EP1. Improving Outcome Following Delayed Peripheral Nerve Grafting: The Application of Photochemical Tissue Bonding and Crosslinked Amnion Nerve Wraps

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Introduction: Photochemical tissue bonding (PTB) creates sutureless, watertight bonds between two apposed tissue surfaces that have been stained with photoactive dye and illuminated with a 532nm laser. Building on previous success in end-to-end repair, we have recently showed that, when applied to large gap injury and nerve grafts, PTB can result in superior outcomes in comparison to suture fixation. Up to now, the success of this technique has only been observed in repairs performed immediately following injury. This rarely occurs clinically and according to some, a delay of several weeks may actually improve regenerative outcome due to clearance of myelin and axonal debris from the distal stump. It was the aim of this study to assess the efficacy of PTB when applied to delayed nerve grafting, and to establish if any additive benefit is detectable in comparison to repairs performed immediately.

Methods: 40 inbred male Lewis rats were randomized into 4 groups (n=10). All 40 rats had 15mm gaps created in their left sciatic nerves. In groups 1 and 2, nerve gaps were repaired immediately with reversed isografts harvested from adjacent rats and fixed with either conventional epineurial suture or PTB, respectively. In groups 3 and 4, repair took place 30-days following injury using reversed isografts harvested from 10 additional donor rats and fixed with either conventional epineurial suture or PTB, respectively. Outcomes were assessed using monthly walking track analysis and sciatic function index (SFI), gastrocnemius muscle mass retention and nerve histomorphometry. Statistical analysis was performed using ANOVA and the post hoc Bonferroni test.

Results: PTB resulted in greater recovery of SFI following immediate and delayed repair but these results were not statistically significant (-72.3+/4.7 vs. -68.5+/4.7; p=0.4 and -80.1+/4.4 vs. -77.3+/4.1; p=1). SFI following both suture and PTB was significantly greater when performed immediately rather than after a 30-day delay after injury (-72.3+/4.7 vs. -80.1; p=0.003 and -68.5+/4.7 vs. -77.3+/4.1; p=0.002). Muscle mass retention was significantly greater following PTB fixation in both immediate and delayed repairs (65.1%+/+4.1 vs. 57.8%+/-2.5; p=0.03 and 60.2%+//-4.1 vs. 54.1%+/-5.3; p=0.04). There were no significant differences between immediate and delayed repairs. Histomorphometric analysis is in progress.

Conclusions: PTB results in non-significant improvements in SFI and significant improvements in muscle mass retention in comparison to conventional suture when performed immediately and after a delay of 30-days. Delaying repair for 30-days did not result in any significant additional improvement in outcome. We are hopeful that histomorphometric analysis will support these findings.
EP2. Improving Outcome Following Large Deficit Peripheral Nerve Injury: The Application of Photochemical Tissue Bonding and Crosslinked Amnion Nerve Wraps

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Introduction: Photochemical tissue bonding (PTB) uses visible light to create sutureless, non-thermal, watertight bonds between two closely apposed tissue surfaces stained with a photoactive dye. When used with a human amnion nerve wrap for end-to-end nerve repair, this technique results in superior functional and histological outcomes in comparison to conventional epineurial suture. When applied to large gap injury and nerve grafting, this technique has been limited by proteolytic degradation of amnion and photochemical bonds during extended periods of recovery. Chemical crosslinking of nerve wraps prior to PTB may improve wrap durability and efficacy of technique. By investigating several candidate nerve wraps and fixation techniques, we have attempted to ascertain the optimal approach for these challenging injuries.

Methods: Three candidate nerve wraps (human amnion (HAM), crosslinked human amnion (xHAM), crosslinked swine intestinal sub-mucosa (xSIS)) and 3 fixation methods (suture, fibrin glue, PTB) were investigated. Crosslinking was performed using (1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC)/N-hydroxysuccinimide (NHS). Biomechanical tests were performed using a tensiometer. Wrap durability was assessed using a collagenase degradation assay. 110 inbred male Lewis rats had 15mm left sciatic nerve defects created and repaired with reversed isografts. 9 groups (n=10) had isografts secured by one of the aforementioned wrap/fixation combinations. Positive and negative control groups (n=10) were repaired with graft+suture and no repair respectively. Outcomes were assessed using monthly sciatic function index (SFI), and following sacrifice after 5-months, gastrocnemius muscle mass retention and nerve histomorphometry. Statistical analysis was performed using ANOVA and the post hoc Bonferroni test. Significance was set at p<0.05.

Results: Optimal tensile strength, photochemical bond strength and resistance to collagenase degradation were achieved using 4mM EDC/1mM NHS. Following sacrifice, crosslinked nerve wraps were still present. Un-crosslinked material was completely degraded. Nerves repaired using xHAM+PTB experienced greatest recovery of SFI although this was not statistically significant compared with standard repair (-67.9 +/- 5.1 vs -71.7 +/- 4.8). xHAM+PTB repairs also recovered greatest muscle mass retention and this was statistically significant in comparison to standard repair (67.3% +/- 4.4 vs 60.0% +/- 5.2). No significant difference in axon diameter existed between treatment groups. Fiber and axon diameter and myelin thickness were all greater in the xHAM+PTB group in comparison to standard repair (6.87μm +/- 2.23 vs. 5.47μm +/- 1.70; 4.51μm +/- 1.83 vs. 3.50μm +/- 1.44; 2.35μm +/- 0.64 vs. 1.96μm +/- 0.47, respectively).

