminal branches to the carpometacarpal joints were identified in two cadaveric wrists.

Summary Points

Constant radial periosteum PIN branches might be involved in dorsal wrist pain that can be observed in wrist fracture late follow up. The benefit of PIN denervation should be evaluated in highly comminuted distal radius fractures to avoid those painful wrist syndromes.

Bibliography

1: Kearns McCarthy C., Breen T.F. Arborization of the distal posterior interosseous nerve. J Hand Surg 1995;20A:218-220.

2: Amadio P.C. Compression of the posterior interosseous nerve at the wrist. Chirurgie de la main 2004;23:S155-S159

AM Poster 388: Trends in Pediatric Distal Radius Fracture Surgery

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems;Practice Management
Level 2 Evidence

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Hypothesis

Distal radius fractures (DRF) are extremely common among the pediatric population with the incidence expected to continue to increase. Recently, a trend towards operative treatment of pediatric DRF has emerged. Despite the increasing frequency of operative treatment, there is little consensus regarding optimal surgical treatment strategies. The aim of this study was to evaluate the operative treatment trends of American Board of Orthopaedic Surgery (ABOS) Part II candidates using closed reduction and percutaneous fixation (CRPP), external fixation (EXFIX), or open reduction and internal fixation (ORIF) for operative treatment of pediatric DRF. We hypothesize that treatment via ORIF would have increased over the study period.

Methods

The ABOS Part II operative database was reviewed for the treatment of DRF of patients aged 17 years from 2007 to 2013. Current Procedural Terminology (CPT) codes were used to identify CRPP, EXFIX, and ORIF cases. ABOS Part II candidate geographic practice region as well as patient age, gender, and complication rates were analyzed. Linear regression models were used to analyze the trends in the proportion of procedures with comparison of categorical variables where appropriate. $P < 0.05$ was the level of significance for all tests.

Results

1500 pediatric distal radius fractures were surgically treated from 2007 to 2013 with CRPP, and ORIF accounting for 88.9%, 0.5%, and 10.6% of the cases. There was no change in the overall incidence of surgical fracture fixation ($P = 0.09$). Utilization of CRPP (85% to 89%; $P = 0.47$), EXFIX (2% to 0%; $P = 0.88$), and ORIF (12% to 10%; $P = 0.88$) remained relatively stable during the study period. Pediatric DRF patients undergoing ORIF were significantly older than patients undergoing CRPP (15 years versus 11 years; $P < 0.001$) or EXFIX (15 years versus 13 years; $P = 0.044$). There was an increased risk of iatrogentic bone fracture among patients undergoing ORIF ($P = 0.01$) when compared with CRPP and EXFIX. No increased risk of secondary surgery was identified when comparing CRPP, and ORIF ($P = 0.87$).

Summary Points

- There has been stable utilization of CRPP, EXIFX, and ORIF as well as no change in the overall frequency of surgical fixation of pediatric DRF.
- CRPP is utilized 8 times more frequently than ORIF and 170 times more frequently than EXFIX.
- Our data suggests that CRPP is widely favored in the operative treatment of pediatric DRF with no increased risk of complications or secondary surgery.

Bibliography

1: 1.Khosla S, Melton LJ 3rd, Dekutoski MB, Achenbach SJ, Oberg AL, Riggs BL. Incidence of childhood distal forearm fractures over 30 years: a population-based study. JAMA. 2003 Sep 17;290(11):1479-85

2: 2.Bae DS. Pediatric distal radius and forearm fractures. J Hand Surg Am. 2008 Dec;33(10):1911-23

AM Poster 389: Traumatic Brachial Plexus Palsy: How Accurate is the Pre-Operative Diagnosis?

Category: Pediatrics/Congenital and Nerve

Nerve
Level 4 Evidence

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Michael Heckman, MS

Hypothesis

Assess at the individual nerve root level the accuracy of pre-operative diagnosis following evaluation by physical examination, CT, MRI and EMG.

Methods

Consecutive patients with non-penetrating traumatic brachial plexus injury requiring surgery by the same surgical team between 2005 to 2016 were included in the study. Pre-operative assessments of nerve root injury were made at individual nerve root levels using physical examination, MRI, CT myelogram, and EMG. The results were compared to intraoperative findings. Patient demographics were also recorded.

Results

Sixty patients were included in the study. Nine patients were female, 51 patients were male. Fifty four patients had CT myelogram, MRI or both. Fifty-five patients had EMG. All patients had a physical examination. Median patient age was 38 years and median BMI was 27.6. Considering all the nerve roots studied, the accuracy of CT myelogram /MRI was 77.8%, physical examination was 76.7% and EMG was 73.1%, however, physical examination was the most accurate for injury diagnosis of the upper roots while CT myelogram/MRI was the most accurate for the lower roots. The greatest accuracy of each of the tests was for injury diagnosis at the T1: CT/MRI 88.9%, physical examination 81.7% and EMG 76.4%. CT/MRI and EMG were least accurate at C5 (64.8% and 69.1) while physical examination was least accurate a C7 (60.7%). When considering combinations of tests, the greatest accuracy was again seen at T1.Injury status of T1 was also the most accurately diagnosed among patients with a BMI > 30. CT myelogram/MRI and physical examination were equally the most accurate in the pre-operative diagnosis in the >30 BMI subgroup.

Summary Points

- The accuracy of the diagnosis decreased significantly in the group with BMI less than 25.
- CT/MRI is more reliable in the pre-operative assessment of patients with brachial plexus injuries than either PE or EMG.
- We conclude that the pre-op status of C8 and T1 nerve roots were more accurately assessed in our study when compared to other nerve roots regardless of the type of testing performed.

Bibliography

1: Thatte MR1, Babhulkar S, Hiremath A. Brachial plexus injury in adults: Diagnosis and surgical treatment strategies. Ann Indian Acad Neurol. 2013 Jan;16(1):26-33.
2: Somashekar D, Yang LJ, Ibrahim M, Parmar HA. High-resolution MRI evaluation of neonatal brachial plexus palsy: A promising alternative to traditional CT myelography. AJNR Am J Neuroradiol 2014; 35:1209–1213.
3: Songcharoen P: Management of brachial plexus injury in adults. Scand J Surg 2008, 97(4):317-323.
4: Spires MC, Brown SM, Chang KW, Leonard JA. Interrater reliability of electrodiagnosis in neonatal brachial plexopathy. Muscle Nerve. 2017 Jan;55(1):69-73.
5: Songcharoen P: Management of brachial plexus injury in adults. Scand J Surg 2008, 97(4):317-323.

AM Poster 390: Quantitative Outcomes are Needed in the Reporting of Brachial Plexus Reconstruction

Category: Pediatrics/Congenital and Nerve

Nerve
Level 4 Evidence

Kevin Chan, MD, MSc, FRCSC
Antony Raymond, BMBS, MRCS
Tom J. Quick, MB, MA(Cantab), FRCS, FHEA

Hypothesis

To demonstrate the use, benefit and utility of a continuous, quantitative measurement of the strength recovered by re-innervated muscle. Manual muscle testing using solely The Medical Research Council (MRC) scale is no longer a valid outcome. We hypothesize that the current literature has insufficient data on continuous, quantitative outcomes of the strength of muscle re-innervation following nerve transfers in brachial plexus reconstruction.

Methods

A systematic review of the English language literature was performed to include studies evaluating intra- and extra-plexal nerve transfers (without intervening grafts) in adults to regain elbow flexion. Primary outcome of interest was motor recovery assessed quantitatively or using the MRC.

Results

57 studies were identified (figure 1). The weighted mean elbow flexion strengths were 4 ± 2.4 kg for single Oberlin, 5.2 ± 1.8 kg for double Oberlin, and 2.6 ± 1.2 kg for intercostal nerve transfers. This data was reported in only 31.6% of the studies and was reported more frequently in recent years than earlier time periods (figure 2).

Summary Points

- Amongst the studies that reported motor recovery after nerve transfers, there remains a relative paucity of data regarding continuous quantitative elbow flexion strengths.
- Continuous, quantitative data on re-innervated muscle function is necessary in outcome reporting of brachial plexus reconstruction
- Available data suggests a possible advantage with the double Oberlin transfer.
- Further advancement requires a more critical assessment of outcomes.

AM Poster 391: Clavicle Fracture is Not Associated with an Increased Risk of Brachial Plexus Birth Palsy in the Setting of Shoulder Dystocia

Category: Pediatrics/Congenital and Nerve

Congenital and Pediatric Problems;Nerve
Level 3 Evidence

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Hypothesis

Shoulder dystocia is the strongest known risk factor for brachial plexus birth palsy (BPBP) (1). It remains unknown whether a clavicle fracture that occurs during a birth delivery with shoulder dystocia increases the risk of BPBP or, alternatively, is protective (2, 3). We hypothesize that clavicle fracture in the setting of shoulder dystocia is not associated with an increased or decreased risk of BPBP.

Methods

The 1997-2012 Kids' Inpatient Database was analyzed for this study (4). ICD-9 codes were used to identify newborns diagnosed with shoulder dystocia and BPBP as well as a concurrent fracture of the clavicle. Newborns with shoulder dystocia were stratified into two groups: dystocia without a clavicle fracture and dystocia with a clavicle fracture. Multivariate logistic regression was used to quantify the risk for BPBP among shoulder dystocia subgroups.

Results

The database yielded 5,564,628 sample births extrapolated to 23,385,597 live births in the population (95% CI 22,780,168 - 23,991,026) over the 16-year period. BPBP occurred in 28,063 newborns (1.2 per 1,000 births). 0.26% of all births sustained a clavicle fracture. The incidence of clavicle fracture decreased by 36.4% over the study period (0.33% in 1997 vs. 0.21% in 2012, $p<0.001$, Table 1). Shoulder dystocia occurred in 0.23% of all births. The incidence of shoulder dystocia did not significantly change over the study period.

Among cases of BPBP, 18.78% were associated with shoulder dystocia and 7.84% with clavicle fracture. 1.26% of BPBP cases were associated with both shoulder dystocia and clavicle fracture. In the setting of shoulder dystocia, BPBP occurred in 9.82% of births without clavicle fracture and 11.77% of births with clavicle fracture (Table 2). Shoulder dystocia without a concurrent clavicle fracture was an independent risk factor for BPBP (OR 112.1, 95% CI 103.5 – 121.4). Those with shoulder dystocia and clavicle fracture had a risk for BPBP comparable to those with shoulder dystocia but no fracture (OR 126.7 vs. 112.1, $p=0.262$).

Summary Points

- Shoulder dystocia remains a strong independent risk factor for BPBP.
- The incidence of clavicle fracture decreased over the 16-year period, which may be explained by a trend towards earlier labor induction and scheduled caesarean sections to prevent shoulder dystocia.
- Clavicle fracture in the setting of shoulder dystocia is not associated with a significant change in the risk of BPBP. Additional factors such as the timing of fracture and severity of dystocia warrant investigation to determine if clavicle fracture has a protective role.

Bibliography

1: Foad SL, Mehlman CT, Ying J. The epidemiology of neonatal brachial plexus palsy in the United States. J Bone Joint Surg Am. 2008;90(6):1258-64.

2: Leshikar HB, Bauer AS, Lightdale-Miric N, Molitor F, Waters PM, Group TS. Clavicle Fracture Is Not Predictive of the Need for Microsurgery in Brachial Plexus Birth Palsy. J Pediatr Orthop. 2016.

3: Wall LB, Mills JK, Leveno K, Jackson G, Wheeler LC, Oishi SN, et al. Incidence and prognosis of neonatal brachial plexus palsy with and without clavicle fractures. Obstet Gynecol. 2014;123(6):1288-93.

4: HCUP Kids' Inpatient Database (KID). In: (HCUP) HCaUP, editor. Rockville, MD: Agency for Healthcare Research and Quality, Rockville, MD; 1997, 2000, 2003, 2006, 2009, and 2012.

AM Poster 392: Patterns of Production of Collagen-Rich Deposits in Peripheral Nerves in Response to Injury: A Pilot Study in a Rabbit Model

Category: Pediatrics/Congenital and Nerve

Nerve;Diseases and Disorders
N/A - not a clinical study
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Hypothesis

Although collagen-rich deposits are the main component of neural scars, the patterns of their formation are ill defined. Essential to the biosynthesis of collagen fibrils are enzymes catalyzing posttranslational modifications and chaperones that control the formation of the collagen triple helix. Prolyl-4-hydroxylase (P4H) and heat shock protein-47 (HSP47) play a key role, and their production is upregulated during scar formation in human tissues. Alpha smooth muscle actin (aSMA) is also produced during fibrotic processes in myofibroblasts that participate in fibrotic response. In injured peripheral nerves, however, the distribution of cells that produce these markers is poorly understood.

Methods

The goal of this study was to determine the distribution of the aSMA-positive, HSP47-positive, and the P4H-positive cells to better understand the formation of collagen-rich fibrotic tissue (FT) in response to peripheral nerve injury. To reach this goal, we employed a rabbit model of crush-injury and partial-transection injury of the sciatic nerves.

Results

Our study demonstrated that aSMA is expressed in a relatively small number of cells seen in neural FT. In contrast, cells producing P4H and HSP47 are ubiquitously present in sites of injury of the sciatic nerves.

Summary Points

P4H and HSP47s may serve as valuable markers that define fibrotic activities in the injured peripheral nerves.

This research was supported by a Basic Science Grant from the American Foundation for Surgery of the Hand.

AM Poster 393: Pretreatment with Resveratrol Improved Axonal Regeneration in Replantation Surgery for Nerve Root Avulsion Injury in Rats

Category: Pediatrics/Congenital and Nerve

Nerve;Diseases and Disorders
N/A - not a clinical study
Grant received from: JSPS KAKENHI Grant Numbers JP24592232 and JP16K10857

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Hypothesis

Replantation of avulsed nerve root has been developed to treat the brachial plexus injury. However, functional improvement is limited. In replantation surgery, a nerve graft is usually needed to bridge the nerve defect between the spinal cord and the stump of the avulsed nerve root. Pretreatment of the grafted nerve is one of the possible procedures to improve the axonal regeneration. Resveratrol is a polyphenol with anti-oxidant and anti-inflammatory effects, which was reported to promote the release of neurotrophic factors from glial cells. We hypothesized that the pretreatment with resveratrol for nerve autograft improve the outcome in replantation surgery after nerve root avulsion.

Methods

Twenty-four 8-week-old male adult Sprague-Dawley rats were randomly assigned into two groups; the control group (n=12) and resveratrol group (n=12). Two surgical procedures were performed. In the first procedure, SD rats were subjected to the avulsion of the left C6 nerve root and harvest of nerve autografts. The harvested grafts were explant-cultured in the Schwann cell medium for 1 week. In the resveratrol group, the grafts were explant-cultured in the medium with 100 U/ml resveratrol, whereas in the control group, the grafts were explant-cultured without resveratrol. The second procedure was replantation of the C6 nerve root using the explant-cultured nerve graft 1 week after the first procedure. Eight weeks after the replantation surgery, the C6 spinal cord segments and left C6 nerve roots (2mm distal to the neurorrhaphy site) were harvested and assessed histologically. All data were expressed as the mean ± standard

error and the data were compared using the unpaired t-test. The differences were considered significant at $P < 0.05$.

Results

The number and myelin thickness of regenerated axons in the distal part of the replanted nerve root were significantly increased in the resveratrol group compared to the control group. Although there was no significant difference in the number of survived motoneurons in the lesioned ventral horn of C6 spinal cord between both groups, the number of regenerating motoneurons were significantly increased in the resveratrol group compared to the control group.

Summary Points

- The pretreatment of the nerve autograft with resveratrol increased the number and myelin thickness of the regenerated axons, and the number of regenerating motoneurons in the C6 spinal cord segment.
- Resveratrol potentially promote axonal regeneration in replantation surgery for the cervical root avulsion.
- This procedure might contribute to the improvement of the outcome in the replantation surgery for the cervical root avulsion.

Bibliography

1: Carlstedt, T., Grane, P., Hallin, R.G. & Noren, G. (1995). Return of function after spinal cord implantation of avulsed spinal nerve roots. Lancet, 346, 1323-1325.
2: Zhang, F., Wang, Y.Y., Liu, H., Lu, Y.F., Wu, Q., J. & Shi, J.S. (2012). Resveratrol Produces Neurotrophic Effects on Cultured Dopaminergic Neurons through Prompting Astroglial BDNF and GDNF Release. Evid Based Complement Alternat Med, 2012, 937605

AM Poster 394: Postoperative Neurologic Deficits after Incisional Biopsy and Surgical Enucleation of Schwannomas of the Upper Limb

Category: Pediatrics/Congenital and Nerve

Nerve
Level 4 Evidence

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Hypothesis

Neurological deficits occur in a significant number of patients after surgical enucleation of schwannomas of the upper limb. Incidence of adverse outcomes can be minimized through appropriate selection of patients. The purpose of this study was to identify risk factors for postoperative neurologic deficits.

Methods

We evaluated 43 patients who had undergone enucleation of schwannomas located in the upper limb between 2003 and 2017. There were 21 males and 22 females, with a mean age of 50.4 years (15 to 79 y). The mean follow-up was 22.7 months (3 to 98 m). The 45 schwannomas were excised and histopathologically confirmed. There were 1 schwannoma of the plexus, 25 of the median nerve, 15 of the ulnar nerve, and 4 of the radial nerve. Patients with neurological deficits were compared using bivariate analyses and multivariate analysis to those without in terms of age, sex, history of incisional biopsy, location and maximum diameter of tumor, and surgeon experience.

Results

Three months after operation, 12 patients had postoperative neurological deficits (27%). One patient developed motor weakness after excision of a schwannoma of the median nerve in the axilla (2.2%). Ten patients underwent incisional biopsy prior to surgical enucleation. Although statistical analysis demonstrated no relationship between neurological deficits after enucleation and incisional biopsy (Table. 1), three of 10 patients developed new deficits just after incisional biopsy. Multivariate analysis demonstrated that schwannomas in the elbow and more proximal

part of the limb were significantly associated with higher risk of neurologic deficits ($p = 0.039$, Table. 2).

Summary Points

- Neurologic deficits were experienced by a similar number of patients receiving incisional biopsy (30%) and surgical enucleation (27%). Unnecessary biopsy should be avoided to minimize the risk of nerve injury.
- Schwannomas in the elbow and more proximal part of the limb were significantly associated with higher risk of neurologic deficits after enucleation.
- Prior to incisional biopsy and surgical enucleation of schwannomas in the proximal part, patients should be thoroughly informed about the potential for postoperative neurologic deficits to occur.

