



### ASRM SHORT PRESENTATIONS

Monday, January 16, 2017, 4:00pm – 6:00pm

## 78. Tissue Engineered Ears: Almost There

Cornell University, Ithaca, 221, USA

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**INTRODUCTION:** Currently, the gold standard treatment of pediatric microtia is autologous reconstruction, an invasive surgical technique that often produces sub-optimal aesthetic outcomes. We have successfully formed human-shaped auricles containing bovine auricular chondrocytes (AuCs) which demonstrate long-term stability following implantation. However, ear constructs require large ( $>200 \times 10^6$ ) numbers of cells, which cannot be achieved through standard monolayer expansion as chondrocytes undergo phenotypic dedifferentiation. Mesenchymal stem cells (MSCs) can differentiate into chondrogenic cells and enhance cartilage generation when co-cultured with chondrocytes. We have previously shown that human AuCs and MSCs encapsulated in collagen discs in a 1:1 ratio generate auricular cartilage *in vivo* that is similar to AuCs implanted alone. In this study, the 1:1 ratio of human AuCs and MSCs was used to engineer full-scale human ear constructs to determine their development following *in vivo* growth.

**METHODS:** Human AuCs were isolated from ear cartilage surgical remnants from otoplasty procedures and expanded to third passage (P3). AuCs were combined with human MSCs in a 1:1 ratio and encapsulated in 10 mg/mL type I collagen hydrogel at a density of  $25 \times 10^6$  cells/mL. The cell-collagen solution was injected into a multi-piece, 3D printed mold of a 6-year-old female ear. Ear constructs were implanted subcutaneously in the dorsa of nude rats and harvested after 3 months.

**RESULTS:** Beginning with  $0.9 \pm 0.3$  g of initial tissue, primary AuCs were expanded to  $109.3 \times 10^6 \pm 36.2 \times 10^6$  cells by P3. Following subcutaneous growth, engineered auricular constructs maintained ear morphology while generating cartilage tissue. Gross-inspection showed that ear

constructs featured a shiny, white cartilage-like appearance after 3 months, while maintaining anatomic features including the helical rim and lobule. Constructs featured full thickness cartilage generation with no necrotic core. Constructs contracted from initial dimensions of 5.0 cm length x 3.0 cm width to a mean length of  $3.0\pm 0.4$  cm and width of  $1.7\pm 0.3$  cm. Ear constructs also demonstrated elastic mechanical response to bending and featured positive staining for proteoglycan content and elastin fibers.

**CONCLUSIONS:** Beginning with a clinically relevant amount of donor tissue, human AuCs were expanded to sufficient numbers to form tissue engineered auricles by MSC supplementation. Full-scale ear constructs successfully maintained ear morphology, developed auricular cartilage tissue, and demonstrated elastic mechanical properties. The potential for human AuCs and MSCs to form tissue engineered auricles using 50% fewer chondrocytes is a critical step towards clinical translation for a less invasive, patient-specific tissue engineered for ear reconstruction.

## **79. A New Human Chimeric Cells Technology of Myoblast and Mesenchymal Stem Cell Origin for Restoration of Muscle Function.**

University of Illinois at Chicago, Chicago, 203, USA

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**Introduction:** Clinical strategies to prevent denervation atrophy and maintain muscle function following massive tissue loss are physical therapy and electrical/magnetic stimulations, which have not shown significant efficacy in muscle repair. Allogeneic stem cell therapies and Vascularized Composite Allotransplants (VCA) aiming to restore affected muscles are challenged by limited engraftment and rejection. Chimeric Cells (CCs), created via ex vivo fusion of donor and recipient cells, represent a novel and promising therapeutic option in the field of muscle regeneration and VCA, eliminating the need for life-long immunosuppression.

The aim of this study was to characterize phenotype and efficacy of engraftment of the CC therapy of myoblast and mesenchymal stem cell (MSC) origin, as well as restoration of muscle function in the DMD mdx/scid mice model.

