

### AAHS/ASPN/ASRM Joint Outstanding Paper Session

#### **AAHS #1 Patient Factors Associated with Complications within 30 days of Hand Surgery; an Analysis of 9,969 Patients Using the 2006-2011 ACS-NSQIP Datasets**

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**Introduction:** The ACS-NSQIP database collects detailed and validated data on patient demographics, co-morbidities, and 30-day postoperative outcomes on patients undergoing operations in most subspecialties. This dataset has been previously used to delineate specific complication risks and risk factors in a number of surgical subspecialties, but has not yet been used for hand surgery. While the risk of early complications following hand surgery is generally believed to be low, it is important to define these risks quantitatively, and to identify patient groups who are at higher risk for complications so that preventive measures can be employed.

**Materials and Methods:** ACS-NSQIP data from 2006-2011 was queried using 293 hand-specific CPT codes. Descriptive statistics were calculated for the population, and potential risk factors and patient characteristics contained within the NSQIP database were analyzed for their association with complications in the 30-day postoperative period. The most common complications were identified, and significantly associated variables were determined.

**Results:** 204 hand-specific CPTs were represented in the data. Of these, 81 resulted in at least one complication. The overall 30-day complication rate for hand surgery was 2.7%. Women had fewer complications than men, and there were significant differences between races. Age and BMI did not correlate significantly with complication rates. Significant increase in complication rates were associated with insulin-dependent diabetes (10%), pre-operative dyspnea (5.4%), COPD (7.4%), hypertension (4.2%), peripheral vascular disease (14.9%), renal failure (44.1%), preoperative steroid use (10.5%), bleeding disorder (16.7%) and emergent surgery (10%). Increased surgical wound class was associated with increased rate of complications. Lower complication rates were associated with operations done under local or regional anesthesia. Decreased operating time and anesthesia time were significantly associated with decreased rate of complications. The most common complications were superficial and deep surgical site infections, urinary tract infection, unplanned intubation, sepsis, pneumonia, and wound disruption.

**Conclusions:** This study utilized a large, prospective national database to characterize the 30-day complication profile and risk factors for surgery of the hand. Overall, the incidence of complications is low, approximately 2.7%. However, rates are significantly elevated in certain sub-groups and with some perioperative conditions. The most common complications are listed and quantified. This information is valuable in counseling patients preoperatively, and in identifying groups of patients on whom risk reduction efforts should be focused.

## **AAHS #2 Can Platelet-rich Plasma Impact the Formation of Flexor Tendon Adhesions?**

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**Background:** Because of its regenerative potential, platelet-rich plasma has been studied extensively. Chickens contain nucleated thrombocytes that contain many of the growth factors contained within mammalian platelets. We aimed to separate the thrombocyte-rich plasma (TRP) from avian whole blood, deliver this growth factor-rich concentrate to a traumatic flexor tendon laceration and evaluate its effect on flexor tendon healing - specifically the formation of peritendinous adhesions.

**Methods:** 9 chicken surgeries were performed on 18 digits (3rd, 4th digit). Prior to surgery, the digits were randomized to undergo laceration and repair - in an area homologous to zone two in the human hand - followed by the addition of thrombocyte-rich plasma (treatment) or closure without TRP (control). 5 cc of whole blood, separated via the Biomet GPS III system generated 1 cc of thrombocyte-rich concentrate. Post-operatively, all chicken feet were immobilized using a plaster cast. Three weeks later, subjects were euthanized and the tendons were examined histologically by five independent, study-blinded pathologists for the presence of connective tissue, peritendinous adhesion formation and the presence of a peritendinous space. These specimens were graded on a scale of 1 to 5 and a mean value for each specimen was calculated. The difference in severity of tendon adhesions between the treatment and control groups was calculated using a paired t-test.