Bibliography

1: Siqueira MG, et al. Acta Neurochir. 2013;155:1745-9.
2: Sawada T, et al. J Hand Surg Br. 2006;31:629-34.
3: Park MJ, et al. J Bone Joint Surg Br. 2009;91:1482-6.
4: Kim SM, et al. Int Orthop. 2012;36:1721-5.
5: Levi AD, et al. Neurosurgery. 2010;66:833-40.

AM Poster 395: Wrist Arthroscopy in Children and Adolescents with Chronic Wrist Pain

Category: Pediatrics/Congenital and Nerve

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

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Hypothesis

Wrist pain is a relatively rare within childhood and adolescence. Although many children possess a traumatic background, clinicians should bear in mind that there might be underlying inflammatory diseases or congenital malformations.
Wrist arthroscopy is a valuable step for management of wrist disorders which has grown from a diagnostic tool to a curative, adjunctive procedure. Our aim is to report preliminary results of diagnostic and therapeutic wrist arthroscopy (WASC) in youngsters with persistent wrist pain.

Methods

Retrospective review of 24 children and adolescents who underwent WASC between 2014-2017 was done. 18 girls and 6 boys with mean age of 14.6 (11-18) were operated.
Indication was chronic wrist pain refractory to nonsurgical treatment for more than 12 weeks following trauma, systemic inflammatory disease, selected cases of congenital and developmental disorder.

Results

10/24 patients had a history of ipsilateral upper limb trauma. 6/24 were suspected of TFCC tears in MRI reports. 4/24 had rheumatoid symptoms, juvenile idiopathic arthritis (JIA), 1 child had underlying arthrogryposis and also suspected TFCC injury. The rest had persistent, unclassified wrist pain and needed diagnostic WASC.
The procedure was performed as a day case and mainly done under regional block and/or GA, undertaken by 2 hand surgeons. 14 patients were demonstrated to have synovitis at ulnocarpal, radiocarpal, midcarpal joint capsules; treated with synovectomy. 5 showed TFCC Palmer 1A tears and 7 had midcarpal hypermobility without clinical instability and were managed by TFCC debridement and gentle midcarpal joint capsule shrinkage. 3 patients received arthroscopically assisted ganglionectomy. One case showed a partial split at radioscaphocapitate ligament;

demonstrating an extra strand of scar. Other pathologies were scapholunate, lunotriquetral ligament hypermobility, TFCC dimpling and sagging, ulnar abutment, triquetral chondromalacia. No complications were observed.

Summary Points

- Wrist arthroscopy is a safe procedure to detect and treat paediatric wrist disorders with chronic pain. We treated 24 children with mild arthroscopic capsule shrinkage for midcarpal hypermobility, TFCC debridement and synovectomy. No complications were observed.
- In addition, a subgroup of JIA patients with few clinical symptoms despite known progressive and extensive joint destruction underwent arthroscopic synovectomy.
- In addition, though a safe procedure, we recommend that wrist arthroscopy in children should only be carried out by well-trained, experienced hand surgeons.

AM Poster 396: Surgical Management for Brachial Plexus Tumors

Category: Pediatrics/Congenital and Nerve

Nerve;Diseases and Disorders
Level 5 Evidence

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Hypothesis

An injudicious surgical resection of tumors developing from the brachial plexus itself or its proximity can often result in neurological deficit. An intraoperative nerve stimulator, ultrasonic surgical aspirator (CUSA) and a surgical microscope were utilized to prevent damage of normal nerve tissue. For the surgical approach, tumor resection was completed without clavicle osteotomy in combination with video-assisted thoracic surgery (VATS) to ensure safety and minimal invasiveness.

Methods

Twelve patients with a benign histopathological diagnosis, all at the same developing site, were included. The mean age was 53.9 years, and the group consisted of 6 women and 6 men. We retrospectively investigated the histopathological diagnosis, site of occurrence, surgical approach, surgical method, and surgical complications of each patient.

Results

The histopathological diagnoses included schwannoma in 9 cases, and ganglioneuroma, solitary fibrous tumor and esophageal cyst in 1 case each, respectively. The supraclavicular surgical approach was used in 6 cases, supraclavicular approach with VATS in 4 cases,infraclavicular approach in 1 case,and the transmanubrial approach in 1 case.
The surgical method for schwannoma of the brachial plexus was used in 5 cases; enucleation was performed under the microscope. At that time, either epineurium was stimulated using a nerve stimulator and the site on epineurium without muscle contraction was incised longitudinally, or enucleation using a microscope and nerve stimulator was performed after volume reduction by CUSA when it was impossible to enucleate from the longitudinal section because the tumor was too large for the incisional range.. Total excision occurred in the 7 remaining cases without neurological deficit.

Postoperative complications were unrelated to the tumor site and surgery method, and there were no cases of motor dysfunction. Horner's syndrome occurred in 5 cases; numbness in an upper extremity in 4 cases; esophageal injury in 1 case; and no complications occurred in 3 cases.

Summary Points

- Because postoperative neurological deficit is a problem in cases of tumor removal in the brachial plexus, it is essential that an intraoperative nerve stimulator and surgical microscope are used to prevent nerve damage.
- CUSA is useful in patients with schwannoma because enucleation can be performed after volume reduction, and when there is no capsule around the tumor, function can be preserved by performing sole volume reduction.
- Reports of the clavicle osteotomy approach are found on occasion, but these results show that with VATS, a safer and less-invasive tumor resection is possible.

Bibliography

1: Anterior cervical approach for resection of brachial plexus schwannoma expanding into the thoracic apex. Oishi H, Ohta S, Inaba H, Yoshida H, Takagi A.Kyobu Geka. 2004 Jun;57(6):459-63.
2: Video-assisted thoracoscopic dissection of the brachial plexus: cadaveric study and illustrative case. Morgan CJ, Lyons J, Ling BC, Maher PC, Bohinski RJ, Keller JT, Howington JA, Kuntz C 4th.Neurosurgery. 2006 Apr;58(4 Suppl 2)
3: Is surgery for brachial plexus schwannomas safe and effective? Lee HJ, Kim JH, Rhee SH, Gong HS, Baek GH. Clin Orthop Relat Res. 2014 Jun;472(6):1893-8.
4: Primary brachial plexus tumors: imaging, surgical, and pathological findings in 25 patients. Binder DK, Smith JS, Barbaro NM. Neurosurg Focus. 2004 May 15;16(5):E11.
5: Anterior cervical approach for resection of brachial plexus schwannoma expanding into the thoracic apex. Oishi H, Takagi A. Kyobu Geka. 2004 Jun;57(6):459-63.

AM Poster 397: Fanconi Anemia in Patients with Thumb Hypoplasia

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems;Nerve
Level 4 Evidence

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Hypothesis

Thumb hypoplasia is a relatively common congenital anomaly. A small percentage of patients will have Fanconi anemia (FA), a severe blood disease. There have been more reported cases with FA in Japan than in the United States (US). Bayne et al. reported 1 patient in a series of 101 patients. Goldfarb et al. reported 1 in 164. We hypothesized that thumb hypoplasia with FA in Japan would be more frequent than previously reported in the US.

Methods

We investigated 113 patients with thumb hypoplasia to determine the number with FA in our hospital between October 2003 and September 2017. In addition, we investigated their specific presentation characteristics.

Results

There were five patients with eight hands (modified Blauth classification, Type II, 1; Type IIIa, 1; Type IIIb, 3; and Type IV, 4) (3.1%; three males and two females), associated with FA. All patients were diagnosed with FA after initial surgery. The average age at the time of diagnosis with FA was 4.4 years, while that of initial surgery was 3.2 years. All had severe FA (neutrophil < 500/μl), and all were treated hematopoietic stem cell transplantations. Of the five patients, two were brothers and all were of a short stature (average height: -1.9 SD). Four patients had café au lait spots. The blood tests made prior to the initial surgery showed that the red blood cell and platelet counts were as low in all patients at 2.58 to 4.30 million and 38 to 128 thousand, respectively. The hemoglobin levels were low in three patients.

Summary Points

- The prevalence of FA in patients with thumb hypoplasia in Japan was 4.4% (5 patients with the anemia in a series of 113 patients); this is a higher prevalence than previous US reports.
- The severity of thumb hypoplasia ranged from hypoplasia of the thenar muscles (Type II) to floating thumbs (Type IV).
- In all patients, the FA was diagnosed after the initial surgery for thumb hypoplasia.
- It is important to consider possibility of the association with FA for the patients with thumb hypoplasia. Short stature, skin pigmentation, low red blood cell and platelet counts, or low hemoglobin levels are indicators of possible FA.

Bibliography

1: Fanconi G. Familial constitutional panmyelocytopathy, Fanconi's anemia (F.A.). I. Clinical aspects. Semin Hematol. 1967 Jul;4(3):233-40.
2: Bayne LG, Klug MS. Long-term review of the surgical treatment of radial deficiencies. J Hand Surg Am. 1987 Mar;12(2):169-79.
3: Goldfarb CA, Wall L, Manske PR. Radial longitudinal deficiency: the incidence of associated medical and musculoskeletal conditions. J Hand Surg Am. 2006 Sep;31(7):1176-82.
4: Manske PR, McCarroll HR Jr, James M. Type III-A hypoplastic thumb. J Hand Surg Am. 1995 Mar;20(2):246-53.

AM Poster 398: Percutaneous Skeletal Traction Aided Reduction (PSTAR) of Irreducible Radius and Ulna Fractures in Children: An Innovative Approach

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Elbow and Forearm;Congenital and Pediatric Problems
Level 3 Evidence

Shelley Uppal

Hypothesis

PSTAR offers comparable post-operative fracture displacement and angulation results to closed reduction treatment in cases of pediatric distal radius and ulna fractures. In cases of geometrically complicated fractures, where open reduction is indicated over closed reduction treatment, PSTAR offers an alternative that minimizes the risk of infection and postoperative complications associated with open reduction treatment.

Methods

Over a 2 year period, 24 children (mean age=12) with distal radius and ulna fractures participated in this study. Group 1 consisted of 6 patients (mean age=8) with uncomplicated fractures, who underwent standard closed reduction treatment under general anesthesia and post-operative long arm cast application. Group 2 consisted of 18 patients (mean age=14) with complicated fractures that prevented standard closed reduction treatment. Patients in group 2 underwent PSTAR and post-operative long arm cast application (Figure 1). Patients were followed up with serial x-rays carried out at 1,3, and 12 weeks postoperatively. At the final follow-up at 12 weeks, patients in both groups were assessed for cast-related complications, pin site infections, fracture healing, and fracture displacement and angulation.

Results

Table 1 documents the postoperative fracture displacement and angulation results, as compared to preoperative fracture displacement and angulation, for patients in groups 1 and 2. In addition, on analysis during postoperative followup, group 2 patients did not experience pin site infections or cast-related complications. The fractures healed at 12 weeks with callus appreciated on radiograph. Patients in group 2 also did not experience any pain or motion tenderness at the fracture site.

Summary Points

- Based on the data comparing both groups in terms of post-operative displacement and angulation of fractures, the results of measured fracture displacement and angulation in patients treated by standard closed reduction treatment and PSTAR are comparable.
- Patients treated with PSTAR also experienced successful fracture healing without cast-related complications or pin-site infections.
- PSTAR offers a unique treatment alternative to closed reduction treatment in cases of complicated fracture geometry. It reduces the risk of infection and postoperative complications that is associated with open reduction treatment.

AM Poster 399: Epidemiological and Clinical Aspects of Cleft Hand: A. Case Series from a Tertiary Public Hospital in São Paulo, Brazil

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems
Level 4 Evidence

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Hypothesis

Cleft hand is a rare and congenital deformity that affects hands and feet and can be associated with other malformations. The objective was to evaluate cleft handed patient's epidemiological and clinical aspects in a case series.

Methods

Baseline characteristics associated to this deformity such as sociodemographic characteristics, affected upper limb side, family history, clinical manifestations and the classifcation according to Barsky, Manske and Halikis, and Valenti classifications were analyzed in 38 patients treated in the Department of Orthopedic Surgery of the Irmandade da Santa Casa de Misericórdia de São Paulo, Brazil.

Results

It was found a predominance of typical hands as classified by Barsky, types II and IV as classified by Manske and Halikis, and type IV by Valenti. A high frequency of typical cases (55.3%), as defined by Barsky, had a positive family history ($p= 0.031$) and were associated to other clinical manifestations (44.7%), when compared to atypical cleft hand patients ($p< 0.001$)

Summary Points

- Typical Barsky cleft hands were more commonly associated with family history of cleft hands as was the presence of other concomitant clinical manifestations.
- Patients with either narrowed or merged thumb web, Manske and Halik's types II and IV, respectively, had a higher incidence in the present study.
- This is one of the largest case series on cleft hands

Bibliography

1: Barsky AJ, Cleft hand: classification, incidence, and treatment, J Bone Joint Surg 46:8:1707-20, 1964.
2: Manske PR, Halikis MN, Surgical classification of central deficiency according tio the thumb web, J Hand Surg 20A:4:487-97, 1995.
3: Valenti P, Lozano Gonzales E, Vergara E, Amador E, Cogswell LK, Cleft hand: a review of 33 cases and new ideas about classification, Chir Main 27:121-8, 2008.
4: Tonkin MA, Oberg KC, The OMT Classifications of Congenital Anomalies of the Hand and Upper Limb, Hand Surg 20:3:336-42, 2015
5: Falliner AA, Analysis of anatomical variations in cleft hands J Hand Surg 29A:994-1001, 2004.

AM Poster 400: Association of Hospital Characteristics with Outcomes of Pediatric Digit Replantation Following Traumatic Amputation: An Analysis of 1,140 Pediatric Replantations

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems
Level 2 Evidence

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Hypothesis

Centers that perform a higher volume of pediatric digit replantations following traumatic amputation result in a lower rate of revision procedures and complications compared to lower volume centers.

Methods

The Kid's Inpatient Database (KID) from the Healthcare Cost and Utilization Project (HCUP) for 2000 to 2012 were queried for traumatic amputations of the thumb or finger (ICD-9: 885.0, 886.0). Subjects who underwent replantation (ICD-9-CM: 84.21, 84.22) were isolated and further divided into a replantation revision group that included revision amputation (ICD-9-CM: 84.01, 84.02) and microvascular revision (ICD-9-CM: 39.3, 39.4). Hospital characteristics including private and public ownership as well as teaching and non-teaching hospitals were extracted for all replantation procedures. In-hospital complications (wound dehiscence, infection, thrombosis, cardiac, respiratory, urinary) were also extracted for all replantation procedures. Fisher's exact tests and multivariable regressions were used with p values < 0.05 determined to be significant a priori.

Results

Between 2000 and 2012, 1,140 pediatric patients underwent replantation following traumatic digit amputations. Privately owned hospitals performed 969 replantations of which 332 (34.2%) patients required revision procedures. Publicly owned hospitals performed 47 replantations with 16 patients requiring revision procedures (34.5%) (p=0.975). Teaching hospitals performed 814 replantations with 311 (38.3%) undergoing revision procedures. Non-teaching hospitals performed 155 replantations with 32 (20.6) replantations requiring revision procedures (p = 0.0032)(Table 1). There was no difference between in-hospital complications within hospital

ownership (Private: 13.96%, Public: 12.19%, p = 0.824). Similarly, there was no difference between hospital teaching status (Teaching: 14.27%, Non-teaching: 14.02%, p=0.502). Following multivariable regression, pediatric replantation in non-teaching hospitals were 2 times less likely to undergo revision procedures than teaching hospitals (OR: 0.473, 95% CI: 0.261, 0.857, p = 0.0138)(Table 2).

Summary Points

- High volume centers for pediatric replantations following traumatic digit amputations include privately owned hospitals and teaching hospitals
- Revision procedures following replantation occurred at a higher proportion in these high-volume centers compared to low volume centers of publicly owned and non-teaching hospitals.
- In-hospital complications were not different between private or public and teaching or non-teaching hospitals
- Given the resources involved in privately owned and teaching hospitals, the attempt rate for digit replantations and subsequent risks for revision are higher
- Referral to privately owned teaching hospitals following pediatric digit replantation is crucial for proper evaluation and chance of operative intervention

Bibliography

1: Berlin NL, Tuggle CT, Thomson JG, Au A. Digit replantation in children: A nationwide analysis of outcomes and trends of 455 pediatric patients. Hand. 2014. doi:10.1007/s11552-014-9628-8.
2: Lee S, Reichert H, Kim HM, Steggerda J, Chung KC. Patterns of surgical care and health disparities of treating pediatric finger amputation injuries in the United States. J Am Coll Surg. 2011. doi:10.1016/j.jamcollsurg.2011.07.017.
3: Shale CM, Tidwell JE, Mulligan RP, Jupiter DC, Mahabir RC. A Nationwide Review of the Treatment Patterns of Traumatic Thumb Amputations. Ann Plast Surg. 2013;70(6):647-651. doi:10.1097/SAP.0b013e31828986c9.

AM Poster 401: Pediatric Acute Compartment Syndrome: A Systematic Review and Meta-Analysis

Category: Pediatrics/Congenital and Nerve

Elbow and Forearm;Congenital and Pediatric Problems;General Principles
Level 4 Evidence

James S. Lin
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Hypothesis

Pediatric acute compartment syndrome (ACS) should be approached as a distinct condition from the adult version, where delayed fasciotomy (= 24 hours from injury) is considered more deleterious than beneficial due to risk of infection and wound complications. We hypothesize that decompressive fasciotomy in pediatric ACS results in good outcomes even for those presenting in a delayed manner.

Methods

We performed a systematic review of multiple databases based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to investigate the average time from injury to diagnosis, the most common presentations, the degree to which providers obtained pressure measurements, and the outcomes of ACS in the pediatric population. Review articles, studies lacking statistical data, single case reports and other evidence level V studies were excluded.

Results

Eleven studies were included, with all reporting clinical outcomes following diagnosis and intervention of ACS in children. There were a total of 194 children with an average age of 9.1 years (SD 5.9, range 0 to 18) (Table 1). The most common causes of ACS were trauma-related: pedestrian vs motor vehicles (25%); motor vehicle accidents (MVA)(15%); and falls (15%). 78% of patients had concomitant fractures. Compartment pressures were measured in 68% of patients to aid diagnosis. Pain was the most common presenting symptom (90%) followed by paresthesias (32%). The mean time from injury to fasciotomy was 25.4 hours. Overall, patients had good outcomes with 88% achieving full functional recovery. ROM deficit (10%) was the most common complication. We did not detect a significant difference in time from injury to fasciotomy, age, sex, presence of fracture, or anatomic location in those patients who achieved full functional recovery compared to those patients who did not (Table 2).