Conclusions: Crosslinking of nerve wraps improves tensile strength, resistance to biodegradation and preserves photochemical bonding. xHAM+PTB creates water-tight, sutureless bonds and results in superior muscle retention and histomorphometry in comparison to conventional suture repair.
EP4. Determining the Roles of the Components of Schwann Cell Differentiation Medium
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Introduction Adipose-derived stem cells (ASCs) differentiated into Schwann Cells (SC) may potentially facilitate peripheral nerve regeneration. However, the role of the components of ASC-SC differentiation medium has not been well-studied. In this study, we removed the components of ASC-SC differentiation medium one at a time from the medium and observed the changes in the expression of SC specific genes.

Materials & Methods: ASCs isolated from rat inguinal fat pads were characterized with flow cytometry and adipogenic, osteogenic, and chondrogenic differentiation. Cells in culture flasks were divided into 6 groups. In the control group, cells were supplemented with cell growth medium. In experimental groups cells were initially treated with β-mercaptoethanol and all-trans-retinoic acid. In group I cells were fed with SC differentiation medium [cell growth medium supplemented with platelet-derived growth factor (PDGF), basic fibroblast growth factor (bFGF), forskolin, and glial growth factor (GGF)]. In each of the other groups, one of the above components was removed from differentiation medium: GGF in group II, forskolin in group III, bFGF in group IV, and PGDF in group V. Cells were fed with corresponding differentiation medium for two weeks. The fold changes in expression levels of the genes S100, integrinβ4, and nerve growth factor receptor (NGFR) were detected with qRT-PCR. Results were confirmed with immunofluorescence (IF) staining.

Results: ASCs were negative for endothelial and white blood cell markers CD 31 and CD 45, but were positive for mesenchymal stem cell markers CD44 and CD90. Adipogenic, osteogenic, and chondrogenic differentiation of ASCs were documented by oil O red, alizarin red, and alcian blue staining respectively. The results of qRT-PCR revealed that undifferentiated ASCs expressed S100 gene at a certain level but did not express integrinβ4, and NGFR. Groups III and IV that lacked forskolin and bFGF respectively had the highest expression levels of integrinβ4, and NGFR. The cells treated with complete differentiation medium showed a 3.2 fold increase in the expression of S100 but the expression of integrinβ4 and NGFR was significantly lower in comparison to groups III and IV. Group II that lacked GGF showed no significant levels of SC specific gene expression. In comparison to other groups, the gene expression profile in group IV was the closest to the SC differentiation group. IF staining confirmed the results obtained with qRT-PCR.

Conclusions: Our results showed that GGF is a vital component of SC differentiation medium, while bFGF played no significant role in a murine model.
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**Introduction:** Motor and sensory neuron death may be an overlooked component of disability following neonatal nerve injuries, such as obstetrical brachial plexus injury. Previously, we have demonstrated that increasing motor and sensory neuron survival with a novel neuroprotective agent, P7C3, improves functional recovery in a rat model of neonatal nerve injury. However, P7C3 is not approved for clinical use. N-acetyl cysteine (NAC) has demonstrated neuroprotective properties in adult models of peripheral nerve injury and has a long history of safe clinical use in pediatric populations. This study investigates the efficacy of NAC in protecting motor and sensory neurons from cell death following neonatal nerve injury in a rat model.

**Materials and Methods:** Animals were injured 3 days after birth with either a crush or transection injury of the sciatic nerve and treated with intraperitoneal injections of NAC at a dose of 750mg/kg/day for 2 weeks. Four weeks following injury, surviving cells were retrograde-labeled with a fluorescent tracer, and a sample of nerve distal to the site of injury was harvested to assess axon regeneration. Spinal cords and dorsal root ganglia were harvested three days later and serially sectioned for motor and sensory neuron counts.

**Results:** Motor neuron survival following sciatic nerve crush injury was increased with NAC treatment in comparison to vehicle treated animals (505.4 ± 39 vs. 403.7 ± 57) (p<0.05). NAC treated animals did not significantly improve axon regeneration distal to the site of injury in comparison to vehicle treated animals (6224 ± 620 vs 5508 ± 908). Transection injury resulted in significantly more motor and sensory neuron death than crush injury, however NAC did not improve motor neuron survival following transection injury.