**Results:** Mean adhesion score for the treatment group was 3.40 and mean adhesion score for the control group was 3.36 ( $p=0.90$ ). Mean Olympic adhesion scores (highest and lowest score not included) for the treatment and control tendons were 3.40 and 3.44, ( $p=0.91$ ) respectively. A score of 3 suggests moderate adhesions, peritendinous space preserved in more than 50 % of the circumference and a score of 4 denotes severe adhesions, peritendinous space obliterated in more than 50 % of the tendon circumference. Adhesion formation varied between hosts, but there were no differences between treatment and control groups or between digits 3 and 4.

**Discussion:** The efficacy and reproducibility of platelet-rich plasma delivery is controversial. Laboratory evidence suggests that the addition of platelet-rich plasma may aid in tendon healing, but thus far there is no literature detailing its effect on adhesion formation. Though we have shown no difference in adhesion formation between control and study tendons, there are two significant limitations to this study: our ability to reliably quantify the growth factors within the thrombocyte-rich fraction and to consistently deliver the same volume to the repair site.

## **ASPN #1 The Result of Contralateral C7 Spinal Nerve Transfer – a 28 Years of Experience**

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**Introduction:** Total root avulsion of the brachial plexus remains to be a major reconstructive challenge. This study aims to evaluate the functional outcomes of brachial plexus patients with unilateral total root avulsion, who were reconstructed with CC7 spinal nerve transfer.

**Method and Materials:** 168 patients who suffered from total brachial plexus palsy, and underwent reconstruction with CC7 spinal nerve transfer from 1985 to 2013 were analyzed. We then selected and analyzed the characteristics and the achievements of the 10 patients who attained the best functional outcomes.

**Results:** The average age was 24.8 years old. 89 patients had their dominant upper limb affected. All but 4 had more than one body part injured, 21 % of them suffered from concomitant fractures in their affected upper limbs. 40 patients had vascular injuries on their affected limbs. The average time from injury to initial nerve reconstruction was 133.5 days and the average time from initial injury to CC7 transfer was 263 days.

Neither significant nor permanent donor site morbidity was noted. The average follow-up period was 5 years

For the 10 patients with best functional outcomes, no significant difference in their basic characteristic, their injury or their time from injury to initial nerve reconstruction was noted when compared with the other patients. A majority attained an education level of upper high school or above. They attended more follow-sessions with a longer average follow-up period of 8.2 years

6 patients had their CC7 transfer to both median and musculocutaneous nerves while 4 patients had their CC7 transfer to their median nerve only. This ratio is comparable to the remaining patients. 8 out of 10 patients underwent more than 1 surgery, which was significantly more than the rest of the patients. All patients with CC7 transfer to musculocutaneous nerve could achieve an elbow flexion motor grading of 4. 3 out of 4 patients with CC7 transfer to median nerve only had a finger flexion of grade 3. 9 patients had a finger flexion of at least grade 2. They all had protective finger sensation. Their self-perception improved post nerve reconstruction. They also had a significant improvement in DASH and Michigan Hand score.

**Conclusion:** CC7 is a good treatment option for patients with total brachial plexus injuries. Patients who are young and have high education status and motivation appear to achieve better functional results in the long term.

## **ASPN #2 A Quantitative Analysis of the Sensory and Motor Fibres of the Brachial Plexus in Man**

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**Introduction:** Any surgical nerve reconstruction must take into account amount of individual nerve fibres at any given level of injury. To date, however, literature on qualitative and quantitative assessment of motor axons of the peripheral nerves of the upper extremity is scarce. Furthermore, none of these studies have depicted the topography of motor fibres along the entire course of these peripheral nerves. The aim of the present study is to present the total number of motor fibres of the brachial plexus from each root down to the level of its corresponding branches.