Summary Points

- Pediatric acute compartment syndrome occurs most often in the setting of trauma.
- Pain is the most common symptom, but it is critical to maintain a high level of suspicion even when etiologies and presentations are atypical. Intracompartmental pressure measurements can aid diagnosis.
- Pediatric ACS differs from adult ACS, as pediatric patients generally achieve good outcomes even when presenting in delayed fashion and undergoing fasciotomies = 24 hours.
- We recommend considering decompressive fasciotomy in children even if there is prolonged time from injury to diagnosis.

Bibliography

1: Grottkau BE, Epps HR, Di Scala C: Compartment syndrome in children and adolescents. J Pediatr Surg 2005;40:678-682.
2: Livingston KS, Glotzbecker MP, Shore BJ: Pediatric Acute Compartment Syndrome. J Am Acad Orthop Surg 2017;25:358-364.
3: McQueen MM, Gaston P, Court-Brown CM: Acute compartment syndrome. Who is at risk? J Bone Joint Surg Br 2000;82:200-203.
4: Livingston K, Glotzbecker M, Miller PE, et al.: Pediatric Nonfracture Acute Compartment Syndrome: A Review of 39 Cases. J Pediatr Orthop 2016;36:685-690.
5: Kanj WW, Gunderson MA, Carrigan RB, Sankar WN: Acute compartment syndrome of the upper extremity in children: diagnosis, management, and outcomes. J Child Orthop 2013;7:225-233.

AM Poster 402: Characterizing Forearm Deformity in Chronic Pediatric Monteggia Fractures Using 3D Imaging: A Basic Classification

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Elbow and Forearm;Congenital and Pediatric Problems
Level 4 Evidence

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Hypothesis

The deformity associated with chronic Monteggia injuries is poorly understood, and often results in failed attempts at surgical reduction. The purpose of this study is to characterize the sagittal, coronal, and axial deformities of the ulna and radius in chronic missed Monteggia injuries using 3D computed tomography (CT) imaging. We hypothesized that axial rotation would contribute a significant portion of the overall deformity of the forearm, and deformity would be present in the radius as well.

Methods

A retrospective chart review was used to identify 11 patients treated for missed Monteggia fractures from 2014 to 2016. The mean age was 7.9 years old at time of injury and 12.6 years old at time of presentation. All patients had a history of forearm injury treated with a cast. Original injury films were not available. All patients underwent bilateral forearm CT scans with 3D reconstruction per Materialise protocol. Measurements were recorded for axial, sagittal, and coronal plane deformities, as well as the position of the proximal radioulnar joint (PRUJ) in relation to the transepicondylar humeral axis utilizing Mimicks commercially available software. Measurements were compared to their contralateral uninjured side.

Results

The mean axial rotational deformity was 19 degrees for the radius and 14 degrees for the ulna. The mean sagittal plane deformity was 3 degrees with an average of 6mm sagittal displacement of the proximal radius, and 5 degrees with an average of 8mm sagittal displacement of the proximal ulna. The mean coronal plane deformity was 4 degrees with an average of 4mm coronal displacement of the proximal radius, and 3 degrees with an average 4mm coronal displacement of the proximal ulna. The PRUJ was internally rotated an average of 9 degrees anteriorly on the proximal ulna compared to the contralateral side.

Summary Points

- Chronic Monteggia injuries are associated with predominantly axial rotational deformities of both the radius and ulna compared to sagittal and coronal plane deformities.
- Radial deformities are present in nearly all cases despite absence of known radial fractures at the time of injury.
- It is likely that secondary deformities occur in the proximal ulna from the longstanding radial head dislocation.
- Chronic Monteggia fractures can be classified into two types based on whether PRUJ rotational deformity of the proximal ulna is present or absent. They can be subclassified based on presence or absence of radius deformity.
- These deformities have significant implications for successful corrective osteotomies.

AM Poster 403: What is the Optimal Management of Chronic Seymour Fractures?

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems
Level 4 Evidence

James S. Lin
Richard Samade, MD, PhD
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Hypothesis

There is no consensus on the optimal management of chronic pediatric Seymour fractures (those presenting > 24 hours from injury). We hypothesize that: 1) cephalexin does not provide adequate antibiotic coverage for chronic Seymour fractures; 2) surgical indications include the presence of frank purulence and/or unsuccessful closed reduction; and 3) most chronic Seymour fractures will achieve good outcomes with non-operative treatment.

Methods

A retrospective review was performed at a large tertiary care pediatric hospital from 2009-2017 evaluating patients with delayed presentation of Seymour fractures to elucidate management principles such as operative indications and antibiotic selection, and determine outcomes. Inclusion criteria were patients less than 18 years of age with a clinically and radiographically evident Seymour fracture with initiation of treatment more than 24 hours after the injury. Outcomes assessed were: fracture healing, infection, malunion, physeal disturbance, nail dystrophy, antibiotic side effects, and need for surgical intervention. Statistical analyses included the Fisher's exact test and Wilcoxon rank sum methods.

Results

The mean age of included patients was 11 years (SD 3) with 56 males (77%) and 17 females (23%) sustaining a total of 73 chronic Seymour fractures. The median time from injury to presentation was 7 days (range 1 to 65; SD 12). 68 (93%) cases were initially managed nonsurgically, and 5 (7%) cases were initially managed operatively with formal irrigation & debridement, open reduction, and K-wire fixation (Table 1). 2 of 5 (40%) operative patients had evidence of deep infection with gross purulence at presentation. Unsuccessful closed reduction or material interposed in the fracture site were cited as operative indications in all cases. 58% of patients received antibiotics, with clindamycin and cephalexin being most commonly used (Table 2). Cephalexin treatment failed in 3 cases (16% of cases using cephalexin), and these patients

were transitioned to clindamycin. Clindamycin was effective in all cases. 3 patients taking clindamycin reported possible mild adverse reactions, with no cases of C. diff (Table 1). 4 of 68 (6%) of nonsurgical patients had evidence of osteomyelitis, and all were treated with clindamycin. Physeal disturbance and nail dystrophy were the most common complications.

Summary Points

- To our knowledge, this is the largest series of chronic pediatric Seymour fractures reported in the literature.
- Surgical indications of chronic Seymour fractures include the presence of frank purulence or the inability to achieve a closed reduction.
- We recommend treatment with clindamycin rather than cephalexin due to better bony penetration for chronic Seymour fractures.

Bibliography

1: Reyes BA, Ho CA. The High Risk of Infection With Delayed Treatment of Open Seymour Fractures: Salter-Harris I/II or Juxta-epiphyseal Fractures of the Distal Phalanx With Associated Nailbed Laceration. J Pediatr Orthop. 2017;37(4):247-253.
2: Al-Qattan MM. Extra-articular transverse fractures of the base of the distal phalanx (Seymour's fracture) in children and adults. J Hand Surg Br. 2001;26(3):201-206.
3: Krusche-Mandl I, Köttstorfer J, Thalhammer G, Aldrian S, Erhart J, Platzer P. Seymour fractures: retrospective analysis and therapeutic considerations. J Hand Surg Am. 2013;38(2):258-264.
4: Abzug JM, Kozin SH. Seymour fractures. J Hand Surg Am. 2013;38(11):2267-2270; quiz 2270.
5: Fraimow HS. Systemic antimicrobial therapy in osteomyelitis. Semin Plast Surg. 2009;23(2):90-99.

AM Poster 404: Are Nerve Transfers Supplanting Nerve Grafting as the Primary Treatment Strategy for Brachial Plexus Birth Palsy?

Category: Pediatrics/Congenital and Nerve

Congenital and Pediatric Problems;Nerve
Level 2 Evidence

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Hypothesis

Primary surgical treatment for brachial plexus injuries utilizing microsurgical techniques has evolved over time due to the increasing popularity of nerve transfer options in adults. The evolution of primary surgical treatment strategies for brachial plexus birth palsy (BPBP) has not been described on a national level. We hypothesize that nerve transfers have supplanted nerve grafting as the primary treatment strategy in children with BPBP.

Methods

The Pediatric Health Information System (PHIS) database was queried to identify all pediatric patients (age 0-18 months) who underwent primary nerve surgery for the treatment of BPBP between 1997 and 2015. Procedures were categorized as neurolysis alone, isolated nerve grafting (with or without neurolysis), isolated nerve transfer procedures (with or without neurolysis) or a combination of nerve grafting and nerve transfer procedures (with or without neurolysis) based on ICD-9 and ICD-10 diagnostic codes and CPT codes. Trend analyses using z-tests were performed to assess fluctuations in rates of these procedures over the study period.

Results

A total of 2,975 primary nerve surgery procedures were performed in children with BPBP (58.1% females) at 49 children's hospitals during the study period of 1997 to 2015. The mean age at the time of surgery was 7.4 ± 1.4 months. The rate of neurolysis alone decreased from 41.2% in 1997 to 16.2% in 2015 ($p<0.001$). Similarly, the rate of isolated nerve grafting procedures decreased from 42.4% to 15.2% over the study period ($p<0.001$). However, the rate of nerve transfer procedures increased significantly from 11.8% in 1997 to 59.0% in 2015 ($p<0.001$). The rate of procedures involving a combination of nerve grafting and nerve transfers also increased significantly (4.7% in 1997 to 9.5% in 2015, $p<0.001$). Over the last decade, orthopaedic surgeons performed nerve transfers 2.4 times more often than nerve grafting procedures for BPBP, while

neurosurgeons and plastic surgeons continued to perform nerve transfers less often than nerve grafting procedures (ratio 0.9 and 0.5 respectively, $p<0.001$).

Summary Points

- The rate of neurolysis as a stand-alone procedure for BPBP has deceased by a factor of 2.5 over the past two decades.
- The rate of nerve transfer procedures for the treatment of BPBP has increased by five times, and has supplanted nerve grafting as the most common primary nerve surgery in children with BPBP.
- Nerve transfers for the treatment of BPBP have been more readily adopted by orthopaedic surgeons in comparison to neurosurgeons and plastic surgeons.

AM Poster 405: Pediatric Upper Extremity Surgery: BMI Does Not Increase Complication Rate

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Shoulder and Arm;Congenital and Pediatric Problems
Level 4 Evidence

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Jacob Lifton
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Kathrine Au, MD

Hypothesis

While the effects of BMI on upper extremity surgical outcomes has been investigated in adults, limited data exists on this topic in the pediatric population. We hypothesized that increasing BMI would not be predictive of increased complication rates in plastic surgery of the pediatric upper extremity.

Methods

All subjects were pediatric patients that underwent inpatient and outpatient reconstructive surgery at Shriner's Hospitals for Children in Los Angeles, CA between 2005 and 2011. Subjects were identified and data collected through a retrospective chart review using IRB-approved protocol. Demographic data such as patient sex and date of birth were recorded, and patient age and BMI at the time of each individual operation were calculated. BMI percentiles were calculated based on patient sex and age at operation, and subjects were classified as Underweight (<5th percentile), Healthy Weight (5th - <85th percentile), Overweight (85th - <95th percentile), or Obese (95th percentile and above). Many operations involved multiple procedures, and for each procedure, procedure type, anatomic location, tissue type involved, and complications were recorded. Postoperative complications included death, wound infection, partial wound dehiscence, hematoma/seroma formation, tissue expander exposure, need for flap coverage, need for short or long dressing, need for hospital admission and observation, or reoperation. Complication rates were compared between BMI percentile groups using Chi-square analysis.

Results

We identified 182 patients who underwent a combined total of 269 operations that comprised a total of 805 procedure codes. The cohort analyzed included 88 females (48.35%) and 94 males (51.65%), with an average age of 13.02 years (standard error = 0.13). The average number of procedures per operation was 2.99 (range 1-27). Of the 805 procedures, 47 (5.84%) included at least one post-operative complication, with a total of 78 complications across all procedures. The most common complication was partial wound dehiscence (2.98%), followed by need for short-dressing (1.86%) and hospital admission (1.37%). Furthermore, only 9 procedures (1.12%) required reoperation. BMI was not demonstrated to be a predictor of post-operative complication rates ($p = 0.669$) (Table 1).

Summary Points

- In our pediatric patient population, BMI was not a significant risk factor for post-operative complications.s
- Inpatient and outpatient plastic surgery of the upper extremity may be safe in the pediatric population with low complication rates and no reported mortality in our study.
- Future studies, involving larger patient populations across multiple institutions, are now necessary to validate these results

AM Poster 406: Glenohumeral Joint Congruity has Minimal Effect on Glenohumeral Motion in Brachial Plexus Birth Injuries

Category: Pediatrics/Congenital and Nerve

Shoulder and Arm;Congenital and Pediatric Problems;Nerve
Level 4 Evidence
Grant received from: Shriners Hospitals for Children Clinical Research Grant (2016-2018)

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Hypothesis

This study aims to investigate the effect of glenohumeral (GH) joint congruity on GH motion following tendon transfer with closed or surgical GH reduction in children with brachial plexus birth injuries (BPBI). It was hypothesized that patients maintaining more congruent joints after surgery would demonstrate greater GH motion.

Methods

Fifty-three subjects with BPBI between the ages of 4-17 who underwent a transfer of latissimus dorsi and teres major or teres major alone participated in this study. Concomitant closed or surgical GH reductions were also performed with the tendon transfer surgery. On the date of study participation, GH joint dysplasia was assessed via ultrasound, and subjects were grouped as either 1) normal/minimal (n=25) or 2) moderate/severe (n=28). Motion capture was used to measure the three-dimensional orientations of the trunk, scapula, and humerus segments as participants held their arms in the positions in Figure 1. Glenohumeral joint angles at each position were calculated using a modified globe method, and GH joint angular displacements were calculated from a neutral position with the arm resting by the side to each of the tested positions. A one-way MANOVA was performed for each of the positions with factor levels of congruity group and dependent variables of GH joint displacements. Pending significant MANOVA results ($a<0.05$), univariate ANOVAs with Bonferroni correction ($a<0.017$) were conducted to determine which of the three GH axes values produced significant results.

Results

Only two significant differences were identified between the minimal dysplasia and moderate/severe dysplasia groups. The mild dysplasia group demonstrated significantly greater ($p=0.014$) GH elevation in the hand-to-nape position than the moderate/severe dysplasia group (25.6° vs. 15.2°, respectively) (Figure 2). During abduction in the scapular plane, the minimal dysplasia group held the arm closer to the scapular plane with 17.9° GH cross-body abduction displacement versus 2.7° in the minimal dysplasia group. There were no significant differences in GH joint displacements in the 13 other positions evaluated.

Summary Points

- Surprisingly, there were only two statistically significant differences in GH joint motion between the normal/minimal dysplasia group and moderate/severe dysplasia group.
- The minimal clinically significant differences in GH joint angular displacements identified in this study suggests that surgical procedures to reduce GH dysplasia in children with BPBI may not provide any functional benefit.
- The dogma of early interventions to prevent and/or reduce GH dysplasia in children with BPBI should be reconsidered with advances in objective outcome measures of GH function.

Bibliography

1: Abzug, J et al. (2010) Journal of Pediatric Orthopaedics, 33(6):430-435.
2: Pearl, M. et al. (1992) Journal of Shoulder and Elbow Surgery, 1(2):113-118.

AM Poster 407: Results of Biofeedback in the Treatment of Chronic Wrist and Forearm Pain in Adolescents

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems
Level 4 Evidence

Matthew Folchert
Cora Breuner
Suzanne Steinman, MD

Hypothesis

Adolescents with chronic wrist and forearm pain can see improvement of their symptoms following biofeedback. Additionally, there is a higher ratio of chronic wrist/forearm pain in females as well as a correlation between report of paresthesias and underlying psychologic issues.

Methods

Thirty-one mutual patients seen by an upper extremity surgeon and a biofeedback expert at a pediatric hospital between 2011 and 2017 were identified using the EMR. Sixteen of these patients met the follow inclusion criteria: between 10 and 18 years old, experiencing wrist or forearm pain for longer than 6 weeks, and referral to an adolescent medicine clinic for the same complaint. Of these patients, 13 were referred to biofeedback (the other 3 had resolution of symptoms with PT/OT prior to referral) and 9 completed a minimum of 5 sessions (1 patient attended a single session, the other 3 were lost to follow-up). Patients' charts were reviewed to determine pain intensity, frequency, and duration for both before and after biofeedback as well as self-report of depression, anxiety, self-harm, or suicidal ideation. Additional collected variables included brace wear, history of injury, ulnar variance, prior medical or surgical treatments, and presence of numbness/tingling/hypersensitivity.

Results

Of those who completed at least five sessions of biofeedback, 8 (89%) had improvement of their symptoms with 5 (56%) having resolution of their pain and 3 reporting improvement as determined by documented pain intensity, duration, and frequency. The single patient without improvement underwent surgery for chronic wrist pain prior to biofeedback referral. Of the 16 total patients in this study, 14 (88%) underwent PT/OT, 11 (69%) used a removable wrist brace/cast/splint, and 14 (88%) were female. Additionally, five of the 16 (31%) patients reported associated numbness/tingling/hypersensitivity. Of these five, 100% had associated anxiety, depression, suicidal ideation, or history of self-harm. Of the 11 patients who did not report

numbness/tingling/hypersensitivity, only 2 (18%) had a history of similar psychologic issues (PPV 100%, NPV 82%).

Summary Points

- Biofeedback can positively impact adolescents suffering from chronic wrist and forearm pain.
- There is a predilection of chronic wrist and forearm pain in females.
- There is a strong correlation between underlying anxiety/depression/SI/self-harm and report of numbness/tingling/hypersensitivity.

Bibliography

1: 1.Hermann C, Blanchard EB. Biofeedback in the treatment of headache and other childhood pain. Appl Psychophysiol Biofeedback. Jun 2002;27(2):143-162.
2: 2.Scharff L, Marcus DA, Masek BJ. A controlled study of minimal-contact thermal biofeedback treatment in children with migraine. J Pediatr Psychol. Mar 2002;27(2):109-119.
3: 3.Hermann C, Blanchard EB, Flor H. Biofeedback treatment for pediatric migraine: prediction of treatment outcome. J Consult Clin Psychol. Aug 1997;65(4):611-616.
4: 4.Labbe EE. Treatment of childhood migraine with autogenic training and skin temperature biofeedback: a component analysis. Headache. Jan 1995;35(1):10-13.