**Conclusions:** N-acetyl cysteine demonstrated motor neuron protection following neonatal crush injury. Neonatal sciatic nerve transection results in significantly more motor neuron death than crush injury, and therefore improving motor neuron survival may require higher treatment doses or longer treatment duration with NAC.
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Objective: Guiding Regeneration Gel (GRG) was developed in response to the clinical need of improving treatment for peripheral nerve injuries and helping patients regenerate massive regional losses in peripheral nerves. The efficacy of GRG based on tissue engineering technology for the treatment of complete peripheral nerve injury with significant loss defect was investigated.

Background: Many severe peripheral nerve injuries can only be treated through surgical reconstructive procedures. Such procedures are challenging, since functional recovery is slow and can be unsatisfactory. One of the most promising solutions already in clinical practice is synthetic nerve conduits connecting the ends of damaged nerve supporting nerve regeneration. However, this solution still does not enable recovery of massive nerve loss defect.

Methods: The proposed technology is a biocompatible and biodegradable gel enhancing axonal growth and nerve regeneration. It is composed of a complex of substances comprising transparent, highly viscous gel resembling the extracellular matrix that is almost impermeable to liquids and gasses, flexible, elastic, malleable, and adaptable to various shapes and formats.

Results: Preclinical study on rat model of peripheral nerve injury showed that GRG enhanced nerve regeneration when placed in nerve conduits, enabling recovery of massive nerve loss, previously unbridgeable, and enabled nerve regeneration at least as good as with autologous nerve graft “gold standard” treatment.
EP7. Perineural tumor spread in pelvic malignancies
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Introduction: Perineural tumor spread in pelvic malignancies has emerged as an anatomic explanation for selected cases of neoplastic lumbosacral plexopathy. We present a case series and provide summarized clinical and imaging characteristics. To our knowledge a similar series has not been presented yet.

Material and methods: We retrospectively reviewed cases concluded as perineural tumor spread and excluded cases without histological confirmation of the perineural spread and cases with widespread pelvic disease infiltrating the plexus. We reviewed clinical data and imaging studies, and recorded all time-points.

Results: Ten patients (8 men, 2 women) were included in the study (prostate cancer n=5; rectal cancer n=2, bladder cancer n=2, cervical cancer n=1). Mean age was 69 years (range 48-85 years). Pain was the initial symptom in 6 patients, pain and weakness in 1 patient, weakness in 1 patient, and 2 patients were asymptomatic. In 1 patient the diagnosis of lumbosacral plexopathy preceded the tumor by 3 months, in other patients the mean time from the tumor diagnosis to the initial symptom was 67 months. On presentation, 6 symptomatic patients had pain, sensory loss and weakness corresponding to the affected nerves. On MRI (n=10) the affected nerves were enlarged and demonstrated thick perifascicular enhancement. MRI finding correlated with increased uptake on FDG PET/CT (n=4) and 11C-Choline PET/CT (n=3) scans. EMG (n=9) demonstrated lumbosacral plexopathy in 8 patients; in 1 patient it was normal. Six patients had no signs of distant metastatic disease at the time of the lumbosacral plexopathy diagnosis; two patients had metastases in lungs, one patient had metastases in pelvis and one had solitary metastasis in liver. Seven patients were alive at the time of the last follow-up. Mean time from the initial symptom to the last follow-up was 51 months.

Discussion: Our proposed route of the tumor spread is from the pelvic organ to the lumbosacral plexus and beyond using the splanchnic nerves as a conduit. We believe this theory can explain selected cases of neoplastic lumbosacral plexopathy. The route of spread can be visualized as a unilaterally thickened and enhancing perirectal fascia containing the pelvic and sacral splanchnic nerves.

Conclusion: We presented a series of 10 cases of perineural tumor spread in pelvic malignancies. We believe that this mechanism is an otherwise underrecognized cause of morbidity and recurrence in pelvic cancer patients.
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Introduction: Neurotropic melanoma is an uncommon type of melanoma. It is locally aggressive, however, nodal invasion and metastases are less common than in conventional melanoma. Clinically it can mimic benign lesions or arise in an amelanotic form leading to late diagnoses and a poor prognosis for the patient. Lesions usually arise associated with other types of melanoma. Less commonly a conventional melanoma reoccurs as a neurotropic melanoma. Over half of the neurotropic melanoma lesions are found on the neck and head. Primary compromise of the hand is less common with few reports of neurotropic melanoma involving the median nerve.

Materials & Methods: We present a case of a 57 year old male patient with history of a malignant epithelioid melanoma on the right thumb with right axillary node and capsular invasion. He came to our Hand Center sixteen months after thumb amputation and axillary lymphadenectomy was performed in another facility. He presented with complaints of pain at the amputated stump. In the physical exam two solid painful masses were palpated. Incisional biopsies revealed tumor recurrence as a neurotropic melanoma with compromise of the median nerve and the sensory branch of the radial nerve. According to oncologic staging and a multidisciplinary committee evaluation, palliative surgery was recommended.