**Methods:** Eight ex vivo fusions of human myoblast-MSC and myoblasts-myoblast were performed, using the polyethylene glycol technique. CCs phenotype and genotype were characterized by flow cytometry, confocal microscopy, HLA-typing and STR-PCR. CCs were cultured for 30 days to test proliferation capacity and myogenic differentiation. To test the efficacy of human CCs in vivo, mdx/scid mice (n=4/group) received intramuscular injection of: Group 1 – vehicle (PBS), Group 2 – non-fused MSC and myoblasts, Group 3 -  $0.5 \times 10^6$  of human myoblast/MSC CCs or Group 4 -  $0.5 \times 10^6$  of human myoblast/myoblast CCs to the gastrocnemius muscle. The pattern of injection sites was standardized for all of the experimental groups. The therapeutic effect was monitored by muscle function tests (grip strength, wire hanging, in vivo and ex vivo muscle contractility). Muscle characteristics (weight, inflammation, fibrosis, dystrophin expression) were assessed at day 7 and 90 after human CCs were injected into the mdx/scid model.

**Results:** Following fusion, human CCs presented cell markers, HLA antigens and gene alleles of both parent cells, maintained proliferative capacity in long-term cultures and differentiated toward mature skeletal myocytes. CCs survival and engraftment to the gastrocnemius muscle were confirmed by dystrophin expression of 12% at 7 days and 17.5% at 90 days after intramuscular injection. CCs recipients showed a 2.5-time increase in muscle force ( $p=0.04$ ) and improved tolerance to fatigue at 90 days after CCs delivery compared to vehicle treated mdx/scid mice.

**Conclusion:** This study confirmed feasibility and efficacy of CCs therapy in restoration of gastrocnemius muscle function. CCs therapy represents a novel, universal approach for restoration of muscle function in muscular dystrophy, traumatic muscle tissue loss and regeneration of muscle components of the VCA.

## 80. Surgical Strategies to Approach Recurrent Enterocutaneous Fistulas with Complex Abdominal Wall Defects: From the Plastic Surgeon Perspective

China Medical University Hospital, Taichung, 256, Taiwan

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**Background:** Enterocutaneous fistulas are a very challenging surgical problem, with a reported mortality rate between 7-20%. Often, these fistulas coexist with major abdominal wall defects, requiring multiple staged operations. Herein, we present a 1-stage approach based on 3 concepts: meticulous enterolysis using microscope magnification, a pedicle seromuscular bowel flap to reinforce the bowel anastomosis and compound flaps with rotational flaps to reinforce/reconstruct the abdominal wall.

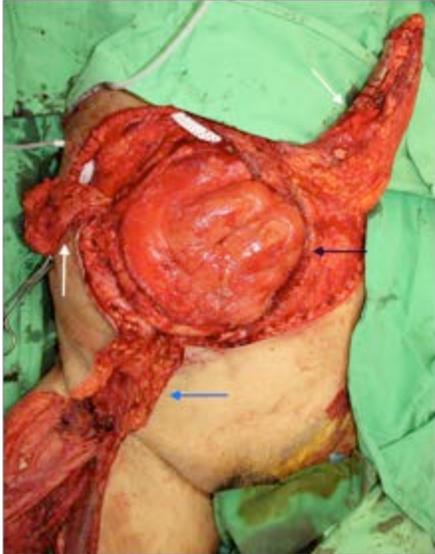
**Methods:** Retrospective review of patients who required simultaneous correction of enterocutaneous fistula(s) and abdominal wall reconstruction based on our surgical approach. Demographics, etiology, OR time, segment of bowel resected, type of flap performed and complications were recorded.

**Results:** Eighteen-patients were analyzed. All of them were males with a average age of 40 (range 25-59yo). The etiology in 13 patients was secondary to abdominal trauma, in four-patients, a mesh eroded over the bowel after ventral hernia repair and one-patient presented after type b aortic dissection and mesenteric ischemia. The mean ventral size hernia was 21 cm (Figure-1). The mean OR time for each case was 10 hrs. Extensive enterolysis was performed under microscope magnification in all patients. 10-38 cm of jejunum or ileum was resected in 8 patients and 9 cm of transverse colon in 2 patients. Before bowel anastomosis, a 5 cm of a segment of bowel was left based on its mesenteric pedicle, opened at the anti-mesenteric border, the mucosa was removed and the seromuscular flap placed over the bowel anastomosis for reinforcement (Figure-2).

Patients were reconstructed using compound flaps (tensor fascia lata, vastus lateralis and ALT) with an average skin paddle of 31.4 x 14.1 cm (Figure-3). During the following period (19-months), there were no reports of intrabdominal fistulas, abscess, bowel obstruction, short-gut syndrome, bowel ischemia and all flaps survived (Figure-4). However, 3-patients presented with wound dehiscence in the proximal aspect of the flap, which was treated with local dressings.