AM Poster 408: Accuracy of Intramuscular Botulinum Toxin Injection in Pediatric Patients with Brachial Plexus Palsy

Category: Pediatrics/Congenital and Nerve

Shoulder and Arm;Congenital and Pediatric Problems;Nerve
Level 4 Evidence

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Background

Birth-related brachial plexus palsy is frequently associated with internal rotation contractures of the shoulder as a result of muscle imbalance. Botulinum toxin A (BTX) injection into muscles that contribute to internal rotation and adduction contractures of the shoulder has demonstrated efficacy and reduced the need for tendon transfers.(1) We seek to assess the accuracy of BTX injection into the affected muscles using muscle palpation and anatomical landmarks alone.

Hypothesis

We hypothesize that injection of BTX using muscle palpation and anatomical landmarks is insufficient to ensure consistent and reliable accuracy of intramuscular injection.

Methods

Between April 2010 and May 2013, 52 patients suffering from sequelae of birth-related brachial plexus injuries underwent BTX injection for contractures of the shoulder and elbow. The patients underwent initial placement of a Teflon-coated needle into the target muscle(s) based on palpation and anatomical landmarks; target muscles included teres major, pectoralis major, subscapularis, and latissimus dorsi. A nerve stimulator was then used to confirm intramuscular placement of the needle. The number of "sticks" necessary to obtain nerve-stimulator confirmation was recorded for each muscle. All procedures were performed by the senior author (JAIG) in all patients.

Results

Sixty-nine BTX procedures were performed on 52 patients. Successful needle stimulation of the targeted muscles was achieved in all cases, but some cases required multiple needle sticks to achieve nerve stimulation. Success rate, measured by the number of stimulator-confirmed needle sticks divided by total number of needle sticks ranged from 50-100%. The mean success rate of nerve-stimulator confirmed needle placement was 88.8%+/-15.9%.

Summary Points

- It has previously been demonstrated that, regardless of injector experience, relying solely on muscle palpation and anatomical landmarks is insufficient to ensure the accuracy of BTX, even for large, superficial muscles.(2)
- Systematic review of the literature suggests that instrumented guidance of BTX injection results in improved intramuscular administration accuracy.(3)
- We have demonstrated that there is an unacceptable level of inaccuracy associated with BTX administered by the use of anatomic landmarks alone. We, therefore, recommend that a nerve stimulator be used when administering BTX to patients with birth-related brachial plexus palsy.

Bibliography

1: Duijnisveld BJ, van Wijlen-Hempel MS, Hogendoorn S, et al. Botulinum Toxin Injection for Internal Rotation Contractures in Brachial Plexus Birth Palsy. A Minimum 5-Year Prospective Observational Study. J Pediatr Orthop. 2017;37(3):e209-e215.
2: Schnitzler A, Roche N, Denormandie P, Lautridou C, Parratte B, Genet F. Manual needle placement: accuracy of botulinum toxin A injections. Muscle Nerve. 2012;46(4):531-534.
3: Grigoriu A-I, Dinomais M, Rémy-Néris O, Brochard S. Impact of Injection-Guiding Techniques on the Effectiveness of Botulinum Toxin for the Treatment of Focal Spasticity and Dystonia: A Systematic Review. Arch Phys Med Rehabil. 2015;96(11):2067-2078.e1.

AM Poster 409: The Role of Neurolysis for Hourglass Constrictions in Chronic Parsonage-Turner Syndrome

Category: Pediatrics/Congenital and Nerve

Nerve;Diseases and Disorders
Level 4 Evidence

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Hypothesis

Wide variability in recovery of patients affected by Parsonage-Turner syndrome (PTS) is now recognized, with up to 60% experiencing residual motor deficits or pain. Using high-resolution MRI and ultrasound (US), we routinely identify hourglass constrictions (HGCs) in affected nerves of patients with persistent motor paralysis from PTS. We hypothesized that patients with chronic PTS and HGCs would experience motor recovery and functional improvement following microsurgical epi- and perineurolysis of the constrictions.

Methods

Eight patients (5 M, 3 F) ages 21-61 years with chronic, persistent motor palsy from PTS and HGCs were treated with microsurgical epi- and perineurolysis of HGCs. Average time from symptom onset was 12.0 ± 4.7 months. Preoperative electrodiagnostic (EDX) testing and manual motor testing confirmed muscle denervation in the distribution of affected nerve(s). HGCs were identified in one or more nerves in all patients using 3.0 T MRI and ultrasound. Microneurolysis was indicated for the following: failure to improve in clinical and EDX function after 6 months with 3 successive exams, each at least 6 weeks apart (n = 3), or 12 months without improvement since symptom onset (n = 5). Muscle strength was assessed pre-and postoperatively using the modified Medical Research Council (MRC) scale and EDX. Changes in MRC and EDX classifications were assessed using a two-tailed Wilcoxon signed-rank test.

Results

Average postoperative clinical and EDX follow-up was 9.5 months (range, 4-17) and included data on 27 of 29 affected muscles. Thirty HGCs in 11 nerves were identified on imaging and confirmed intra-operatively, involving the radial, pronator teres (PT) and anterior interosseous fascicular bundles of the median (AIN), suprascapular, and axillary. One patient initially presented with bilateral disease. 7/8 patients experienced functional recovery and 6/8 experienced electrical recovery in the majority of affected muscles. Average MRC increased from 1.0 ± 1.5 to 3.0 ± 1.6 among the 7 patients with unilateral disease and from 0.7 ± 1.3 to 2.3 ± 1.9 for the entire cohort ($p<0.01$). EMG revealed significant motor unit recovery from axonal regeneration in 16/28 muscles ($p<0.01$).

Summary Points

- High resolution MRI and US imaging detected hourglass constrictions of peripheral nerves and nerve fascicles in PTS patients with chronic, recalcitrant motor palsy
- Microsurgical epi- and peri-neurolysis of HGCs in this small patient cohort was associated with significant electrical and functional muscle recovery at an average of 9.5 months
- We recommend microsurgical epi- and perineurolysis of HGCs for patients with PTS motor palsy who fail to improve with non-operative treatment

Bibliography

1: van Alfen N, van Engelen BG. The clinical spectrum of neuralgic amyotrophy in 246 cases. Brain. 2005;129(2):438-450.
2: Sneag DB, Saltzman EB, Meister DW, Feinberg JH, Lee SK, Wolfe SW. The MRI Bullseye Sign: An Indicator of Peripheral Nerve Constriction in Parsonage-Turner Syndrome. Muscle & Nerve. 2016 Nov 16. doi: 10.1002/mus.25480.
3: Feinberg JH, Nguyen ET, Boachie-Adjei K, Gribbin C, Daluiski A, Wolfe SW. The Electrodiagnostic Natural History of Parsonage-Turner Syndrome. Muscle & Nerve. 2017 Jan 3. doi: 10.1002/mus.25558. [Epub ahead of print]
4: Pan Y, Wang S, Zheng D, et al. Hourglass-like constrictions of peripheral nerve in the upper extremity: a clinical review and pathological study. Neurosurgery. 2014 Jul;75(1):10-22 Images
5: Lee J-Y, Kircher MF, Spinner RJ, Bishop AT, Shin AY. Factors Affecting Outcome of Triceps Motor Branch Transfer for Isolated Axillary Nerve Injury. The Journal of Hand Surgery. 2012;37(11):2350-2356. doi:10.1016/j.jhsa.2012.07.030.

AM Poster 410: Carpal Injuries Pattern in a Paediatric Hand Trauma Unit

Category: Pediatrics/Congenital and Nerve

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

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Kerstin Oestreich

Hypothesis

Whilst blunt trauma to the wrist is a common cause of emergency presentation in the paediatric population, carpal injuries are uncommon(1). The lack of standardized treatment for children with carpal injuries can translate to variability of care. Our aim is to characterize the injury pattern and treatment course of wrist trauma treated in a tertiary hand unit to allow refinement of the local management protocol.

Methods

A prospective audit of consecutive cases of blunt wrist trauma referred to our tertiary hand trauma unit was conducted between September 2017 and April 2018.

Results

37 cases were included. The mean age is 12.3 years (range 7-16). 86% of patients presented within 48 hours of injury to the emergency department, and 70% of cases were referred to our hand unit within the same day. 54% of cases were secondary to fall on an outstretched hand. Immobilisation from the emergency department consisted of casting(35%), splinting(30%), volar slab(19%) and none(16%).

The mean period between referral to initial review at the hand trauma unit is 4 days. 92% of patients described pain, 46% reduced range of motion and 34% swelling of the affected wrist. Plain film radiology revealed a fracture in 28% of cases, no fracture in 36% and suspected fracture in 36%.

At the second review, 43% of patients described pain, 5% with swelling and 5% with reduced range of motion. MRI confirmed carpal fractures in 43% of cases(16 cases), 20% showed no carpal fractures, 22% revealed other pathologies and 15% were awaiting scans. 94% of carpal fractures on MRI involved the scaphoid, with 10 waist fractures, 4 distal pole and 1 proximal pole fracture. 5 cases had concomitant injuries (1 capitate fracture, 2 trapezium fractures, 1 lunate

fracture and 1 metacarpal base fracture, 1 ganglion), and there were 2 cases of distal radius fractures, 1 hamate and 1 pisiform fracture identified.
28 patients have completed treatment. The mean number of clinical visits was 3.2 (range 2-5), with an average of 5.3 weeks follow-up (range 1-11). 4 patients necessitated referral to hand therapy for management of stiffness and persistent pain. None required surgery.

Summary Points

Review of the injury pattern and characteristics of paediatric carpal injuries allow refinement of the local standardised treatment protocol, which can be a valuable tool in the early and medium-term management of children with wrist trauma to reduce the variance in treatment and number of clinical visits.

Bibliography

1: 1. Slaar A et al. A clinical decision rule for the use of plain radiography in children after acute wrist injury: development and external validation of the Amsterdam Pediatric Wrist Rules. Pediatr Radiol 2016;46:50-60.

AM Poster 411: Elbow Flexion Deformity in Children with Birth Brachial Plexus Palsy: An Analysis of its Cause and Prevention

Category: Pediatrics/Congenital and Nerve

Congenital and Pediatric Problems;Nerve
Level 2 Evidence

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Hypothesis

The flexion deformity at the elbow is one of the least researched aspect of birth brachial plexus palsy (BBPP). However, in clinical practice it is a common concern among parents. This study was performed to answer two research questions:
Is the triceps weakness a cause of the elbow flexion deformity?
Does the shoulder deformity and co-contractions contribute to elbow flexion deformity?

Methods

We analyzed 113 consecutive children with BBPP prospectively at their presentation to our out-patient clinic for the presence of elbow flexion deformity. These children were assessed in detail to analyze the cause or contributory factors to the deformity. An additional, 20 patients who underwent surgeries to correct shoulder deformity were analyzed at two years follow up to compare this group of patients with the general cohort so as to know if the improvement in shoulder deformity at early stage had an effect on the elbow flexion deformity in this group of children.

Results

We noted that 90/113 patients had elbow flexion deformity (79.7%) and in 48 children (42.5%) it was more than 30 degrees. The presence of shoulder abduction limitation, biceps-shoulder abductor co-contractions and biceps-triceps co-contractions significantly correlated with the presence and severity of elbow flexion deformity ($p=<0.001$, 0.002 and <0.001 respectively). Overall, the weakness of elbow extension significantly correlated with the presence of elbow flexion deformity ($p=0.01$) but presence of good motor power was not preventive of the deformity as 46/113 children with motor power of 4 or 5 had an average of 30.11 degrees of deformity. The elbow flexion deformity was significantly lesser in 20 children who had early correction of the shoulder deformity. The biceps flexion power and presence of internal rotation deformity at the shoulder were not significantly associated with elbow flexion deformity ($p=0.32$ and 0.94 respectively).

Summary Points

- Elbow flexion deformity is common in children with birth palsy and it was noted in 79.7% of children who visited hospital.
- Children with weak triceps tend to have elbow flexion deformity more often but it is not the sole determinant of elbow flexion deformity and even the children with good triceps power could have elbow flexion deformity (46% in this series).
- Children with limited shoulder abduction and co-contractions between biceps and triceps and biceps and shoulder abductors are at risk of developing elbow flexion deformity.
- Early correction of the shoulder deformity may reduce the severity of elbow flexion contracture in these children.

AM Poster 412: Anastomosis Between the Deep Branch of Ulnar Nerve and a Branch of the Median Nerve (Cannieu-Riché Anastomosis) and Thenar Muscles Innervation: An Anatomical Study and Clinical Implications

Category: Pediatrics/Congenital and Nerve

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

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Edie Benedito Caetano, MD, PhD

Hypothesis

The objective of this paper was to report the incidence of the anastomosis between deep branch of ulnar nerve and a branch of the median nerve commonly named Cannieu-Riché anastomosis (CRA). Furthermore, thenar muscles innervation pattern was evaluated.

Methods

The anatomical dissection of 80 limbs from 40 fresh adult cadavers was performed in the Department of Anatomy at the Medical School of the Catholic University of São Paulo. The incidence of CRA and thenar muscle innervation was studied.

Results

The CRA was found in all dissected hands (100%). The abdutor pollicis brevis and opponens pollicis muscle were innervated exclusively by the median nerve in all dissected hands. The superficial head of flexor pollicis brevis was innervated by the median nerve in 56 (70%) while in 24 (30%) it had double innervation (median nerve and deep branch of ulnar nerve). The deep head of flexor pollicis brevis was absent in 11 hands (14%) and in 52 (65%) a double innervation pattern was observed. In 14 (17.5%), it was innervated exclusively by the deep branch of the ulnar nerve while in 3 hands (3.6 %), exclusively by a branch of the median nerve. The oblique head of adductor pollicis muscle was innervated only by the deep branch of the ulnar nerve in 66 (82%) of dissected hands while 14 (17.5%) had a double innervation. The transverse head of adductor pollicis was innervated exclusively by deep branch of ulnar nerve in 77 hands (96.4%) and in 3 (3.6%) it had a double innervation. The abductor pollicis brevis and opponens pollicis

received innervation exclusively by the median nerve. Both the oblique and transverse heads of adductor pollicis were exclusively innervated by the ulnar nerve.

Summary Points

- Cannieu-Riché anastomosis (CRA) was present in all dissected hands
- The distribution of median and ulnar innervation to the thenar muscles was described

Bibliography

1: Cannieu, A. Recherche sur l' innervation de l'eminence thenar par le cubital. J. Med. Bord., 1896. pp.377-9.
2: Riché, D. Le nerf cubital et les muscles de l'eminence thenar. Bull. Mem. Soc. Anat. Paris, 72:251-2, 1897.
3: Ajmani, M. L. Variations in the motor nerve supply of the thenar and hypothenar muscles of the hand. J. Anat., 189(Pt. 1):145-50, 1996.
4: Bölükbasi, O.; Turgut, M. & Akyol, A. Ulnar to median nerve anastomosis in the palm (Riches-Cannieu anastomosis). Neurosurg. Rev., 22(2- 3):138-9, 1999.
5: Rowntree, T. Anomalous innervation of the hand muscles. J. Bone Joint Surg. Br., 3lB(4):505-10, 1949.

AM Poster 413: Outcomes of Phalangeal Neck Fractures in a Pediatric Population

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems;Practice Management
Level 4 Evidence

Ruth E.Tan
Jin Xi Lim
Alphonsus Chong

Hypothesis

Phalangeal neck fractures occur mostly in the pediatric population. Acute and displaced phalangeal neck fractures are regarded as unstable and hence surgical fixation has been recommended. Less displaced fractures are sometimes treated non-surgically – however, their outcomes have not been well documented. This study aims to investigate the outcome of displaced phalangeal neck fractures treated non-surgically with attention to the change in fracture displacement over time. Our hypothesis: displaced phalangeal neck fractures could be treated non-surgically with acceptable outcomes, with potential for remodeling in these fractures.

Methods

A retrospective review was conducted of pediatric patients with phalangeal neck fractures aged 16 and below who were treated non-surgically at our institution. Patient with open fractures, intra-articular involvement, extension to the physis, delayed presentation (more than 1 week from time of injury) or insufficient data were excluded. Angulation and translation of the distal fracture fragment in both the coronal and sagittal plane were measured from radiographs taken at 2 intervals – within 7 days of the injury and at least 21 days after the injury. Angulation was measured between a line drawn down the perpendicular axis of the phalanx and a 2nd line perpendicular to the articular surface. Translation was measured as a percentage (0, 25, 75 or 100%) of the entire fracture length.

Results

A total of 45 patients treated non-surgically were included. Patients with Type I, IIA, IIB and IIC fractures (classification according to Al Qattan) were noted in our study population. Average radiological follow-up was 4.2 months (SD=13.3). We noted a significant improvement in the sagittal angulation ($p<0.01$) and sagittal translation ($p<0.01$). There was also improvement in coronal angulation ($p=0.26$) and translation ($p=0.37$), but this was not statistically significant. 12 of 45 patients received manipulation and reduction of the fracture before immobilization. Even

with exclusion of these patients, there was still a significant improvement in sagittal angulation (p=0.03). It was found that fracture classification and age did not affect the change in displacement between initial and final radiographs.

Summary

Patients with phalangeal neck fractures treated non-surgically did not displace significantly as the fracture healed. In fact, the significant improvement in sagittal angulation and translation suggests that there is potential for remodelling of phalangeal neck fractures despite no physeal involvement. The above suggests that some Type II (displaced) phalangeal neck fractures in children may be treated conservatively.

Bibliography

1: Al-Qattan MM, Al-Qattan AM. A review of phalangeal neck fractures in children. Injury. 2015;46(6):935-44.
2: Al-Qattan MM. Phalangeal neck fractures in children: classification and outcome in 66 cases. J Hand Surg Br. 2001 Apr;26(2):112-21.
3: Park KB, Lee KJ, Kwak YH. Comparison Between Buddy Taping With a Short-Arm Splint and Operative Treatment for Phalangeal Neck Fractures in Children. J Pediatr Orthop. 2016 Oct-Nov;36(7):736-42.
4: Cornwall R, Waters PM. Remodeling of phalangeal neck fracture malunions in children: case report. J Hand Surg Am. 2004 May;29(3):458-61.

AM Poster 414: Dorsal Coaptation

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Nerve
Level 4 Evidence

John S.Taras, MD

Hypothesis

Dorsal transposition and coaptation with the corresponding digital nerve is an effective treatment for post-amputation symptomatic digital neuromas.

Methods

A retrospective chart review was conducted to assess the effectiveness of neuroma excision with dorsal transposition and epineurial coaptation for postamputation symptomatic digital neuromas. Neuromas were excised using midlateral fish mouth incision. Digital nerves were mobilized to the dorsum of the digital tip and coapted using 9-0 Nylon epineurial suture. The procedure was modified to salvage viable fingernails or to avoid excessive tension. Herndon's and Mass's Criteria systems were used to evaluate effectiveness.