Results: Resection of the lesion from the distal tumor proximally was performed through out the median and radial sensory nerves, until at least two cm of nerve free of macroscopic disease were obtained at the proximal forearm. Although resection was performed maintaining the recommended safe macroscopic margins, subsequent histology revealed positive margins. Adjuvant radiation was performed. Postoperatively the patient experienced reduction of pain, and improved hand function. 16 months postoperative the patient is alive. A new painfull solid mass at the level of the elbow aroused as recurrence of the neurotropic tumor. Further palliate surgery needs to be performed in the patient.

Conclusions: Neurotropism in melanoma is associated with deep invasion at the primary site and positive margins after excision due to its peri and intraneural extension. A multidisciplinary approach is indicated in the treatment of this extremely rare disease in the hand. In this patient a palliative treatment, with a stage of free macroscopic disease improved pain and hand function for a limited period of time. Local aggressiveness of this tumor makes it difficult to obtain a durable palliative treatment.
**Introduction:** There are over 1 million total joint arthroplasties done annually in the United States, with nerve injury occurring in 0.5-2.0% of cases. Most of these injuries occur to the peroneal nerve; its sequelae can cause significant morbidity. Our goal in this study was to recreate a nerve stretch injury that would be encountered during TJA; to investigate histological differences in the peroneal and tibial nerves versus control nerves.

**Methods:** The peroneal and tibial nerves were harvested bilaterally from 10 fresh human cadavers. Each nerve was sectioned into 2 samples. The control sample was suspended from a frame with sutures at its native length and placed in Karnovsky's Fixative. The other sample was tied with sutures to a frame and stretched to 20% of its native length and placed in fixative. After 1 week in fixative, each nerve was washed 3 times in 0.1M cacodylate buffer, sectioned, and stained with Masson's trichrome. Using ImageJ software, each nerve was analyzed for its overall and individual fascicular cross sectional areas, and roundness (\[(4 \times \text{area}) / (\pi \times \text{diameter}^2)\]) (as roundness approaches zero, the fascicle is more oval). Statistical comparisons were performed using SPSS software with the Friedman test (significance at alpha < 0.05%).

**Results:** The tibial nerves' fascicles decrease in size upon stretching (Table 1); the peroneal nerve has variable changes in area upon stretch (Figure 1). The tibial nerve significantly decreases in roundness with stretch whereas the peroneal nerve does not show a significant change. The proportion of the epineurial tissue that was connective tissue had a tendency to be greater in the tibial nerves (49.6-55.4%) compared to the peroneal nerves (38.1-41.9%). The tibial nerve has significantly more fascicles (29.5) than the peroneal nerve (13.4)(p < 0.001).

**Conclusion:** The peroneal nerve is more prone to injury during total knee and total hip arthroplasty than the tibial nerve. Upon stretching, the peroneal and tibial nerves behave differently, which could account for their difference in injury rates. Though both nerves decrease in area when stretched, the tibial nerve changes in its shape from circular to more oblong; the peroneal nerve stays circular. Perhaps the tibial nerve's higher composition of connective tissue or higher fascicle number accounts for these differences and gives the tibial nerve greater protection. The present study provides new insights into differences between the two main nerves, which may help explain why the peroneal nerve is more at risk of injury with stretch.
EP10. Traumatic Birth As a Potential Cause of Early Onset Migraine Headaches
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Introduction: The origin of chronic headaches are often unknown. Whiplash injuries or cranial surgery are described as a potential cause of chronic headaches. We here investigated traumatic birth as the trigger of migraine headaches that were present since childhood.

Methods: We screened the history of migraine patients of our headache clinic for potential cranial birth trauma that could be responsible for their chronic headaches. Two patients (54 and 30 yo) reported particularly traumatic birth with the use of forceps.

Results: Both patients presented with visible scars across the head and suffered since early childhood from chronic headaches were refractory to pain medication. Chronic headaches were invalidating, rated as 6-7/10 during 15 and 30 days per month. Headaches were also causing the loss of more than 30 days per year of work for a patient and the complete inability to work for the other. Headaches responded positively (0/10) to a peripheral nerve block in multiple, selected triggers. Patients benefited from selective neurolysis in all known main migraine triggers (supra-orbital, supra-throchlear, zigomatico-temporal, auricolo-temporal, greater occipital, lesser occipital and third occipital). After one-year follow-up headaches significantly decreased leaving the patients headache free during most of their time and seldom with lighter pain responding to over the counter medications.

Conclusions: Traumatic birth can induce persistent deformations of the skull and mechanical and fibrotic damage to the sensitive nerves of the head. This may lead to chronic headaches since childhood. In our series, patients presented with multiple triggers, which responded well to neurolysis. Difficult birth should be investigated as a possible cause of nerve entrapment and patients may be good candidates for surgery.
**EP11. Compression Neuropathy of the Common Peroneal Nerve Due to an Intramuscular Ganglion Cyst**
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**Introduction:** Compression of the common peroneal nerve (CPN) by an extraneural ganglion causing foot drop is a rare entity; the literature reveals few reported cases. A ganglion is rarely painful but associated symptoms can occur due to either cyst rupture or pressure on adjacent structures. This case report may be of value for awareness and differential diagnosis of progressive peroneal palsy. Early diagnosis and decompression can lead to the best possible neurological recovery.