**Material and Methods:** Nerve samples have been harvested from 12 organ donors immediately after death. From 8 incisions ranging from the neck to the wrist a total of 36 nerve samples were gained per organ donor. A special immunohistochemical protocol was applied to visualize the specific structure of interest within the nerve cross section. Antibody against neurofilament served to determine the total amount of myelinated and unmyelinated axons. Antibody against choline acetyltransferase (ChAT) was used to detect cholinergic/motor fibres. Histology sections were then scanned and evaluated with a digital software program to allow quantification of each cross section. These numbers were cross checked in an animal model with standard retrograde tracing methods. Finally, the quality of this method was also cross checked with staining ventral and dorsal roots of organ donors at spinal cord level.

**Results:** As expected the majority of any given peripheral nerve contains afferent fibers. To our surprise, however, only around 10% of all axons in a mixed peripheral nerve are efferent fibers. In a “pure” peripheral motor nerve (thoracodorsal nerve) one third of the axons are cholinergic. In a pure cranial motor nerve the motor portion rises to about 60%(accessory nerve) but still has a significant afferent fibre population. The control experiments in a rodent animal model show good correlation between retrogradely labelled motor neurons with ChAT positive labels in the peripheral nerve section.

**Conclusion:** Here we present for the first time a quantitative analysis of all afferent and efferent fibres of the brachial plexus and its consecutive nerves. The surprising finding is that even “pure” motor nerves with a suspected high number of motor fibres (thoracodorsal nerve) only have a relatively small number of efferents. Since this ratio is relatively constant for motor nerves at different levels of the extremity these results challenge the traditional view of fiber distribution and innervation density in man.

## ASRM #1 Evaluation of Viability and Structural Integrity after Whole Eye Transplantation

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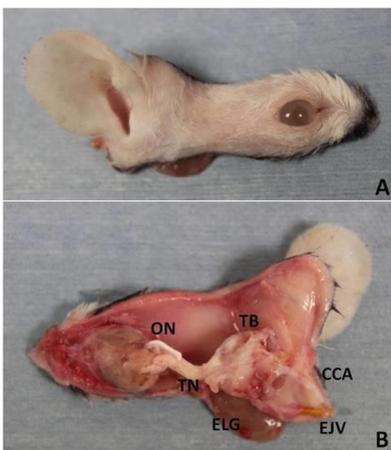
**BACKGROUND:** Approximately 37 million people throughout the world suffer from blindness. Whole eye transplantation (WET) gives the opportunity to provide viable retinal ganglion cells and the entire optical system to recipients with vision loss and irreversible injury to the eye. A key obstacle to WET is the poor regenerative ability of the optic nerve. Recently, several groups have demonstrated optic nerve regeneration, showing promise for eye transplantation. There has been difficulty in establishing a consistent small animal model for basic science research in WET. We previously established and published a functional face transplant model in the rat, and have recently expanded our model to include the whole eye, optic nerve and its blood supply.

**Methods:** All syngeneic transplants were performed in Lewis (RT1<sup>l</sup>) rats. The donor flap, pedicled by the common carotid artery and external jugular vein, is composed of all ocular tissue distal to the optic chiasm, a portion of the temporal bone, and the skin tissues of the eyelids and external ear. The recipient site was prepared by removing a similar region of skin tissue and the eye socket content, with the optic nerve cut at the base of the globe. A nerve apposition between the donor and recipient optic nerve was performed. Slit lamp examination and Optical coherence tomography (OCT) imaging of the cornea, lens and retina were performed weekly after transplantation. Histological sections of the eye were analyzed post-mortem.

**Results:** 6 out of 8 rats survived the surgical procedure while maintaining visual transparency of the anterior eye. All eyes were viable via slit lamp examination. OCT imaging confirmed transparency of the cornea and lens, preservation of the structural layers of the retina, and blood flow throughout the eye. Histology confirmed neovascularization of the cornea as well as preservation of the structural integrity of the retina, with the exception of degeneration of the retinal ganglion cell layer.

**Conclusion:** We have established a viable orthotopic model for vascularized whole eye transplantation in the rat. Maintenance of structural integrity and viability were confirmed by slit lamp examination, OCT, and histology. The model is ideal for examining viability, functional return and immunology in whole eye transplantation.