Results

Twenty-four patients with painful neuromas of the radial and ulnar digital nerves after traumatic amputation were included. Thirty-two digits underwent dorsal coaptation. This procedure yielded a success rate of good or excellent in 88% of cases (28 of 32). Eighty-four percent of digits (27 of 32) registered no pain or stump anesthesia after dorsal coaptation. Seventy-eight percent (25 of 32) of digits operated on demonstrated improved condition and caused no interference with activities of daily living. Eighty-one percent (26 of 32) of digits had normal function. Eighty-eight percent of patients (21 of 24) returned to work.

Summary Points

- Neuroma excision with dorsal transposition and epineurial coaptation is an effective treatment for postamputation symptomatic digital neuroma.
- This report presents a new technique designed to limit axon regeneration and mechanical irritation by neuroma excision, dorsal transposition and coaptation with the corresponding digital nerve.

AM Poster 415: Neuroma Prevention with Neurocap in a Rat Sciatic Nerve Model

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Nerve;Diseases and Disorders
N/A - not a clinical study

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Michael J. Wheatley, MD

Hypothesis

In a rat sciatic nerve transection model placement of the proximal stump into a synthetic polymer conduit with a closed end (NEUROCAP®) will limit axonal sprouting and prevent neuroma formation

Methods

In this randomized controlled trial, right sciatic nerves of 34 Sprague Dawley rats were dissected and transected. The rats were divided into a test group, which received the NEUROCAP® device after nerve transection, and a control group (nerve end left in situ). 10 animals were sacrificed at 3 months (5 test, 5 control), 16 animals at 6 months (8 test, 8 control), and 5 animals at 12 months (3 test, 2 control). Animals were assessed for autotomy during their survival period. Gross and microscopic data were collected regarding neuroma formation, inflammation and outgrowth of nerve axons. Histological data were collected using H&E, Neurofilament 200 and LFB stainings. Data were analyzed utilizing unpaired T-tests.

Results

7 animals showed severe autotomy in the first 3 days (3 test and 4 control) and were replaced, autotomy in all animals resolved after 4 months. 3 additional animals (1 test and 2 control) were euthanized due to non-device related complications. Final sample size was 31. Histopathology at the location of the transected nerve determined if a significant effect existed between test and control samples. Samples were histologically scored for chaotic fascicles, inflammation and nerve outgrowth (NO). At 3 months, the test group had more chaotic fascicles (2.6+/-.55), more inflammation (1.6+/-.55) and less NO (.98+/-.41) versus the control group (0.8+/-1.3, p=.02)), (0, p=.0002) and 2.02+/-1.2, p=NS), respectively. One control animal had neuroma formation versus none in the test group. At 6 months the test group had fewer chaotic fascicles (1.5+/-.53), more inflammation (1.25+/-.46) and less NO (1.51+/-.69) versus the control group (2.75+/-.46, p=.0002), p=.0001) and (3.9+/-2.45, p=.019), respectively. 3 of 8 control animals had neuroma

formation, none of the test animals. At 12 months, the test group had fewer chaotic fascicles (1), less NO (1.03+/-0.95) versus the control group (3, p=N/A) and (3.60, p=NS); no inflammation was observed. Both control animals had neuroma formation, none in the test group.

Summary Points

- The test article performed better or equivalent to control treatment at 3, 6 and 12 months with regards to neuroma formation and nerve outgrowth.
- There was more inflammation in the test group but resolved over time.
- Chaotic fascicles, while initially increased in the test group, were fewer with longer follow-up.

Bibliography

1: Yan H, et al Mechanisms of Nerve Capping Technique in Prevention of Painful Neuroma Formation. PLos One 2014;9(4):e93973

AM Poster 416: Seymour Fractures a Retrospective Review of Treatment and Outcomes

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems;Practice Management
Level 4 Evidence
Grant received from: NIH/NCRR Colorado CTSI Grant Number UL1 RR025780

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Hypothesis

Open Seymour fractures are important to recognize and treat promptly as injuries may result in growth disturbance, nail deformity, or infection. Prior retrospective review of 34 patients suggested early surgical treatment is associated with a reduction in superficial infections and osteomyelitis.1 We hypothesize that the administration of antibiotics within 24 hours of injury will be associated with a decreased rate of infection.

Methods

A retrospective review of 75 patients with open Seymour fractures evaluated at a level I pediatric trauma hospital between 2002 and 2017 was conducted. Patients less than 18 years of age with open physes were included if clinical exam and radiographs demonstrated an open Seymour fracture. Those with less than 25 days of follow up were excluded from data analysis. The timing of antibiotic administration and procedural or surgical treatment details were reviewed. The presence of superficial infections or radiographic evidence of osteomyelitis was recorded.

Results

Of 75 patients with open Seymour fractures, 56 had greater than 25 days of follow up and were included in data analysis. The average age at the time of injury was 10.1 years. 35/56 (62.5%) patients were injured secondary to a crush type mechanism. The overall infection rate was 29.3% (17/58 fractures). Among the 29 patients who received antibiotics within 24 hours of injury, 2 infections (6.9%) were noted at final follow up. Delayed administration of antibiotics beyond 24 hours post injury was observed in 18 patients and was associated with an increased

infection rate of 77.8% (14/18, p=0.000). Antibiotic administration and/or timing of administration was not known in 9 patients. There was no significant difference in the rate of infection in patients who received definitive treatment in the emergency department when compared to those that were treated in an operating room (p=0.291).

Summary Points

- Early administration of antibiotics within 24 hours of injury is associated with a reduction in the development of infections.
- Patients with delayed antibiotic administration may be at high risk for early superficial infection or osteomyelitis.
- This study highlights the importance of early identification and appropriate treatment of open Seymour fractures including the prompt administration of antibiotics following injury.

Bibliography

1: BA Reyes, CA Ho. The High Risk of Infection With Delayed Treatment of Open Seymour Fractures: Salter-Harris I/II or Juxta-epiphyseal Fractures of the Distal Phalanx With Associated Nailbed Laceration. J Pediatr Orthop. 2017; 37:247-253

AM Poster 417: Management of Radial Club Hand with Modified Radialization Technique

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Elbow and Forearm;Congenital and Pediatric Problems
Level 4 Evidence

Mohamed Abdel-Wahed

Hypothesis

Congenital Radial Club Hand (RCH) is one of the most challenging pediatric hand anomaly. The standard management of RCH is either centralization or radialization procedures. Both of which can be facilitated by a period of preliminary soft tissue distraction using an external fixator. We hypothesize that Preliminary soft tissue distraction can be followed by pinning of the ulno carpal joint in a corrected position and tendon transfer of FCU to ECU, and this can substitute for the formal capsulotomy utilized to achieve centralization or radialization, this can preserve the range of motion more at the wrist joint.

Methods

5 children with congenital Radial Club hand have been managed with a protocol comprising an initial period of soft tissue distraction using external fixator, the period of which was 4 weeks on average, this was followed by another session in which the carpus was aligned over the ulna using a modification of the radialization technique without formal opening of the capsule, an intramedullary pin was inserted under the image intensifier to maintain the ulno carpal alignment, and tendon transfer of the FCU to ECU was done through a 7 cm ulnar longitudinal incision. The limb was protected in a long arm cast for 6 weeks, followed by a full time splint for 6 months. The pin was left for 6 months and then removed

Results

5 children was managed with the modified radialization technique. Mean age was 4.65 year, and mean follow up was 22 months The primary end point of our study was a clinical recurrence of the radial deformity at last follow-up. Secondary end points were the radiographic parameters and the range of wrist motion at last follow-up. Of the 5 limbs, only one can be considered as having poor clinical results, this required revision surgery to realign the carpus over the ulna, due to visible recurrence of the deformity, after 18 months of the original surgery. Complications were all tolerable and were related to the external fixator used initially for distraction.

Summary Points

- Modified radialization technique is effective for the management of congenital Radial Club hand, it avoids the extensive dissection used for capsulotomy in formal radialization, and this improves the range of wrist motion

Bibliography

1: Dana C, Aurégan JC, Salon A, Guéro S, Glorion C, Pannier S. Recurrence of radial bowing after soft tissue distraction and subsequent radialization for radial longitudinal deficiency. J Hand Surg Am [Internet]. Elsevier Inc.; 2012;37(10):2082–7. Available from: http://dx.doi.org/10.1016/j.jhsa.2012.07.018

2: Manske MC, Wall LB, Steffen J a., Goldfarb C a. The effect of soft tissue distraction on deformity recurrence after centralization for radial longitudinal deficiency. J Hand Surg Am [Internet]. Elsevier Inc; 2014;39(5):895–901.

3: Taghinia AH, Al-Sheikh A a, Upton J. Preoperative soft-tissue distraction for radial longitudinal deficiency: an analysis of indications and outcomes. Plast Reconstr Surg. 2007;120:1305–12; discussion 1313–4.

4: Kessler I, Baruch A, Hecht O. Experience with distraction lengthening of digital rays in congenital anomalies. J Hand Surg Am [Internet]. 1977 Sep [cited 2015 Aug 24];2(5):394–401.

AM Poster 418: Social Support and Coping Strategies in Patients with Brachial Plexus Injury

Category: Pediatrics/Congenital and Nerve

Shoulder and Arm;Nerve;Diseases and Disorders
Level 2 Evidence
Grant received from: UL1 TR000448, Sub award KL2 TR000450 from the NIH-National Center for Advancing Translational Sciences (NCATS), components of the National Institutes of Health (NIH), and NIH Roadmap for Medical Research

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Hypothesis

Increasing attention has been directed towards the relationship between psychosocial characteristics and clinical outcomes. Given the life-altering nature of brachial plexus injuries (BPI), emotional and social characteristics of patients may influence their engagement in the recovery process. We hypothesized that, compared to age- and sex-matched controls, BPI patients have quantifiably different levels of social support and coping strategies.

Methods

Previously validated questionnaires for social support (Interpersonal Support Evaluation List [ISEL-12] and Social Support Questionnaire [SSQ-6]) and coping strategies (Brief COPE) were administered to BPI patients and an age- and sex-matched volunteer cohort (without a history of BPI). Responses for each questionnaire were compared using a paired t-test (for continuous variables) or a chi-squared test (for categorical variables).

Results

Among the BPI patients, 2 completed the surveys before surgery, 3 within 3 months of surgery, and 18 >3 months from surgery. Patients with BPI (n=23; mean/SD 26.6±7.5) and healthy volunteers (n=22; mean/SD 27.5±7.1) scored similarly (p=0.66) on the ISEL-12 assessment of interpersonal support, which has a maximum score of 36. On the SSQ-6, there was no difference in the number of persons listed as available for emotional support (p=0.44), with BPI patients and healthy volunteers reporting a median of 3.5 and 4 persons, respectively. BPI patients and

healthy volunteers reported similar levels of satisfaction with these relationships ($p=0.44$). Of the coping strategies assessed in the Brief COPE questionnaire, the following were significantly more common among BPI patients: active coping, substance use, use of emotional support, behavioral disengagement, venting, positive reframing, planning, humor, and acceptance (all $p<0.05$). There was no difference between the two groups for these coping strategies: self-distraction, denial, use of instrumental support, religion, and self-blame.

Summary Points

- Patients with BPI have similar levels of social support when compared to healthy volunteers, but are more likely to utilize a distinct array of coping strategies.
- Surgeons, hand therapists, and other health care professionals caring for patients with BPI should be aware of the coping strategies favored by their patients, particularly the possibility of substance use.
- This work will inform future investigations into the influence of social support and coping strategies on clinical outcomes and patient engagement after BPI and its surgical treatment.

Bibliography

1: Cooper DC, Ziegler MG, Nelesen RA, Dimsdale JE. Racial Differences in the Impact of Social Support on Nocturnal Blood Pressure. Psychosomatic medicine. 2009;71(5):524-531. doi:10.1097/PSY.0b013e31819e3a93

2: Su X, Lau JT, Mak WW, et al. A preliminary validation of the Brief COPE instrument for assessing coping strategies among people living with HIV in China. Infectious Diseases of Poverty. 2015;4:41. doi:10.1186/s40249-015-0074-9

3: Teresa L. Hagan, Joel N. Fishbein, Ryan D. Nipp, Jamie M. Jacobs, LaraTraeger, Kelly E. Irwin, William F. Pirl, Joseph A. Greer, Elyse R. Park, Vicki A. Jackson, Jennifer S. Temel. Coping in Patients With Incurable Lung and Gastrointestinal Cancers: A Validation Study of the Brief COPE

4: Merz EL, Roesch SC, Malcarne VL, et al. Validation of Interpersonal Support Evaluation List-12 (ISEL-12) scores among English- and Spanish-Speaking Hispanics/Latinos from the HCHS/SOL Sociocultural Ancillary Study. Psychological assessment. 2014;26(2):384-394. doi:10.1037/a0035248

AM Poster 419: Functional, Aesthetic, and Patient Reported Outcomes of Index Pollicization for Thumb Hypoplasia

Category: Pediatrics/Congenital and Nerve

Congenital and Pediatric Problems
Level 4 Evidence
Grant received from: Center for Human Appearance (CHA)

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Hypothesis

Children born with severe thumb hypoplasia often require thumb amputation and index finger pollicization in order to obtain a functional prehensile hand with a more normal appearance. In this study, we evaluated long term functional and aesthetic outcomes of pollicized index fingers.

Methods

All patients who underwent index pollicization were identified and contacted via mail or phone call and invited for examination. At the clinic exam, medical and surgical histories were updated, a clinical exam was performed including range of motion and strength, a Jebsen Hand Function Test (JHFT) was performed, and the Michigan Hand Outcomes Questionairre (MHQ) was administered. Outcomes were tabulated and compared to normal age-adjusted values.

Results

Fourteen patients who underwent pollicization over twelve years were identified and contacted, of which four patients (29%) returned to clinic (Table 1). By and large, patients had good total active range of motion; one patient had hyperextension of their carpometacarpal joint. Compared to age-matched-controls, our patients had diminished strength, about 40% of normal; two patients were unable to generate enough force to engage the dynamometer. During the JHFT, patients tended to be slower to complete the various tasks than age matched controls in all domains, but this was exaggerated in gross motor tasks compared to fine motor tasks. MHQ results showed that patients' hands function well (mean 86) and appeared like a hand aesthetically (mean 80) and that all four patients were satisfied with the result of their pollicization (mean 90). Mean total MHQ scores were 84.

Summary Points

- We confirm that index pollicization provides in an excellent functional and aesthetic thumb for congenital thumb hypoplasia
- Hands undergoing pollicization have weaker grip and pinch strength, but patients are able to acheive prehension and maintain fine motor skills and activities of daily living
- Children having undergone pollicization tend to feel positive about the appaerance of their hands

Bibliography

1: Andersson GB, Gillberg C, Fernell E, Johansson M, Nachemson A. Children with surgically corrected hand deformities and upper limb deficiencies: self-concept and psychological well-being. Journal of Hand Surgery (European Volume). 2011 Nov;36(9):795-801.
2: Taylor NE. Evaluation of hand function in children. Arch Phys Med Rehabil. 1973;54:129-35.

AM Poster 420: Lower Trapezius to Triceps Tendon Transfer in Brachial Plexus Injury: Surgical Technique and Outcome

Category: Pediatrics/Congenital and Nerve

Elbow and Forearm;Shoulder and Arm;Nerve
Level 4 Evidence

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Hypothesis

In brachial plexus palsy cases sparing hand function, reconstructing triceps muscle function is important for hand positioning in space. When nerve reconstruction or traditional tendon transfers, such as latissimus dorsi or posterior deltoid, is not an option, lower trapezius to triceps tendon transfer is an alternative option. This study describes the surgical technique and reviews the clinical outcomes of this transfer.

Methods

A retrospective review of patients undergoing lower trapezius to triceps transfer was performed. The lower trapezius origin is harvested with a strip of lumbar fascia and transferred to the intact triceps tendon without need for additional tendon graft. Outcome measures include preoperative and postoperative British Medical Research Council score, range of motion (ROM), and complications.

Results

Between March 2010 and August 2017, 8 male patients with a mean age of 34.9 years (range, 11-72) underwent a lower trapezius to triceps tendon. All patients had at minimum a posterior cord palsy, 7 secondary to trauma and 1 secondary to a perineurioma. Surgery was performed at a mean of 42 (range, 15-121) months post injury. Mean follow up was 21 (range, 2-55) months. Preoperatively, 7 patients exhibited grade M0 and one had M1 triceps strength. All patients had preoperative M5 trapezius strength except 1 (M4). Postoperatively, all patients developed at least M3 triceps muscle strength, with 5/8 developing M4 or greater. Postoperative elbow mean active ROM was 10°-105° (range, 5-135). Complications included a ruptured tendon transfer in 1 patient, requiring revision surgery ultimately achieving M3 triceps strength.

Summary Points

- Lower trapezius to triceps tendon transfer is a reliable option to restore elbow extension in patients with long standing brachial plexus injury
- Prolonging the lower trapezius origin with a strip of lumbar fascia enables the transfer to reach the triceps tendon without need for additional graft

AM Poster 421: Factors Associated with Failed Ulnar Nerve Fasicle to Biceps Motor Branch Transfer: A Case Control Study

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Elbow and Forearm;Nerve
Level 3 Evidence

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Hypothesis

Restoration of elbow flexion following brachial plexus injury is often regarded as the most important reconstructive goal. Ulnar nerve fascicle (to the Flexor Carpi Ulnaris) to biceps motor branch transfer is a well described and reliable transfer to restore elbow flexion. However, there is a paucity of literature discussing predictors of failed transfers. The purpose of this study was to identify factors contributing to failed ulnar nerve fascile to biceps motor branch transfer.

Methods

A retrospective review of adult brachial plexus patients treated with an ulnar nerve fascicle to biceps motor branch transfer with a minimum 1 year follow-up was performed. Treatment failure was defined by modified British Medical Research Council grade <3 elbow flexion. Controls (M=4- elbow flexion) were randomly selected after matching age, sex and type of surgery. Demographics, mechanism, preoperative examination, and range of motion were compared between groups.