**Materials & Methods:** A 60-year-old woman presented to the emergency department with pain over the lateral aspect of the right lower extremity, loss of sensation in the first and second web spaces, and an inability to dorsiflex the right foot. The physical exam was remarkable for pain and swelling over the head of the fibula and her history was negative for trauma. MRI revealed a mass overlying the right fibular head with CPN compression. The patient underwent excision of an intramuscular mass in the anterior tibialis muscle and pathology exam of the mass revealed a ganglion cyst.

**Results:** Five weeks postoperatively, the patient had excellent dorsiflexion of the affected foot and great toe. However, the patient still experienced minimal residual weakness of great toe extension. Deep peroneal nerve sensibility was restored by five weeks.

**Conclusion:** Ganglionic impingement neuropathy presents more challenges to the physician and may require multiple imaging and operative interventions to diagnose and prevent permanent impairment. Although compression of the peroneal nerve by an intramuscular ganglion cyst is rare, this entity should be considered in the differential diagnosis for the cause of foot drop.

![Figure 1A & 1B. MRI imaging revealing a lesion consistent with a benign cyst.](image1)

![Figure 2. Intraoperative image demonstrating the location of the ganglion within the anterior tibialis muscle compressing the CPN.](image2)

![Figure 3. Exposure of Intramuscular Ganglion Cyst.](image3)
**EP12. Intercostal nerve transfer to suprascapular nerve after brachial plexus roots avulsion**

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**Objective:** The purpose of this investigation was to perform anatomic study on the intercostal nerve transfer to the suprascapular nerve and a case report.

**Methods:** 30 thoracic walls of human cadavers were used to investigate the anatomical possibility for the repairment of the suprascapular nerve by using Intercostal Nerves III-IV. The dissections of the intercostal nerves from the thoracic walls were done to measure the length of the intercostal nerves from the midclavicular line to the midaxillary line (L) and the distance from the relevant intercostal space to the middle of the clavicle (D).

**Results:** The results showed that the differences between L and D of III-IV intercostal nerves were calculated as (2.50±1.06)cm• A(1.63±1.36)cm• A(0.20±1.45)cm• A(-3.51±2.16)cm respectively.

**Conclusions:** So we believed that the intercostal nerve III and IV could be transferred to the suprascapular nerve without nerve graft. Since the Suprascapular nerve could be dissociated and stretched about 2 centimeters under the clavicle, the intercostal nerve V could also be transferred to the suprascapular nerve directly. The intercostal nerve IV could be neurotized to the suprascapular nerve with nerve graft or increasing the dissection length of the intercostal nerve. Based on this study, An 42 yrs male who had a motorcycle crash one month before, he had C5-7 roots avulsion and partial injury of C8, T1 of the right side, the accessory nerve was also injured. We transferred intercostal nerve III and IV to suprascapular nerve and intercostals nerve V-VIII to musculocutaneous nerve, after 32 months postoperative, the patients got 30 degrees of shoulder abduction and 45 degrees of external rotation, also, he had 90 degrees of elbow flexion.
EP13. Double team approach to brachial plexus surgery
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Introduction: Brachial plexus surgery is a complex and demanding procedure requiring surgical skills and long operative time. Few studies have been published regarding optimizing time and outcomes in brachial plexus surgery. The aim of our study is to assess the advantages of having a double operating team approach and analyze surgeons position during the procedure.

Patients and methods: Six patients with brachial plexus palsy were analyzed. Three of them underwent surgery operated by a double team and three by single team. The operating time of the procedure and the position of the two teams at the operating table were measured for each patient. Values were compared to assess any statistical significance.

Results: The mean operating time was 280 min with surgery operated by a single team performing between one nerve transfer without nerve graft harvesting and 256 min in the patient group operated on by two teams in which three anastomoses were performed along with sural nerve harvest. Position of the two teams at different moment during the procedure are illustrated. No perioperative complications were noted.

Discussion and conclusion: Brachial plexus surgery performed by a double team allows the reduction of the operating time and thus minimizes the drawbacks associated with lengthy surgery such as perioperative bleeding and infection. Reimbursement of two teams appears therefore justified by decreased complications rate and surgical time. Surgeon fatigue is another important factor to be considered in decreasing complication rates: microsurgical suturing is easier when performed at the end of a shortened intervention and shared by two senior surgeons. This approach improves the operating conditions and guarantees better outcomes.
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\textbf{Introduction:} Advanced robotic devices capable of simulating the dexterous ability of the upper limb with an array of internal sensors have raised the enticing prospect of replacing the lost intricate functions of the arm following upper limb amputation. However, a large gap still exists in the application of this technology to the human user. In particular, the ability to provide physiologically relevant sensory feedback – to have the amputee feel like the prosthetic hand as their own – has not yet been achieved.