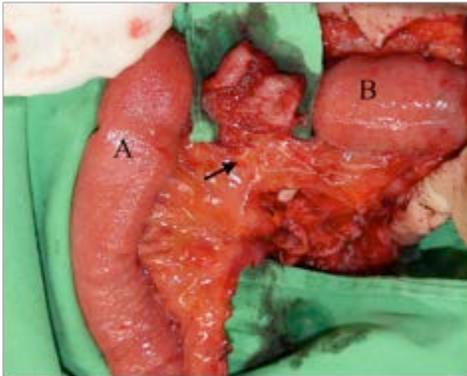
**Conclusion:** Meticulous intrabdominal dissection with resection of disease bowel and replacement with healthy, well-vascularized tissue at the anastomosis site and at the level of the abdominal wall can be an alternative reconstructive option when local reconstructive options have failed.

### Figure 1



Abdominal wall defect (black arrow). Rotational flaps (white arrows). Tunnel for compound flap (blue arrow).

**Figure 2**



Bowel Anastomosis. A: Distal end. B: Proximal end. Black arrow: pedicle of seromuscular flap to reinforce the anastomosis.

**Figure 3**



Compound Flap (black arrow). Tunnel (blue arrow)

**Figure 4**



Final Closure. A: Compound Flap. B and C: rotational flaps

## **81. The Role of Processed Nerve Allograft in the Treatment of Brachial Plexus Birth Palsy**

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### **Introduction:**

Severe brachial plexus injuries affecting multiple roots such as extended Erb's Palsy or total plexus injuries presents multiple challenges including limited supply of donor nerve tissue. Historically, the approach has required a compromise, by under sizing grafts or leaving facets of the injury unrepaired. If left undertreated, suboptimal outcomes adversely impacting musculoskeletal form and function. As new techniques and technologies become available, we have the opportunity to augment traditional approaches for these severe injuries.

Processed nerve allografts (Avance® Nerve Graft, AxoGen Inc) have been established as a viable tissue source for the reconstruction of peripheral nerve injuries in both simple and major nerve repairs. Processed nerve allografts (PNA) has found utility our practice in both adult and pediatric plexus injuries, especially where the availability of sural nerve is inadequate for appropriate reconstruction. Here we report on the outcomes of patients presenting with severe brachial plexus birth injuries repaired with PNA.

### **Methods:**

Retrospective chart review was conducted on surgical cases between 2009-2015 to identify patients presenting with brachial plexus birth injuries. To be included, subjects must have reported baseline muscle strength scores for the effected limb, undergone nerve repair with PNA, and have minimum of 12 months follow-up. Five subjects with 23 nerve repairs met criteria. Demographics, pre/post-operative and follow-up data was collected and analyzed. Meaningful recovery was defined MRC grade 3 or greater after intervention for the effected limb.

### **Results:**

Five subjects presenting with extended Erb's Palsy where found to have non-conducting neuromas at the C5, C6, and C7 upper trunks. The mean age was 7 months  $\pm$  2(4-10). The mean follow-up was 26 months  $\pm$  19(13-56). The mean gap was 33mm(25-50). After resection to healthy fascicular pattern, nerve roots were reconstructed with either PNA in combination with autograft, with PNA alone or with autograft alone. In 4 out of 5 cases, improvement in both shoulder and elbow function were attained to a level of M3 or greater. See Table 1 and 2.

### **Conclusions:**

In this small series, PNA demonstrated utility as a tool in the treatment of brachial plexus birth palsies. No related adverse events were reported. Functional reinnervation at  $\geq$ M3 to the shoulder and elbow muscle groups was observed across a majority of repairs. Limitations of this series include limited follow-up and the single center nature of the study. Additional data collection is ongoing. Findings are promising for the role of processed nerve allograft in brachial plexus birth palsies.

Table 1: Grafting with Processed Nerve Allograft and Autograft after Neuroma Resection in Patients Presenting with Extended Erb's Palsy