Results

A total of 36 patients, 18 failures and 18 controls, were identified. Average follow-up was 20 months (range, 12-28) in failures and 23 months (range, 12-49) in controls (p=0.34). Mean age (38.2 vs 32.9 years, p=0.25), BMI (28.3 vs 27.8, p=0.80), smoking status (33.3% vs 22.2%, p=0.71), and time from injury to surgery (6.3 vs 5.1 months, p=0.13) were similar between failures and controls. Rate of preganglionic injury was similar between groups (66.7% vs 55.6%, p=0.47), but partial C8/T1 involvement was significantly higher among failures (77.8% vs 27.8%, p=0.007). High energy mechanisms were noted for all patients with no difference in concomitant head injury (33.3% vs 27.8%, p=0.72) or ipsilateral upper extremity injury (50% vs

50%, p=0.99). All patients had preoperative FCU strength =M4, however preoperative FCU weakness (M<5) was significantly more common in failures compared to controls (77.8% vs 33.3%, p=0.02). Additionally, rate of complete FCU recovery was significantly higher in controls (85.7% vs 7.1%, p=0.002). There was no difference in total arc of elbow motion in failures (117 °passive) compared to controls (124° active) (p=0.27).

Summary Points

- Presence of preoperative FCU weakness is associated with a significantly greater risk of failed ulnar nerve fascile to biceps motor branch transfer
- Preoperative FCU weakness (M=4) should not be considered a contraindication to fascicular transfer as excellent outcomes can be obtained if near normal FCU recovery occurs

AM Poster 422: Use of Hexapod Frame to Gradually Correct Congenital and Acquired Forearm Deformity

Category: Pediatrics/Congenital and Nerve

Elbow and Forearm;Congenital and Pediatric Problems;General Principles
Level 4 Evidence

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Hypothesis

Forearm deformity is a common problem affecting patients with Multiple Hereditary Exostosis (MHE), Ollier's Disease and after post-traumatic physeal arrest. The correction of such deformities is complicated by the lack of a normal contralateral for comparison as well as the risk of neurovascular compromise when making large, acute deformity correction in multiple planes. We hypothesized that the use of hexapod frame would allow for reliable correction of forearm deformity without neurovascular compromise.

Methods

This retrospective, case series reviewed all patients undergoing osteoplasty of the radius and ulna between January 1, 2008 and December 31, 2017 among two surgeons. Patient demographics, comorbidities, and external fixation index (EFI, defined as the duration of external fixation in months divided by the total amount of bone transported and/or the amount of lengthening in centimeters) were recorded from chart review. Radiographs were reviewed for pre- and post-fixation deformity frontal and lateral plane length and angular measurements as well as point of maximum radial bow from the radial tuberosity to the radial styloid. Complications were recorded.

Results

Nine patients were identified as having undergone osteoplasty of the radius or ulna with hexapod frame. Five patients presented with a diagnosis of MHE, two patients with a diagnosis of Ollier's, one with SHOX deletion and one with post-traumatic growth arrest. The rate of lengthening proceeded between 0.5-1 mm/day in all cases with an average EFI of 3.7 months/cm for the radius and 7.4 months/cm for the ulna. Average radius lengthening was 1.5 cm and average ulnar lengthening was 2.7 cm. Average radial bow preoperatively was 17.9 mm with a location of the maximal radial bow at an average of 61% from the radial tuberosity.

Postoperative radial bow was corrected to 11.9 mm on average with a location of the maximal radial bow at an average of 63%. Frontal and lateral plane correction of the radius and ulna was achievable with hexapod frame (Table 1). No patients exhibited nerve deficit nor neurapraxia at the conclusion of treatment; however, one fracture at the osteotomy site occurred after frame removal, which was treated with open reduction and internal fixation.

Summary Points

- Severe deformities of the forearm are associated with various genetic abnormalities as well as post-traumatic growth arrest and represent complex clinical problems
- Hexapod frames can be used to gradually correct forearm deformities without neurovascular compromise

Bibliography

1: Abe M, Shirai H, Okamoto M, Onomura T. Lenthening of the Forearm by callus distraction. J Hang Surg Br. 1996;21B(2):151-163.
2: Villa A, Paley D, Catagni MA, Bell D, Cattaneo R. Lengthening of the forearm by the Ilizarov technique. CORR 1990;250: 125-137.
3: Raimondo RA, Skaggs DL, Rosenwasser MP. Lengthening of pediatric forearm deformities using the Ilizarov technique: functional and cosmetic results. J Hand Surg 1999;24A: 331-338.

AM Poster 423: Brachial Plexus Birth Injury is Poorly Represented in the General Pediatric Literature

Category: Pediatrics/Congenital and Nerve

Congenital and Pediatric Problems;Nerve
N/A - not a clinical study

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Hypothesis

Late referrals observed in clinical practice suggest that general pediatricians may not receive up-to-date or accurate information regarding brachial plexus birth injuries (BPBI). It was hypothesized that articles about BPBI are under-represented compared to other medical or surgical topics of similar incidence.

Methods

All 22 general pediatric journals within the top 50 Scimago Journal & Country Rank (SJR) were identified. Three searches were completed within these journals using Scopus, Ovid Medline, and PubMed. Articles prior to 1972 were not included. Search terms included brachial plexus, birth palsy, Erb palsy, obstetrical palsy, neonatal palsy, and plexus injury. An analogous process was carried out for cystic fibrosis and congenital heart defects. All articles were then reviewed by 3 independent reviewers, and a concordance analysis was performed to identify relevant facts and recommendations contained within each article.

Results

There were a total of 138 articles among the 3 searches. Analysis of the manuscripts resulted in elimination of 128 articles (93%) unrelated to the topic. Ten relevant articles were reviewed for content. By comparison, there were 417 articles in the journal “Pediatrics” on a just a Pubmed search of “cystic fibrosis” and 784 for “congenital heart defect.”
Of the 10 articles on BPBI:

- Six of the ten articles did not mention diagnostic testing.
- Six articles did not mention an accepted rehabilitation program.
- Four articles failed to define the timing of surgery, and only four clearly stated a 3-6 month time frame.
- Five articles had no early treatment recommendations, such as glenohumeral joint stretching.

- There was no consensus on referral strategy.
- Only one article alluded to timing of motor endplate demise.

Summary Points

- Diseases with similar or lower incidence such as moderate to severe congenital heart defects (3:1000) and cystic fibrosis (1:3500) are much more frequently addressed in the general pediatric literature.
- Of all the literature analyzed, only one article contained a proper referral plan.
- Nearly half the articles failed to mention a viable diagnostic, rehabilitation, or surgical treatment plan.
- Only one article mentioned poor muscle function recovery after 18 months. With sporadic mention of what needs to be done, by whom, and when, pediatricians have little to no information regarding the urgency of nerve surgery or when and where to refer patients for specialty evaluation.
- Improved interdisciplinary publication and education efforts may facilitate early and appropriate referral of patients with BPBI.

Bibliography

1: Piatt, JH, et al. (2004) Pediatric Clinics of North America. 51: 421-440
2: Lindqvist, PG, et al. (2012) Acta Paediatrica. 101: 5790-582
3: Dodds, SD, et al. (2000) Current Opinions in Pediatrics. 12: 40-47
4: Andersen, J, et al. (2006) Journal of Paediatrics and Child Health 11(2): 93-100
5: Chater, M, et al. (2004) Journal of Paediatrics and Child Health 9(8): 556-560

AM Poster 424: Controlling Axonal Regeneration with Acellular Nerve Allograft Reduces Neuroma Formation Following Peripheral Nerve Transection in Both a Rodent and Swine Model

Category: Pediatrics/Congenital and Nerve

Nerve
N/A - not a clinical study
Grant received from: Congressionally Directed Medical Research Program (CDMRP) W81XWH-15-1-0625, 2015

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Amy Moore, MD

Hypothesis

Previous research using acellular nerve allografts (ANA) has shown an unintentional, controlled termination of axonal regrowth in long graft lengths. The purpose of this study was to test the hypothesis that coaptation of a long (5 cm) ANA would prevent neuroma formation following transection of a peripheral nerve in both a rodent and swine model.

Methods

Lewis rats (n=75) underwent transection of the sciatic nerve and were randomized to one of five groups: transection only, traction neurectomy, proximal crush only, proximal crush with ANA, and ANA only. At 20 weeks, nerves from both groups were harvested and quantitative histologic analysis was performed. The dorsal root ganglion (DRG) was also harvested and assessed for pain marker expression. In the second arm of the study, female Yucatan miniature swine (n=20) were randomly assigned to control (ulnar nerve transection proximal to the medial epicondyle only) or treatment (ulnar nerve transection and coaptation of a 5cm long ANA). At 20 weeks, the transected nerves including neuroma or graft were harvested and quantitative histologic analysis was performed.

Results

Neuroma formation was observed in control group rats, whereas groups with ANA coapation showed controlled arrest of axon regeneration within the ANA. Immunohistochemistry and histomorphometric data demonstrated axonal regeneration into the proximal portion of the 5 cm ANAs with a gradual distal tapering. Additionally, analysisof DRG from treatment groups showed decreased levels of pain related gene expression (BDNF, Fos, Gal). Early results from the swine model suggest that neuroma formation is consistently found in the control group as compared to the treatment arm which does not appear to have formed neuromas. The number of myelinated axons [Figure 1] was significantly decreased in treatment group (1248 +/- 581) as compared to control group (44380 +/- 7204) ($p=0.0002$). Cross sectional area of nerve tissue [Figure 2] was significantly smaller in treatment group (9.14 +/- 1.19 mm2) as compared to the control group (3.46 +/-1.87 mm2) ($p=0.02$).

Summary Points

- Aberrant axonal growth is controlled to termination with coaptation of a 5 cm ANA in both a rodent and swine model of nerve injury.
- Gene expression data in the rodent model supports pain mediation, but behavior testing is ongoing to confirm these findings.
- These early results suggest further investigation of this technique to prevent and/or treat neuroma formation.

AM Poster 425: Functional Outcomes of Short Duration Electrical Stimulation on Rat Sciatic Nerve Repair

Category: Pediatrics/Congenital and Nerve

Nerve
N/A - not a clinical study
Grant support received from: 2016 AFSH Basic Science Grant.

Carol Fouad, MD
Galina Pylypiv, MS
William D. Lanzinger, MD
Rebecca Kuntz Willits, PhD

Hypothesis

The purpose of this study was to evaluate the effect of electrical stimulation on a critical nerve gap in a rat sciatic nerve model for peripheral nerve injury. We hypothesized that the addition of intra-operative short duration electrical stimulation would improve functional outcomes compared to the current gold standard of nerve repairs with auto(iso)grafts alone.

Methods

Forty male rats underwent a surgically induced peripheral nerve injury to the right sciatic nerve with creation of a 13 mm gap followed by direct repair with donor auto(iso)graft. All of these rats also underwent sham surgery on the contralateral extremity, but only half were randomly selected to receive ten minutes of intraoperative 24 V/m-DC electrical stimulation. Functional testing including sensory response time to a heat stimulus, extensor postural thrust strength measurement, and sciatic functional index was performed biweekly for 12 weeks. The experimental leg was normalized to the sham leg leading to percent sensory deficit and percent motor deficit values. One-way ANOVA compared percent deficit values between electrical stimulation and control groups. An ANOVA with repeated measures was utilized to compare each group throughout the 12 weeks and demonstrate any improvement over time. Repaired sciatic nerves from both groups at 6 and 12-weeks were stained with osmium black and nerve fibers were quantified. Experimental gastrocnemius muscles were weighed. For all statistical evaluations, a p-value below 0.05 was considered significant.

Results

Rats that underwent electrical stimulation showed a statistically significant increase in extensor postural thrust motor response at post-operative weeks 4 ($p=0.04$) and 6 ($p=0.02$) compared to the control group and significantly lower percent motor deficit compared to the sham leg at those time points. The electrical stimulation group also had statistically significant increase of

axon fiber density of the distal nerve segment compared to the control group (p=0.048).There was no statistical difference compared to the control group in sensory response time, sciatic functional index or gastrocnemius muscle weights.

Summary Points

- -Statistically significant earlier motor recovery with the application of short duration intra-operative electrical stimulation to a peripheral nerve repaired with auto(iso)graft compared to repair with isografts alone
- -Statistically significant increase in axon fiber density distal to nerve-graft anastomosis site with use of short duration intra-operative electrical stimulation compared to controls
- -Statistically significant functional gains throughout the post-operative period of 12 weeks with intra-operative electrical stimulation

This research was supported by a Basic Science Grant from the American Foundation for Surgery of the Hand.

AM Poster 426: Factors Associated with Reoperation after Surgical Treatment for Neuroma

Category: Pediatrics/Congenital and Nerve

Nerve
Level 4 Evidence

Nicolaas Wolvetang,
Jonathan Lans, MD
Svenna Verhiel, MD
Bo Notermans
Neal Chen, MD
Kyle Eberlin, MD

Hypothesis

There are no factors associated with reoperation after surgical treatment for symptomatic neuroma.

Methods

We retrospectively identified all patients undergoing primary surgery for neuroma using CPT codes. All adult patients that were treated between 2002 and 2016 at a single hospital system were included (n=735). The diagnosis neuroma was based on physical examination and patient history in the medical charts describing pain at a distinct cutaneous point, change in sensibility, weakness or a positive Tinel's sign. The median age was 41.3 (IQR:30.6-51.4) years and patients were followed up for an average of 17.4+/-27.0 months. Neuromas were treated by excision (17.8%, n=139), burying in muscle or bone (41.3%, n=323), excision with direct neurorrhaphy with or without nerve grafting (38.9%, n=304) or other miscellaneous treatments (flap coverage, nerve capping and burying or excision and collagen grafting) (2.1%, n=16). We performed a medical chart review to collect data regarding patient-, neuroma- and treatment characteristics along with postoperative complications and reoperation. A secondary surgery for neuroma was defined as additional unplanned surgery of the same painful location as primary neuroma surgery.

Results

The rate of secondary neuroma surgery was 6.5% (51 of 782) after a median of 14.1 (IQR 6.1-34.4) months. In patients with non-neuroma related prior surgery or trauma the time-to-neuroma-surgery was a median of 7.7 (4.4-16.4) months and 6.6 (IQR 1.9-14.6) months respectively ($p<0.001$). Neuromas located on the trunk (OR 0.3, 95% CI: 0.1-0.9, $p=0.04$) were

independently associated with lower secondary neuroma surgery rates compared to the upper extremity. In the primary neuroma surgery treatment group excision and direct neurorrhaphy with or without nerve graft was independently associated with lower secondary surgery rates compared to burying of the neuroma (OR 0.2, 95% CI: 0.1-0.6, p=0.002). When treated by an untrained surgeon in microsurgical nerve repair patients had a lower rate of a secondary neuroma surgery compared to a surgeon trained in microsurgical nerve repair (OR 0.2, 95% CI: 0.1-0.5, p=0.001). The 51 (6.5%) patients that underwent secondary neuroma surgery had this because they still had pain and, or hypersensitivity in most cases (96.1%, n=49).

Summary Points

- Neuroma excision with direct neurorrhaphy or nerve grafting has a lower secondary neuroma surgery rate than nerve excision or neuroma burying.
- Neuromas of the trunk have lower rates of secondary surgery compared to the upper extremity.
- Neuroma treatment by a surgeon trained in microsurgical nerve repair is associated with higher secondary neuroma surgery rates.

AM Poster 427: Unicondylar Phalanx Fractures in Children

Category: Pediatrics/Congenital and Nerve

Hand and Wrist
Level 4 Evidence

Kristin Shoji, MD

Hypothesis

Timely diagnosis and treatment of unicondylar phalangeal fractures are important, as restoration of articular congruity is essential for optimal range of motion and function1-3. There is a paucity of information about unicondylar fractures in children, particularly in patients with delayed presentation. The objective of this study was to compare the radiographic and functional outcomes of pediatric patients after acute versus delayed surgical fixation of unicondylar phalanx fractures.

Methods

Following IRB approval, the EMR of a pediatric tertiary care Level I trauma center was queried. Thirty-five patients with unicondylar phalanx fractures treated with surgical fixation from 2004-2016 were identified. Preoperative and postoperative imaging was evaluated, clinic and operative notes were reviewed. Fracture patterns were classified as described by Weiss et al4. Acute treatment was defined as less than or equal to 4 weeks between date of injury and date of surgery, and chronic was defined as greater than 4 weeks.

Results

There were 24 acute and 11 chronic patients. Of the 24 acute fractures, 18 were oblique volar, 5 volar coronal, and 1 was dorsal oblique; of the 11 chronic fractures, 5 were oblique volar, 4 volar coronal, 1 was dorsal coronal. Joint alignment was determined by measuring the angle between the longitudinal axis of the affected phalanx and a line tangent to the articular condyles. Average joint alignment in the acute group was 6.2 degrees and 11.9 degrees in the chronic group. Of the acute fractures, 7 underwent closed reduction percutaneous pinning and 17 underwent open reduction and fixation (ORIF). Of the chronic fractures, 4 underwent ORIF, 5 underwent osteotomy and ORIF, and 2 underwent advancement osteotomy. Alignment was within 3 degrees of neutral in 21 of the acute injuries and in 8 of the chronic injuries. Average interphalangeal joint motion at the final clinic visit was 1 - 92 degrees in the acute and 9 - 78 degrees for the chronic group. Two patients developed avascular necrosis (AVN), both of which presented with chronic injuries; one underwent ORIF and the second osteotomy and ORIF.

Summary Points

- Unicondylar phalanx fracture patterns and characteristics are similar in pediatric patients as in adults.
- A considerable proportion of unicondylar fractures are missed at initial presentation or delayed in seeking surgical care.
- Radiographic and functional outcomes are improved with both acute and chronic surgical fixation.
- AVN may be more likely in chronic injuries and with disruption of the fracture callus rather than with condylar advancement osteotomy.

Bibliography

1: Tuncer S, Aksu N, Dilek H, Ozkan T, Hamzaoglu A. Fractures of the fingers missed or misdiagnosed on poorly positioned or poorly taken radiographs: a retrospective study. J Trauma. 2011;71: 649–655.

2: Cornwall R, Ricchetti, ET. Pediatric phalanx fractures: unique challenges and pitfalls. Clin Orthop Relat Res. 2006;445: 146-156.

3: Hastings H II, Simmons BP. Hand fractures in children. A statistical analysis. Clin Orthop Relat Res. 1984;188:120 –130.

4: Weiss A, Hastings H II. Distal unicondylar fractures of the proximal phalanx. J Hand Surg.1993;18A:594-9.

AM Poster 428: Radial Nerve Palsy: Nerve Transfer Versus Tendon Transfer to Restore Function

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Nerve
Level 4 Evidence

J. Megan Patterson, MD

Hypothesis

In this study the authors evaluate the clinical outcomes of patients with radial nerve palsy treated with either median to radial tendons transfers (TT) or nerve transfers (NT) utilizing redundant fascicles of median nerve to the posterior interosseous nerve.