\textbf{Materials and Methods:} Although a number of different approaches are being investigated, Targeted Sensory Reinnervation, a refinement of the original Targeted Muscle Reinnervation procedure, is the most recent and promising development in the effort to create a functional human-machine interface with a closed loop sensory feedback system. This technique aims to re-establish hand sensation on the skin so that it can be readily accessed non-invasively during functional tasks. Recent efforts are being directed towards distributing hand maps widely on the stump without interference of sensations from the native area.

\textbf{Results and Conclusions:} We will review the surgical approaches that have been used for sensory reinnervation in upper arm amputation and compare the outcomes and potential functional utility of the techniques. These techniques include traditional targeted reinnervation, cutaneous nerve end-to-side targeted sensory reinnervation, and sensory fascicle end-to-end targeted sensory reinnervation.
EP15. Targeted Muscle Reinnervation after Transhumeral Amputation during Initial Hospitalization
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Introduction: Targeted muscle reinnervation (TMR) has provided a valuable surgical option following traumatic upper extremity amputations by allowing improved prosthetic function under cortical control. Furthermore, transfer of traumatically amputated nerve ends to other nerves may prevent the formation of painful neuromas. Performing nerve surgery in the acute setting avoids dissection of nerve ends in a scarred wound bed, prevents neuroma formation, and prepares amputees for possible myoelectric prosthetic use in the future.

Methods: We present the first known report of acute TMR for a transhumeral amputee.

Results: One year after amputation and nerve transfers, the patient has been successfully fitted with a myoelectric prosthetic under cortical control and demonstrates no clinical evidence of neuroma pain. Pain-related behavior and pain interference were assessed using the Patient Reported Outcomes Measurement Information System (PROMIS).

Conclusions: In the acute setting of traumatic transhumeral amputation, targeted muscle reinnervation can be considered to prevent neuroma pain and to allow future use of a myoelectric prosthesis under cortical control.
EP16. Painful Neuroma after Cosmetic Surgery: Diagnosis and Treatment
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Introduction: Temporary numbness or loss of feeling are quite common and often transient complications after aesthetic surgery. Chronic neuropathic pain occurs rarely and can become a serious challenge for both the surgeon and the patient. We here report three cases of painful neuromas after cosmetic surgery.

Methods: From a review of the patients of our peripheral nerve clinic, we selected three with painful neuromas after aesthetic surgery (one after upper blepharoplasty and two after breast augmentation). All patients were referred to us by their pain doctors. We here describe the common findings in the history and management.

Results: Patients developed pain soon after surgery. The patients consulted back their surgeon several times for persisting pain (daily from 6/10 to 8/10) without any sign of healing problems. Despite attempts to control the pain with several strategies ranging from ergotherapy (desensitization), scar massage, anti-inflammatory drugs and anti-pain drugs, pain could not be controlled several months after the operation. Two of four patients agreed in accepting psychiatric support with no improvement. They reported dramatic deterioration of quality of life.

Patients were then referred to our clinic where we found tinel sign close to the scars and an ultrasound guided lidocaine test resulted in complete resolution of pain (0/10).

Patients were taken to the operation room where we found a neuroma of the zygomatico-temporal branch of the trigeminal nerve (ZTBTG, post superior blepharoplasty) and two intercostal neuromas (post breast augmentation). Neuromas were excised and the proximal end of the nerve was buried in muscle. After ZTBTG surgery the patient reported more than 50% improvement in pain (decreased intensity and frequency) while after intercostal neuromas surgery complete remission of pain was reported.

Conclusion: Neuroma of the zygomatico-temporal branch after upper blepharoplasty has not been reported in the literature to date and we believe that chronic neuropathic pain after cosmetic surgery may be under reported due to difficulties in diagnosis. Postoperative severe pain that does not respond to conventional therapy should be investigated as a potential neuroma and treated accordingly.
EP17. Preoperative and Postoperative Clinical Comparison in Patients with Brachial Plexus Injury with or without Nerve Recording
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Introduction: Brachial plexus injuries are one of the most devastating lesions for the patient; causing function loss of the daily life and occupational activities. The accuracy of a diagnostic test for classifying a patient is a key point to make a treatment decision. In order to establish a diagnostic and offer a treatment in a patient with brachial plexus injury we have to base on physical examination and complementary paraclinic studies. The presurgical low specificity and positive predicted value in the electrophysiology studies are the main indication to perform a intraoperative nerve recording.

Methods: Patients with brachial plexus injury were evaluated, from 2007 to 2014. Two groups were formed, depending on the performance or absence of intraoperative nerve recording. Their pre and post-surgery videos were reviewed and rated according to a scale based on the Narakas and Raimondi valuation table (shoulder abduction, external rotation, retropulsion and thoracobrachial adduction / elbow flexion and extension / forearm pronosupination / wrist flexion and extension / thumb, central fingers and fifth finger movement).