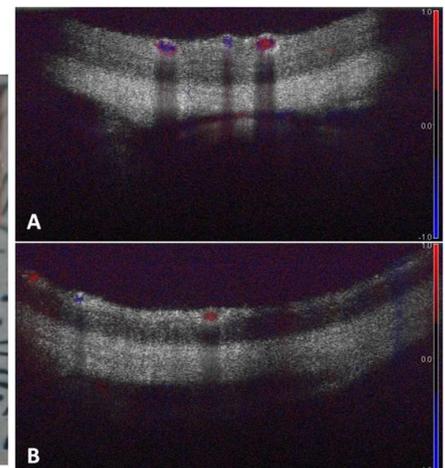
## Figures



**Fig. 1** WET graft. (ON: Optic Nerve; TB: Temporal Bone; TN: Trigeminal Nerve; ELG: External Lacrimal Gland; CCA: Common Carotid Artery; EJV: External Jugular Vein.)



**Fig. 2** Recipient immediately after graft inset, with optic nerve apposition.



**Fig. 3** Retina vascularization with Doppler OCT on POD 7. A: Control retina; B: Transplanted retina.

## **ASRM #2 Implications of Intracranial Facial Nerve Grafting in the Setting of Facial Reanimation**

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**Background:** Most intracranial tumors involving the facial nerve are extirpated with nerve preservation, but when resected, and if feasible, intracranial facial nerve grafting is performed. Results likely depend on multiple factors such as age, anatomic location, pre-operative facial palsy, radiation, and gap-length. Results can vary from complete palsy to varying degrees of tonicity, synkinesis, effective motion, and ocular protection.

**Purpose:** Evaluate the varying degrees of facial reanimation by facial region after intracranial nerve grafting and identify implications for future facial reanimation and pre-operative consultation.

**Methods:** Between the years 1997-2012, twenty-seven patients underwent intracranial nerve grafting after tumor extirpation. Of the 26 candidates, 14 completed evaluations. All patients were prospectively evaluated by three physical therapists specializing in facial nerve rehabilitation and scored with Facial Disability Index (FDI), and two regional grading systems - Facial Nerve Grading System 2.0 (FNGS 2.0), and SunnyBrook Facial Grading Score (SFGS). Additionally, all patients underwent still photos and videography to assess quality of motion and tonicity in repose. Demographic and surgical variables were analyzed as to their possible effect on end results.

**Results:** The average age was 43 (22-66). The average time interval between nerve grafting to evaluations was 44 months (12-146). Average total FDI was 67.5% comprised of the Physical Function and Social/Well-Being portions averaging 62.8% and 72.6% respectively. Subdivisions of the physical function score with worst outcomes were eye dryness/tearing and difficulty speaking. Best outcomes were recorded in teeth brushing, eating, and drinking. FNGS 2.0 demonstrates best outcomes in Eye and Oral Commissure portions and worse in Brow and Nasolabial fold. Final FNGS 2.0 grade average was 4.3 (1-5) i.e. moderately severe dysfunction. The SFGS reveals 64.3% have oral resting symmetry, but only 28.6% resting symmetry in eye and nasolabial fold. Symmetry in voluntary movement revealed gentle eye closure and lip pucker as best – 3.6 and 3.0 respectively, while brow lift as worst - 1.0 and open mouth smile at 2.0 (5-25). Total synkinesis score averaged low at 3.6 (0-15).

**Conclusion:** Intracranial nerve grafting does not provide consistently good facial animation but may provide periocular protection, although not symmetry. It does afford good symmetry of the midface in repose, thus potentially improving results of midface reanimation surgery by providing improved baseline tonicity with minimal synkinesis. This information is important during patient discussions if intracranial facial nerve resection and grafting is anticipated or in the interim between nerve grafting and planned future facial reanimation.