Methods

A retrospective chart review was performed of the clinical records of patients with radial nerve injuries who underwent either tendon or nerve transfer procedures between 2009 and 2017. Seventy-one patients were treated for radial nerve injuries, 42 with TT and 29 with NT. Patients with combined nerve injuries were excluded from the study leaving 47 patients treated for isolated radial nerve injuries. Sixteen of these patients were treated with NT and 31 patients with TT. Fifteen of the 16 patients treated with NT also underwent concomitant pronator teres to extensor carpai radialis tendon transfer to serve as an internal splint for wrist extension. Charts were reviewed for demographic and pre and postoperative strength data. All patients were evaluated using the Disabilities of the Arm, Shoulder and Hand (DASH) Score. The average duration of follow-up was 67 weeks.

Results

Patients treated with NT were significantly younger than those treated with TT (33 vs 48 years old, $p < 0.01$). Women were more likely to be treated with NT (7/16 vs 8/31). Time from injury to surgery was significantly shorter for patients treated with NT (29 vs 125 weeks, $p < 0.02$). Average follow-up was significantly longer for patients treated with NT (108 vs 45 weeks, $p < 0.002$). Post-operative grip strength was higher in the NT group ($p < 0.005$). Both groups showed a significant improvement in DASH and QOL scores after surgery ($p < 0.05$ for TT and $p < 0.002$ for NT) with no significant difference seen between the two groups.

Summary Points

- The radial nerve is commonly injured causing significant morbidity. The median nerve provides a reliable source of both muscle tendon unit and nerve fascicles for either tendon transfer or radial nerve reinnervation.
- Patients treated with both NT and TT showed similar improvements in pain, function, and satisfaction.
- Patients who present for treatment earlier are better candidates for NT, though time to maximal recovery is significantly longer for these patients compared to those treated with TT.
- Both TT and NT are good options for patients with radial nerve palsy with NT patients showing slightly increased grip strength at final follow-up.

AM Poster 429: A Comparison Between Two Collagen Nerve Conduits and Nerve Autograft: A Rat Model of Motor Nerve Regeneration

Category: Pediatrics/Congenital and Nerve

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

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Hypothesis

The use of a novel polyglycolic acid conduit (Nerbridge, Toyobo Co., Ltd., Osaka, Japan), which uniquely contains collagen fibers within the tube, would generate motor recovery equivalent to that of autograft, and superior to a hollow collagen conduit (NeuraGen nerve guide, Integra, Plainsboro, NJ) as a result of its internal scaffold.

Methods

72 Sprague-Dawley rats were randomized into 3 experimental groups, in which a unilateral 10-mm sciatic defect was repaired using either nerve autograft, a hollow collagen conduit, or a collagen-filled conduit. Outcomes were measured at twelve and sixteen weeks postoperatively, and included bilateral tibialis anterior muscle weight, voltage and force maximal contractility, assessment of ankle contracture, and nerve histology. Results were expressed as a percentage of recovery from the contralateral side. Kruskal-Wallis analysis was utilized (alpha= 0.05) with post-hoc Bonferroni-correction for multiple comparisons.

Results

In all groups, outcomes improved between 12 and 16 weeks. On average, the autograft group outperformed both conduit groups, and the hollow conduit demonstrated improved outcomes than the collagen-filled conduit. Differences in contractile force, however, were significant only at 12 weeks (autograft > hollow collagen conduit > collagen-filled conduit) with the results at 16 weeks demonstrating no significant difference but corroborating the same absolute results (autograft > collagen-filled conduit).

Summary Points

- Nerve repair using motor nerve autograft provided superior motor nerve recovery over the two synthetic conduits for a 10-mm nerve gap in a murine acute transaction injury model, with the hollow collagen conduit outperforming the collagen-filled conduit.
- The collagen-filled conduit demonstrated an accelerated rate of recovery between 12 and 16 weeks postoperatively, highlighting a possible point of further study.
- The use of nerve autograft remains the gold standard in reconstruction of a segmental motor nerve defect, outperforming both types of collagen conduits.

Bibliography

1: Shin RH, Vathana T, Giessler GA, Friedrich PF, Bishop AT, Shin AY. Isometric tetanic force measurement method of the tibialis anterior in the rat. Microsurgery. 2008;28(6):452-457. doi:10.1002/micr.20520.
2: Shin RH, Crum BA, Shin AY. Treatment of a segmental nerve defect in the rat with use of bioabsorbable synthetic nerve conduits: a comparison of commercially available conduits. J Bone Joint Surg Am. 2009;91(9):2194-2204. doi:10.2106/JBJS.H.01301.
3: Giusti, Guilherme; Willems, Wouter F.; Kremer, Thomas; Friedrich, Patricia F.; Bishop, Allen T; Shin AY. Return of Motor Function After Segmental Nerve Loss in a Rat Model: Comparison of Autogenous Nerve Graft, Collagen Conduit, and Processed Allograft (AxoGen). J Bone Jt Surg. 2012;94(5):410. doi:10.2106/JBJS.K.00253.
4: Moore AM, Kasukurthi R, Magill CK, Farhadi FH, Borschel GH, Mackinnon SE. Limitations of conduits in peripheral nerve repairs. Hand. 2009;4(2):180-186. doi:10.1007/s11552-008-9158-3.
5: Tan A, Rajadas J, Seifalian AM. Biochemical engineering nerve conduits using peptide amphiphiles. J Control Release. 2012;163(3):342-352. doi:10.1016/j.jconrel.2012.08.009.

AM Poster 430: Trends and Outcomes in the Use of Nerve Grafts for Treatment of Major Peripheral Nerve Injury

Category: Pediatrics/Congenital and Nerve

Nerve
Level 2 Evidence

Neill Li, MD
Justin Kleiner
Andrew P. Harris, MD
Christopher Got, MD

Hypothesis

Advances in nerve reconstruction techniques and research have led to an increasing number of nerve graft procedures in the management of major peripheral nerve injuries over a 13 year period.

Methods

The National Inpatient Sample (NIS) between the years of 2002 and 2014 were queried for major peripheral nerve injuries (International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis code: 955.0 – axillary nerve, 955.1 – median nerve, 955.2 – ulnar nerve, 955.3 – radial nerve, 955.4 – musculocutaneous nerve). Injuries that underwent peripheral nerve grafting were separated with ICD-9-CM procedures code 045. Weighted frequencies were calculated for national estimates of upper limb peripheral nerve injury and nerve surgery procedures. Demographic variables (sex, race, age, insurance), hospital characteristics, total charges, length of stay, complication rate, and mortality rate were evaluated. Rao-Scott Chi-Square Tests, Fisher's exact tests, and multivariable regressions were used with p values of < 0.05 determined to be significant a priori.

Results

Between 2002 and 2014, 94,911 patients sustained major peripheral nerve injury. The trend for nerve grafting was significantly increased from 2.55% intervention in 2002 to 6.05% in 2014 ($p<0.001$)(Figure 1). There were significantly more male nerve injuries (69,239) than female (25,269). Females were significantly less likely to undergo nerve grafting compared to males (OR: 0.615, 95%CI: 0.486 – 0.776, $p < 0.001$). No differences were found with race, insurance status, or age. Patients at teaching hospitals were 2.5 times more likely to undergo nerve grafting than patients at non-teaching hospitals (95% CI: 1.94 – 3.229, $p<0.001$). Post-operative outcomes including total charges, and mortality rate were found to be significantly higher following major peripheral nerve surgery than non-operative treatment. Multivariable regression

demonstrated that major peripheral nerve grafting procedures have 2 times the risk for complication compared to those without grafting (Table 1).

Summary Points

- Nerve grafting procedures following major peripheral nerve injury have significantly increased over time.
- Nerve graft procedures for major peripheral nerves demonstrated a higher complication rate than injuries not undergoing surgery.
- Teaching hospitals had higher odds of performing nerve grafts than non-teaching hospitals
- Male patients undergo a significantly higher number of nerve grafting procedures than females
- With the increasing popularity and continued advances in nerve grafting techniques and grafting options, further research is required to improve the safety and efficacy of major peripheral nerve repair.

Bibliography

1: Squitieri L, Steggerda J, Yang LJ-S, Kim HM, Chung KC. A National Study to Evaluate Trends in the Utilization of Nerve Reconstruction for Treatment of Neonatal Brachial Plexus Palsy [Outcomes Article]. Plast Reconstr Surg. 2011;127(1):277-283. doi:10.1097/PRS.0b013e3181f95c1e

2: K. H, T. Z, M. H, W. X. Thirty-Day Perioperative Adverse Outcomes After Peripheral Nerve Surgery: An Analysis of 2351 Patients in the American College of Surgeons National Surgical Quality Improvement Program Database. World Neurosurg. 2016;94:409-417. doi:http://dx.doi.org/10.1016/j.wneu.2016.07.023

3: Lin MY, Manzano G, Gupta R. Nerve allografts and conduits in peripheral nerve repair. Hand Clin. 2013;29(3):331-348. doi:10.1016/j.hcl.2013.04.003

AM Poster 431: What is the Annual Incidence of Surgery for Brachial Plexus Injury in the United States?

Category: Pediatrics/Congenital and Nerve

Nerve;Diseases and Disorders
Level 4 Evidence
Grant received from: UL1 TR000448, Sub award KL2 TR000450 from the NIH-National Center for Advancing Translational Sciences (NCATS), components of the National Institutes of Health (NIH), and NIH Roadmap for Medical Research

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Hypothesis

Injury heterogeneity and specialized care for brachial plexus injuries (BPI) have made it difficult to estimate the annual incidence of BPI in the United States (USA). Prior studies have not captured the national experience, relying on large single-center series or population-based estimates from limited states and years. Our objectives were both descriptive: (1) to estimate incidence of surgically-treated BPI; (2) to report time from injury-to-surgery among commercially-insured patients with BPI.

Methods

We used an administrative claims database of privately-insured individuals to identify 485 patients who underwent BPI surgery from 2008-2014 with a discernible injury date (detected via diagnosis and injury/E-codes in year prior to BPI surgery). Those with multiple BPI surgeries were censored after their first surgery. Number of days from injury-to-surgery was tabulated. Incidence estimates of surgically-treated BPI per 100,000 persons were calculated from the total beneficiaries enrolled in health plans. These estimates were extrapolated to the general population (all insurance types) based on a previously-published estimate that 47% of BPI cases were paid by private insurers.

Results

The average incidence from 2008-2014 of surgically-treated BPI was 0.66 per 100,000 privately-insured persons; when extrapolated to all payers, the average incidence from 2008-2014 was 1.41 per 100,000 persons. There was an overall increase in surgically-treated BPI from 2008 (0.48 per 100,000 privately-insured persons) and 2014 (0.98 per 100,000 privately-insured

persons) (yearly estimates shown in Figure). Median time from injury-to-BPI surgery among privately-insured was 247 days (interquartile range: 98, 493 days), with 60% having surgery >6 months after injury, 47% having surgery >9 months after injury, and 36% having surgery >1 year after injury.

Summary Points

- The estimated incidence of surgically-treated BPI in the USA is 1.0 per 100,000 persons. This estimate will inform assessments of disease burden for clinical and research resource allocation.
- There has been a notable increase in surgically-treated BPI in the USA from 2008 to 2014. This may reflect changes in actual injury epidemiology, but may also reflect shifts in practice patterns and supply of BPI surgeons.
- BPI surgery in the USA is delayed in many cases, with a median time from injury-to-surgery of 8.7 months and 36% of patients having surgery more than 1 year after surgery. These numbers are similar to a recent report of 3 all-payer, state-level administrative datasets. While there is a role for observation in BPI treatment, increased efforts must be made to enhance referral networks and awareness of referring providers.

Bibliography

1: Midha R. Epidemiology of brachial plexus injuries in a multitrauma population. Neurosurgery. 1997;40(6):1182-1189.
2: Lad, S.P., et al., Trends in median, ulnar, radial, and brachioplexus nerve injuries in the United States. Neurosurgery, 2010. 66(5): p. 953-60.
3: Dy CJ, Baty J, Saeed MJ, Olsen MA, Osei DA. A population-based analysis of time to surgery and travel distances for brachial plexus surgery. Journal of Hand Surgery. 2016;41(9):903-909. e903.

AM Poster 432: Outcomes of Pediatric Scaphoid Nonunions Treated with Distal Radius Autograft

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Congenital and Pediatric Problems
Level 4 Evidence

Greg R. Grenier, DO
Julie Samora, MD, PhD
Pierce Ebaugh DO

Hypothesis

Pediatric patients with scaphoid fracture non-unions will have good outcomes with the utilization of distal radius cancellous autograft.

Methods

A retrospective review was performed at a large tertiary care pediatric hospital from 2012-2017 identifying patients =18 years of age with scaphoid fracture non-unions treated with open reduction and distal radius cancellous autograft. Charts were evaluated for demographic data, mechanism of injury, length of time from injury to treatment, operative procedure, length of immobilization, time to union, use of a bone stimulator, and complications. QuickDASH and PROMIS scores were collected on a small cohort of patients.

Results

A total of 26 patients met the inclusion criteria, 2 of whom were female. The average age was 15.3 years (11-18). The majority of fractures were sustained during sports or secondary to a fall, and most injuries (70%) occurred in the dominant hand. The average time between injury and orthopaedic evaluation was 208 days (0-1125 days). 84.6% of fractures occurred at the waist, and 15.4% occurred at the proximal pole. 8 of 26 (30.7%) patients presented with a DISI deformity. 23 of 26 (88.5%) patients were treated with a single cannulated compression screw with autograft. The average time to union was 111.5 days, with all fractures achieving union. Proximal pole fractures took on average 138.5 days to unite, while waist fractures took 104.7 days (p=0.13). Average post-operative immobilization duration was 84 days (38-175 days). 5 patients (19.2%) were prescribed a bone stimulator, the majority of whom had a proximal pole fracture. There was resolution of all pre-operative DISI deformities at final radiographic follow-up. There was a 34% (9/26) response rate for PROMIS upper extremity, global health, pain intensity, and pain interference surveys and QuickDASH. The average QuickDASH score was 16.7 (0-54.5). 78% of participants scored within 1 SD of average for PROMIS upper extremity function scale. 66.7% of respondents reported little to no pain on the pain intensity scale (0 or 1 of 10),

while 33% reported moderate pain. The average PROMIS upper extremity, and pain interference scores were 48.3 (range 29-57), 49.3 (39-59), and 53.6 (49-58), respectively, all of which were within average range.

Summary Points

- Pediatric scaphoid fracture non-unions that undergo open reduction internal fixation using distal radius cancellous autograft can be expected to go on to union
- Pediatric patients with scaphoid fracture non-unions will have good outcomes with the utilization of distal radius cancellous autograft

AM Poster 433: Reducing Healthcare Costs in the Management of Pediatric Metacarpal Neck Fractures

Category: Pediatrics/Congenital and Nerve

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

Corey T. Beals
Julie Samora, MD, PhD

Hypothesis

Non-operative management is the mainstay of treatment for small metacarpal neck or "Boxer's" fractures. Nonetheless, there are still significant costs to the healthcare system with traditional casting, reduction, and radiographic follow-up. We hypothesize significant cost savings by utilizing a quality improvement initiative to change the management of small metacarpal neck fractures utilizing a removable ulnar gutter Velcro brace without compromising clinical outcomes.

Methods

We applied a quality improvement intervention in a large, urban level 1 trauma pediatric hospital with a high volume of orthopaedic injuries. Baseline data on the number and treatment regimen of small metacarpal neck fractures were collected starting in October 2015. Multiple PDSA cycles were performed and education to staff was provided on a new treatment with removable Velcro braces. Data were collected each month on the number of patients with less than 70 degrees of angulation without rotational deformity that were transitioned in the orthopaedic clinic to a Velcro ulnar gutter brace.

Results

Between October 2015 and November 2017, there were 203 pediatric patients with a small metacarpal neck fracture who met the non-operative guidelines. Prior to this intervention, patients were been casted and followed radiographically for a minimum of two orthopaedic visits (charges to patient total $828.50). From October 2015 to October 2016 only 20.3% (24/118) of patients with metacarpal neck fractures were treated without casting. With the transition of protocol from November 2016 to November 2017, the percentage of patients treated without cast immobilization (most commonly treated with a Velcro ulnar gutter brace) increased to 54.1%. These patients also did not have a scheduled orthopaedic follow up or further radiographic evaluation. In the first 12 months of implementation, this quality improvement saved patients $19,080. In the second year, cost savings increased to $36,570.

Summary Points

- Treatment of pediatric metacarpal neck fractures with a Velcro ulnar gutter splint is a viable option, which can eliminate the risks and expense of cast immobilization
- Cost savings to families by this QI intervention was $55,650 over the span of 2 years

Bibliography

1: 8.Dunn JC, Kusnezov N, Orr JD, Pallis M, Mitchell JS. The Boxer's Fracture: Splint Immobilization Is Not Necessary. Orthopedics 2016;39:188-92.
2: 3.Nakashian MN, Pointer L, Owens BD, Wolf JM. Incidence of metacarpal fractures in the US population. Hand (N Y) 2012;7:426-30.

AM Poster 434: Outcomes of Osteochondral Autograft Transplantation in Pediatric Patients with Osteochondritis Dissecans of the Capitellum

Category: Pediatrics/Congenital and Nerve

Elbow and Forearm;Congenital and Pediatric Problems
Level 4 Evidence

Benjamin B. Clippinger, MD
Mark Ayzenberg, MD
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Dan A. Zlotolow, MD

Hypothesis

Osteochondral autograft transplantation (OAT) is an effective treatment for advanced, symptomatic osteochondral defects of the capitellum in pediatric patients including when the goal is return to high level sport.

Methods

A retrospective chart review was undertaken of 16 patients who underwent OAT at a mean age of 13.4 (range 10 to 19) for symptomatic, advanced lesions of capitellar osteochondritis dissecans between the years of 2011 and 2016. Donor osteochondral plugs were harvested from the superolateral, non-weight-bearing lateral femoral condyle of the ipsilateral knee. Preoperative data collected included affected extremity, hand dominance, type and level of sport participation, elbow symptoms and range of motion, as well as prior treatments. Intra-operative findings, such as loose bodies, plica, lateral wall containment and lesion size were documented. Patients were assessed at follow-up for donor site knee pain, elbow pain, range of motion, return to and level of sport, and for complications and reoperations.