Results: 25 patients, 17 men (68.0%) and 8 women (32.0%), with age range of 1-54 years (mean 28.1 ± 1.28) were obtained. 52% were right brachial plexus injuries and 48% left. We get 15 patients in the group with intraoperative nerve recording and 10 patients in the second group (without nerve recording). 72% of the brachial plexus injury was secondary to motor vehicle accident (car and motorcycle). All postoperative assessments showed a statistically significant improvement (p <0.05) regardless either of the presence or the absence of intraoperative nerve recording. During the postoperative evaluation of the the group with intraoperative monitoring, shoulder external rotation and movement of the middle fingers obtained statistically significant improvement (p <0.05); in comparison to the group without nerve recording. Thoracobrachial adduction was found with bordering statistically significant value (p=0.084). In the postoperative evaluation, 52.4% of patients presented with intraoperative nerve recording arose in 1 or more of the ranges of the rating scale; whereas in patients without it only 22.7% had increased. None of the patients (regardless of the performance or absence of intraoperative nerve recording) gave a lower score while postoperative assessment.

Conclusions: The intraoperative nerve recording studies provide better clinical outcomes in the postoperative period in patients with brachial plexus injury; this can be attributed to the intraoperative information obtained during brachial plexus exploratory surgery.
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Brachial plexus surgery is a challenging procedure, particularly for lower part of the plexus. Minimally invasive or controlled invasive methods may be used to explore lower part of the plexus using da Vinci robot. I did a cadaveric experiment to explore brachial plexus using daVinci robot. Axillary approach looks easy to reach The C7, C8, and T1 roots besides subclavian artery and vein. Anterior scalene muscle can be released easily. In my limited trial shows "da Vinci" may be used through axillary to explore lower part of the roots and subclavian vessels.
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**Background:** The vagus nerve contains the afferent and efferent fibers of the preganglionic parasympathetic fibers to diverse organ systems.

**Objective:** We sought to record and analyze the pattern of intrafascicular action potentials of the vagus nerve with a complex microarray.

**Methods:** [3] lambs delivered prematurely by Caesarean section were ventilated to produce chronic hyper-reactive airway disease. 100 micron pitch high density microelectrode arrays (Utah array) were impacted into the vagus nerve. Recordings were then obtained during methylcholine challenge assay.

**Results:** In the [3] lambs, action potentials were recorded during the methylcholine challenge. Bronchoconstriction was confirmed as elevated peak airway pressures and prolonged expiratory phase on pulmonary function tests. The pattern of action potentials were temporally correlated and spatially clustered on a cluster of electrodes within the array.

**Conclusion:** Intrafascicular recordings of autonomic nerves are possible. The pattern of firing suggest specific fiber localization within the nerve. Information on the physiologic state of organ systems may be gleaned from such detailed recordings of autonomic nerves.
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Introduction: Nerve conduction study of upper trapezius muscle is difficult because of motion artifact of upper trapezius muscle. Repetitive nerve stimulation (RNS) of upper trapezius muscle is more difficult due to the proper immobilization of the recording electrode over the muscle. The middle trapezius muscle recording has less motion artifact, we propose the middle trapezius recording methods for repetitive nerve stimulation.

Methods: In the 12 normal subjects, 24 upper trapezius recordings of RNS with traditional fixation and 24 middle trapezius recordings of RNS without fixation were recorded. 3Hz slow RNS were performed at accessory nerve on the side neck. The compound muscle action potential (CMAP) amplitude decrements (%) were measured in the both group, then we calculated the mean consecutive difference (MCD) of individual decrements.

Results: MCD were 1.7±0.7%(Mean ±SD) in the upper trapezius recording with muscle fixation group, 1.2±0.5% in the middle trapezius recording without muscle fixation group. The latter group has small MCD (p=0.015). Small MCD means less fluctuation and is considered suitable recordings.

Conclusions: Middle Trapezius recording without muscle fixation for RNS is novel and suitable recording.
EP21. Heterotopic ossification of a peripheral nerve following blast injury: A report of two cases
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Introduction: We report on two cases of patients, who had high energy penetrating injuries resulting in transection of their sciatic nerves. At the time of surgical exploration and nerve reconstruction, fibrotic tissue consistent with early heterotopic ossification was encountered. This tissue was not limited to the surrounding muscle, when the residual nerve was opened to identify the fascicles fibrotic tissue and osteoid was also encountered. To our knowledge this is the first instance of combat related heterotopic ossification of a peripheral nerve.

Methods: Resected nerve tissue from sciatic nerve exploration and grafting was determined intraoperatively to have ectopic bone in it. Nerve tissue was taken to the National Institutes of Health Orthopedic Basic Science lab and analyzed for osteogenic and fibrotic markers in addition to markers of mesenchymal progenitor cells (MPCs).

Results: Two patients sustained sciatic nerve transections as a result of gunshot wounds were taken to the OR for exploration and grafting. The nerves were identified as completely transected and the proximal and distal neuromas removed. The defects were reconstructed with cadaveric allograft and the resected nerve ends were analyzed histologically. H and E staining demonstrated osteoid in the nerve sheath while picosirus red staining displayed high levels of collagen 1 in the nerve consistent with a fibrotic environment. Immunofluorescence demonstrated high levels of BMP2 in the neuron with CD44 (a marker for MPCs) in the surrounding tissue and invading the nerve.

Discussion: Heterotopic ossification has been well described in traumatic wounds particularly those relating to combat trauma however this is the first description of it occurring in a peripheral nerve following trauma. The early cases of neuritis ossificans occurred in the absence of trauma without surrounding tissue involvement.

When analyzed the nerve stained positive for BMP2 and substance P both proteins that have been associated with heterotopic ossification. Substance P is known to be increased at sites of bone regeneration and BMP2 is known to sensitize tissue to trauma-induced HO. Additionally there was staining for CD44 in the surrounding tissue of the nerve. Previous studies have identified CD44 as a marker of MPCs and demonstrated the capability of MPCs to undergo osteogenesis. These findings would suggest that high levels of BMP2 in the nerve and surrounding MPCs make the peripheral nerve primed for HO development. The intact nerve sheath likely plays a prominent role in prevention of HO formation in peripheral nerves following trauma.
EP22. Carpal Tunnel Decompression on the Internet - Do You Know What Your Patients are Reading?

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Introduction: It has been reported that 80% of American Internet users utilise the internet to obtain health information. With this ubiquitous usage of the internet it is important that patients are getting reliable and accessible information. We hypothesise that despite its prevalence, the quality and readability of medical websites on the internet is poor and that clinicians need to play a role in guiding their patients to suitable on-line information. The objective of this study was to test this hypothesis.

Methods: We searched the keywords “carpal tunnel decompression” (English Language, exact phrase setting) in the most popular three search engines: Google, Yahoo and MSN/Bing. The top 50 websites were evaluated from each search engine. Exclusion criteria were irrelevant information, repetition and inaccessibility.

Readability of the websites was assessed using the Flesch Reading Ease Score (FRES, index rating – score/100), Flesch Kincaid Grade Level (FKGL) Gunning-Fog Index (GFI), Simple Measure of Gobbledygook index (SMOG), Coleman–Liau Index (CLI) and Automated Readability Index (ARI), which all give a measure of the number of years of schooling required to understand the content.

Results: 84 appropriate websites were analysed out of 150. Excluded websites were due to irrelevant information (28), repetition (27) and inaccessibility (11).

Although the reading indexes did show some variability, the mean combined readability index score was 11.26. This corresponds with the level of readability of the wall street journal and means that a reading level equivalent to 11 years of schooling (11th – 12th grade)

The mean FRES was 56.78 (S.D:15.05), below the universally recommended target of 60-70.

The results of the LIDA medical website validation tool were; accessibility 82.67% (S.D:11.07), usability 59.99% (S.D:15.70) and reliability 42.37% (S.D:29.39).

Conclusions: We have shown that readability scores of the websites are high and not easy to read. The best resources are those belonging to recognised medical and academic institutions, as well as those without financial interests in this field (newspapers). We have found the reliability to be very variable and generally poor. In conclusion, since patient decisions are likely to be influenced by the internet, it is essential that we guide and help patients identify reliable sources of information.
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The tissue processing necessary to remove immunogenic components of human nerve allograft also renders the graft acellular. While seeding the allograft with appropriately supportive cells may improve nerve axon regeneration, little has been done to elucidate the best method for physically implanting these cells into the allograft. Using an in vitro model of fluorescent beads representing cells in solution, bead penetration and distribution into acellular nerve allograft was measured following hypodermic needle injection versus soaking in "solution" after micropuncture of the allograft surface under both normal and pressurized scenarios. Significant differences in bead dispersal suggest that soaking resulted in a more even distribution and a greater percentage of beads implanted in the allograft periphery. The potentially positive neurosupportive cell survival and proliferation implications of this distribution pattern warrant formal in vivo testing of these seeding methods.
EP24. Lymphocyte Subset in Blood is the Helpful Tool for Diagnosis of Autoimmune Peripheral Neuropathy
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Introduction: Cervical spinal canal stenosis, disk hernia, myelopahty, amyotrophic lateral sclerosis (ALS) are often misdiagnosed in peripheral neuropathy patients, especially in multifocal motor neuropathy.

Methods: We show the six cases which were misdiagnosed by other facilities as ALS, myelopathy, disc hernia through conventional study. By using combination of careful physical neurological examinations and extended nerve conduction study, these patients were diagnosed as peripheral neuropathy with conduction block such as multifocal motor neuropathy. We looked for convenient and helpful tools for differential diagnosis, and found the lymphocyte subsets in blood.

Results: All of the six cases show abnormal lymphocyte subsets in the blood, such as CD4, CD8, CD4/CD8, CD3, CD19. Because these abnormal findings are not shown in ALS, cervical spinal canal stenosis, disk hernia, myelopathy, lymphocyte subsets in blood show underlying abnormality of autoimmune peripheral neuropathy.

Conclusions: Lymphocyte subset in blood is the helpful tool for diagnosis of autoimmune neuropathy, especially multifocal motor neuropathy.