Results

Mean follow-up was 30.1 months (range 7-64), with no patients lost to follow-up. Mean arc range of motion increased from 123 degrees (range 90-145) to 139 degrees (range 120-155). 100% of elite athletes (10/10) returned to playing sports; 90% of whom returned to the same level of competition. Two retired from one of their sports but continued with another. The athlete that did not return to elite competition retired from gymnastics but began volleyball. Four were recreational athletes, 100% of which returned to sport. Two patients were non-athletes. Complications were reported in 3 patients. One patient underwent repeat arthroscopy with calcium sulfate hydroxyapatite injection into a subchondral cyst. Another had arthroscopic debridement, removal of loose body and microfracture of native capitellum. One non-athlete, has residual symptoms and is being currently considered for a possible debridement. No

neurological deficits, infections or instability occurred. 81% (13/16) of patients had resolution of pain at final follow-up and reported that they would undergo the surgery again. Knee pain resolved in all patients at an average of 2.2 months (range 1 to 6). Post-operative imaging in available patients showed incorporation of the osteochondral transplants.

Summary Points

- OATs is an evolving and valuable treatment for young patients with symptomatic capitellar OCD lesions
- OATs demonstrates excellent clinical outcomes including return to sports in children with symptomatic OCD lesions of the capitellum

Bibliography

1: Abhijeet L. Wahegaonkar MD, Kazuteru Doi MD, PhD, Yasunori Hattori MD, PhD and Ahamad Addosooki MD Journal of Hand Surgery, 2007-11-01, Volume 32, Issue 9, Pages 1454-1461,
2: Ansah P, Vogt S, Ueblacker P, Martinek V, Woertler K, Imhoff AB. Osteochondral transplantation to treat osteochondral lesions in the elbow. J Bone Joint Surg Am. 2007;89(10):2188e2194.
3: Bauer M, Jonsson K, Josefsson PO, Linden B Osteochrondritis Dissecans of the Elbow. A Long Term Follow-up Study, Clinical Orthopaedics and Related Research, November 1992. Pages 156-160.
4: Bilsel K, Demirhan M, Atalar AC, Akkaya S. A new surgical technique to facilitate osteochondral autograft transfer in osteochondral defects of the capitellum: a case report. Acta Orthop Traumatol Turc. 2010;44(1):82e87.
5: Brownlow H, O'Connor-Read L, Perko M, Arthoscopic treatment of Osteochonditis Dissecans of the Capitellum; Knee Surgery, Sports Traumatology, Arthroscopy, February 2006, Volume 12, Issue 2, Pages: 198-202.

AM Poster 435: Outcomes of Concomitant Open Carpal Tunnel and Cubital Tunnel Release

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Elbow and Forearm;Nerve
Level 4 Evidence

Hannah F. Aultman

Hypothesis

When performed alone, open carpal tunnel and open cubital tunnel release are safe and effective surgical options for the treatment of carpal and cubital tunnel syndromes, respectively. However, there is a paucity of literature that compares the outcomes of performing both procedures concomitantly to those having either carpal tunnel (CarpT) or cubital tunnel (CubT) alone. We compare the outcomes of a cohort of patients who underwent concomitant open carpal and cubital tunnel release (Co-CarpT/CubT) to a cohort of patients who had one of these surgeries individually.

Methods

A retrospective review was conducted of all patients who underwent concomitant open carpal and cubital tunnel release (Co-CarpT/CubT) as well as all patients who had these surgeries individually done by a single surgeon at a single institute between the years 2012 and 2016. Over this period, a total of 188 patients were identified, 16 in the Co-CarpT/CubT group, 131 who underwent CarpT, and 41 who underwent CubT. Pre- and post-operative outcome measures consisting of VAS, SF-12, and quickDASH scores were collected. Complete data was available for all 188 patients.

Results

Sixteen patients (average age of 65.0) underwent Co-CarpT/CubT, 131 (average age 56.7) underwent CarpT and 41 (average age 45.5) underwent CubT alone. Pre- and post-operative comparisons were completed for VAS, SF-12 MCS and PCS components, and quickDASH scores. Using the Tukey test, there was no significant difference in pre- and post-op outcomes between the CarpT and CubT, the CarpT and the Co-CarpT/CubT group, and the CubT and the Co-CarpT/CubT group ($p = 0.06$, 0.2, and 0.9 respectively). There was no significant difference between those combinations among the SF-12 components MCS ($p=0.9$), PCS ($p=0.7$), or the quickDASH ($p=0.7$). In terms of resolution of symptoms, in the CarpT group, 94% of patients had complete resolution of their symptoms. That number was 88% in both the CubT group and the Co-CarpT/CubT group. In terms of complications, 11 of 188 patients (5.9%) in the CarpT group developed a superficial infection requiring antibiotics, and 1 of 188 (0.05%) developed CPRS. In

the CubT group, 2 of 41 (0.49%) developed a superficial infection requiring antibiotics. In the Co-CarpT/CubT group, 2 of 16 (12.5%) developed a superficial infection requiring antibiotics.

Summary Points

Preliminary data demonstrate that Co-CarpT/CubT is a safe and effective treatment option for patients who present with concurrent cubital and carpal tunnel syndromes recalcitrant to non-surgical management. Postoperative results and complications are comparable to open carpal and cubital tunnel releases performed alone.

Bibliography

1: Koh J, Azari KK, Benhaim P. Clinical Diagnosis of Coincident Carpal and Cubital Tunnel Syndromes. Plast Reconstr Surg. 2015 Oct;136(4 Suppl):22-3.
2: Chimenti PC1, McIntyre AW1, Childs SM1, Hammert WC1, Elfar JC1. Combined Cubital and Carpal Tunnel Release Results in Symptom Resolution Outside of the Median or Ulnar Nerve Distributions. Open Orthop J. 2016 May 24;10:111-9.

AM Poster 436: Trends and Outcomes in the Use of Nerve Grafts for Treatment of Digital Sensory Nerve Injuries

Category: Pediatrics/Congenital and Nerve

Nerve
Level 3 Evidence

Neill Li, MD
Justin Kleiner
Andrew P. Harris, MD
Christopher Got, MD

Hypothesis

Advances in nerve reconstruction techniques and research have led to an increasing number of nerve graft procedures in the management of digital sensory nerve injuries over a 13-year period.

Methods

The National Inpatient Sample (NIS) between the years of 2002 and 2014 were queried for digital sensory nerve injuries (International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis code: 955.6 – digital nerve injury). Digital sensory nerve injuries that underwent nerve grafting were identified with ICD-9-CM procedures code 045. Weighted frequencies were calculated for national estimates of upper limb peripheral nerve injury and nerve surgery procedures. Demographic variables (sex, race, age, insurance), hospital characteristics, total charges, length of stay, complication rate, and mortality rate were evaluated. Rao-Scott Chi-Square Tests, Fisher's exact tests, and multivariable regressions were used with p values of < 0.05 determined to be significant a priori.

Results

Between 2002 and 2014, there were 33,204 documented digital sensory nerve injuries. The trend for nerve grafting was significantly increased from 2.53% of injuries in 2002 to 7.43% in 2014 ($p<0.001$) (Figure 1). There were significantly more male nerve injuries (27,854) than female (5,223). Males were significantly more likely to undergo nerve grafting compared to females (OR: 1.62, 95%CI: 1.08 – 2.43, $p < 0.001$). No differences were found with race, insurance status, or age. Patients at teaching hospitals were 2.2 times more likely to undergo nerve grafting than patients at non-teaching hospitals (95% CI: 1.534 – 3.221, $p<0.001$). Post-operative outcomes including total charges, and mortality rate were found to be significantly higher following graft procedures than non-operative treatment. Multivariable regression

demonstrated that digital sensory nerve graft procedures have 2 times the risk for complication compared to injuries without grafting (Table 1).

Summary Points

- Nerve grafting procedures following digital sensory nerve injury have significantly increased over time.
- Nerve graft procedures for digital sensory nerves, demonstrated a higher complication rate than injuries not undergoing surgery.
- Teaching hospitals had higher odds of performing nerve grafts than non-teaching hospitals
- Male patients undergo a significantly higher number of nerve grafting procedures than females
- With the increasing popularity and continued advances in nerve grafting techniques and grafting options, further research is required to improve the safety and efficacy of digital sensory nerve repair

Bibliography

1: K. H, T. Z, M. H, W. X. Thirty-Day Perioperative Adverse Outcomes After Peripheral Nerve Surgery: An Analysis of 2351 Patients in the American College of Surgeons National Surgical Quality Improvement Program Database. World Neurosurg. 2016;94:409-417. doi:http://dx.doi.org/10.1016/j.wneu.2016.07.023

2: Squitieri L, Steggerda J, Yang LJ-S, Kim HM, Chung KC. A National Study to Evaluate Trends in the Utilization of Nerve Reconstruction for Treatment of Neonatal Brachial Plexus Palsy [Outcomes Article]. Plast Reconstr Surg. 2011;127(1):277-283. doi:10.1097/PRS.0b013e3181f95c1e.

3: Lin MY, Manzano G, Gupta R. Nerve allografts and conduits in peripheral nerve repair. Hand Clin. 2013;29(3):331-348. doi:10.1016/j.hcl.2013.04.003

AM Poster 437: Nerve Transfers to the Triceps Muscle: Surgical Technique and Clinical Outcomes

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Shoulder and Arm;Nerve
Level 4 Evidence

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Hypothesis

To report the clinical outcomes and describe the surgical technique of restoring triceps muscle reinnervation using two different nerve transfers: flexor carpi ulnaris (FCU) fascicle of ulnar nerve and posterior branch of axillary nerve.

Methods

A retrospective review of patients undergoing FCU or posterior branch of axillary nerve to triceps nerve branch transfer is performed. The surgical technique for both procedures is described. Outcome measures include preoperative and postoperative British Medical Research Council score, range of motion (ROM), disabilities of the arm, shoulder and hand (DASH) score, visual analog scale (VAS) for pain, and complications.

Results

Between September 2003 and April 2017, six patients were identified. Four patients with a traumatic upper trunk and posterior cord palsy underwent ulnar nerve fascicle to triceps nerve transfer. Two patients with a recovering upper trunk after a pan brachial plexus palsy underwent posterior branch of axillary to triceps nerve branch transfer. Mean age was 36.3 (range, 18-68) years. Surgery was performed at a mean of 7.0 (range, 5.0-8.9) months post injury, with a mean follow up of 46.9 (range, 7.6-176.3) months. Preoperatively, four patients exhibited grade M0 and two patients exhibited grade M1 triceps strength. Four patients had M5 donor muscle strength and two had grade M4. Postoperatively, four patients regained MRC grade M4 or greater triceps muscle strength, one regained M3, and one regained M2+. Mean DASH and VAS improvement were 9.1 (range, -9.2-31.6) and 2.1 (range, -2-6.4) points, respectively. There were no complications.

Summary Points

- In extensive brachial plexus palsy cases with limited donor nerves, nerve fascicles to the FCU and posterior branch of axillary nerve are viable options for obtaining meaningful triceps muscle recovery in a select group of patients.

AM Poster 439: Reconstruction of Neonatal Brachial Plexus Palsy: Assessment of Factors Associated with Shoulder Motor Recovery

Category: Pediatrics/Congenital and Nerve

Shoulder and Arm;Congenital and Pediatric Problems;Nerve
Level 4 Evidence

Raymond Tse, MD
Sarah Lewis, MD

Hypothesis

Neonatal brachial plexus palsy occurs in 1 in 1000 newborns of whom 10-30% undergo primary nerve reconstruction. While methods to obtain elbow flexion can be reliable, recovery of shoulder function remains inconsistent and suboptimal.

Hypothesis

Demographic, palsy, and surgical factors are associated more or better recovery of active shoulder motion following primary reconstruction of neonatal brachial plexus palsy.

Methods

We conducted a retrospective review of prospectively collected data on all infants undergoing primary nerve reconstruction for neonatal brachial plexus palsy.
Surgical indications followed the Toronto protocol. Active movement was recorded at each clinic visit using the Active Movement Scale (AMS) by our center's physical therapist.
Surgical treatment involved excision and grafting. Priority for re-innervation was given to the hand, followed by elbow flexion. Shoulder motors were re-innervated by grafts to the posterior division of upper trunk (PD) with either graft or spinal accessory nerve (SAN) transfer to suprascapular nerve (SSN). Reconstruction with distal transfers alone was performed when adequate donors were available (Type 1 palsy) and there were avulsions of upper roots or dissociative recovery.

AMS scores at 2 years after surgery and changes in AMS scores were compared using t-test. We used the need for secondary musculoskeletal reconstruction as another measure of outcome. Incidence of secondary surgery was compared using chi-square.

Results

Over an 8-year period 450 patients presented to our center. Forty-eight patients underwent nerve reconstruction. Two patients were excluded given that they underwent isolated distal nerve transfers for elbow flexion alone.

When grouped by palsy type, indications for surgery, and number of avulsions, the final AMS scores were higher with less severe injuries, however the change in AMS scores was greater with more severe injuries.

Patients undergoing distal nerve transfers had the highest final AMS scores, however, their pre-operative AMS scores were also the highest. The greatest changes in AMS scores were in those patients undergoing graft reconstruction combined with SAN to SSN transfer.
Improvements in AMS scores were limited when a single cable to PD was used or if graft length was greater than 45mm.

Summary Points

- Distal transfers were used in a select group of patients (Type 1 with avulsions) with the best shoulder motor recovery.
- Nerve grafts combined with spinal accessory nerve transfer had better motor recovery than nerve graft alone.
- Motor recovery was poor when reconstruction involved a single cable graft to PD or graft length was greater than 45mm.

Bibliography

1: Borschel GH, Clarke HM. Obstetrical Brachial Plexus Palsy. Plast Reconstr Surg. 2009 Jul;124(Supplement):144e–155e.
2: Curtis C, Stephens D, Clarke HM, Andrews D. The active movement scale: An evaluative tool for infants with obstetrical brachial plexus palsy. The Journal of Hand Surgery. 2002 May;27(3):470–8.

AM Poster 441: Differences in Outcomes Following the Use of Nerve Grafts between the Treatment of Major Peripheral Nerve and Digit Sensory Nerve Injuries

Category: Pediatrics/Congenital and Nerve

Hand and Wrist;Nerve
Level 2 Evidence

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Hypothesis

Neve Graft procedures for major peripheral nerve surgery carry a greater risk of complication than for digital sensory nerves.

Methods

The National Inpatient Sample (NIS) between the years of 2002 and 2014 were queried for major peripheral nerve injuries (International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) diagnosis code: 955.0 – axillary nerve, 955.1 – median nerve, 955.2 – ulnar nerve, 955.3 – radial nerve, 955.4 – musculocutaneous nerve) and digital sensory nerve (ICD-9-CM: 955.6) Injuries that underwent peripheral nerve grafting were separated with ICD-9-CM procedures code 045. Weighted frequencies were calculated for national estimates of upper limb peripheral nerve injury and nerve surgery procedures. Demographic variables (sex, race, age, insurance), hospital characteristics, total charges, length of stay, complication rate, and mortality rate were evaluated. Rao-Scott Chi-Square Tests, Fisher's exact tests, and multivariable regressions were used with p values of < 0.05 determined to be significant a priori.

Results

Between 2002 and 2014, 3,135 major peripheral nerve injuries and 1,401 digital sensory nerve injuries underwent graft surgery. Digital nerves were 1.2 times more likely to undergo graft surgery. Post-operative outcomes including total charges, and mortality rate were found to be significantly higher following major peripheral nerve graft than digital sensory nerve graft. Multivariable regression demonstrated that major peripheral nerve grafting procedures have 2.4 times the risk for complication compared to those sensory nerve grafting (Table 1).

Summary Points

- Nerve grafting procedures for major peripheral nerves carry a higher risk and cost than those for digital sensory nerves
- A strong need for continued advances in nerve grafting techniques and grafting options with further research is required to improve the safety and efficacy of major peripheral nerve repair.

Bibliography

1: K. H, T. Z , M. H, W. X. Thirty-Day Perioperative Adverse Outcomes After Peripheral Nerve Surgery: An Analysis of 2351 Patients in the American College of Surgeons National Surgical Quality Improvement Program Database. World Neurosurg. 2016;94:409-417. doi:http://dx.doi.org/10.1016/j.wneu.2016.07.023.

AM Poster 443: Early Recovery of Motor Function in A Rabbit Biceps Model of Brachial Plexus Injury

Category: Pediatrics/Congenital and Nerve

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

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Hypothesis

There is a need for a larger animal brachial plexus injury model to simulate nerve grafting and nerve transfer procedures. We have demonstrated reliable C6, C7 innervation of the biceps via the middle trunk in the rabbit (Figure 1). We aim to validate the middle trunk to biceps model by demonstrating that 1) disruption of the middle trunk results in biceps paralysis, and 2) there is no unexpected neuroregeneration affecting the denervated biceps .

Methods

22 rabbits underwent bilateral ultrasound measurement of biceps muscle cross-sectional area (CSA) prior to unilateral biceps denervation. Five rabbits were randomly assigned to the "no repair" group. In the remaining 17 rabbits, the middle trunk was divided and then repaired using 10-0 epineural sutures. Rabbits survived 12 weeks, with ultrasound measurement of biceps CSA performed at 4 weeks, 8 weeks and 12 weeks post-operatively. At 12 weeks, we measured biceps compound muscle action potentials (CMAP) and isometric tetanic force (ITF) in a non-survival procedure. Bilateral biceps muscles were harvested and wet muscle weight recorded. Nerve samples were obtained distally. Total nerve area, myelinated area, axon area and axon counts were obtained. Results for all parameters expressed as a percentage of the non-operated side. The two groups were then statistically compared.

Results

Biceps CSA diminished at 4 weeks, reflecting denervation atrophy in both groups. Repaired group biceps increased in size thereafter (Figure 2). These differences were statistically significant at 2 and 3 months postoperatively. Biceps wet muscle weight was also significantly higher in the repair group (65.8% ± 19.4% of normal) as compared to the no repair group (52.0% ± 9.6%), p=0.047). The repair group exhibited significantly higher CMAP (23.3% ± 29.3%) and ITF

(25.6% ± 37.4%) as compared to the no repair group, which exhibited no recovery (0%, p = .0048 and .012 respectively).

Total nerve area for the repair group was 86.4% ± 104.7% of normal. Total myelinated area was 57.9% ± 63.9%, and total axon area was 48.3% ± 74.9%. Axon count was 70.5% ± 45.1% of the uninjured side. No regeneration was observed in the no repair group.

Summary Points

- Division of the middle trunk of the rabbit brachial plexus results in biceps paralysis without spontaneous recovery, while repair results in measurable recovery at 12 weeks.
- Measurement of biceps CSA, muscle weight, isometric tetanic force and motor nerve histology provide the opportunity for multi-faceted assessment of nerve injury and repair in the upper limb.

This research was supported by a Basic Science Grant from the American Foundation for Surgery of the Hand.