ID	Age at Surgery (Mo)	Lesion	Repair		Motor Strength Score							
			Nerve	Grafts Used	Follow-Up (Mo)	Shoulder Abduction		External Rotation Shoulder		Elbow Flexion		Elbow Extension
						Baseline	Final	Baseline	Final	Baseline	Final	
1*	7	C5, C6, C7	C5 to anterior division of UT	Cabled Repair: 30 mm Avance	13	0	3	0	3	0	3+	0
			C5 to posterior division of UT	30 mm Sural								
			C6 to anterior division of UT	30 mm Sural								
			C6 to posterior division of UT	Cabled Repair: 30mm Sural & Avance								
			C7 to middle trunk	Cabled Repair: 30mm Sural & Avance								
2*	10	C5, C6	C5 to Suprascapular	35 mm Sural	15	2-	3+	2-	3+	2+	4-	3
			C6 to Suprascapular	35 mm Sural								
			C5 to posterior division of UT	Cabled Repair: 35 mm Sural & Avance								
			C6 to anterior & posterior division of UT	Cabled Repair: 35 mm Sural & Avance								
3	6	C5, C6, C7	C5 to Suprascapular	Sural (2 cables)*	13	1	3	1	3	0	4	1
			C5 to anterior division of UT	Cabled Repair: Sural & Avance								
			C6 to posterior division of UT	Sural (3 cables) *								
			C7 to middle trunk	Sural (4 cables) *								
			C7 to anterior & posterior division of UT	1-2 mm Avance (3 Cables)								
4	6	C5, C6, C7	C5 to Suprascapular	2-3 x 30 mm Avance	31	2	3	2	2	1	3	4
			C6 to posterior division of UT	Cabled Repair: 40 mm Sural & Avance								
			C5 to anterior division of UT	Avance 40 mm								
			C6 to anterior division of UT	Cabled Repair: 40 mm Sural & 50 mm Avance								
			C7 to middle trunk	Avance 50 mm								
5	4	C5, C6, C7	C5 to Suprascapular	Sural 30 mm (4 cables)	56	0	4-	0	4-	0	4-	0
			C5 to anterior division of UT	Sural 30 mm (4 cables)								
			C6 to posterior division of UT	Avance 4-5 x 25 mm								
			C7 to middle trunk	Avance 4-5 x 25 mm								

## **82. Simplified Profunda Artery Perforator Flap Design Using Color Duplex Ultrasonography – A Prospective Study**

Chang Gung Memorial Hospital, Taoyuan, 256, Taiwan

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### **Introduction**

Optimal design of the Profunda Artery Perforator (PAP) flap requires precise preoperative mapping of sizable perforators. Computed tomographic angiography, magnetic resonance angiography, hand held Doppler (HHD), and other modalities have been utilized for this purpose. Comparing diagnostic imaging with intraoperative findings frequently shows differing results. From systematic review of the literature, color duplex ultrasonography (CDU) has been shown to have the highest pooled sensitivity and positive predictive value to identify perforators for other flaps. We present a prospective study of PAP flap design comparing CDU, HHD, and clinical findings.

### **Methods**

Over a two-month period, 10 patients were examined with CDU and HHD. We used CDU to evaluate the number of perforators, the muscular or septal course, location at the deep fascia level (emergence point), confluence with neighboring perforators, peak flow velocity, and arterial diameter. A single examiner performed the examinations. With the patient in the unilateral frog-leg position, the detected perforators (0.5 mm and greater diameter) were marked on the skin at a point corresponding to the emergence point. CDU skin markings were measured in relation to the groin crease and posterior border of the gracilis muscle. The distance to the adjacent HHD marking was determined for each perforator found with CDU. Number, diameter, and position of the perforators were then compared with intraoperative findings.

### **Results**

All PAP flaps were used for head and neck reconstruction and were successful. There were no cases of partial necrosis or wound healing complications. All perforators of adequate size found with CDU were confirmed intraoperatively. All perforators were found to be musculocutaneous on intraoperative observation. No sizable perforators found intraoperatively were missed by CDU. Arterial diameter was overestimated by CDU (1.56 mm vs. 0.78 mm,  $p < .05$ ). The average distance from the emergence point to the CDU marking was 2.8 mm (Range: 0 to 6 mm). The average distance from the HHD to the CDU markings was 18.4 mm (Range: 1 to 42 mm). CDU markings facilitated flap design in all cases. Adjoining perforators could be detected preoperatively in half of the cases and influenced number of perforators included in the flap.

### **Conclusion**

CDU offers a superior, precise diagnostic tool for PAP flap planning. It is inexpensive, non-invasive, requires no contrast, or radiation. Ideally, it is performed by a microsurgeon trained in ultrasound technique with the patient in the frog-leg position.

### **83. Re-establishment of Lymphatic Drainage after Vascularized Lymph Node Transfer in a Rat Model**

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#### **Background:**

Vascularized lymph node transfer (VLNT) has recently received attention as a potential surgical treatment for lymphedema. However, further investigation is required in order to understand its mechanism and optimal patient selection criteria. In order to explore the feasibility, viability and mechanism of VLNT, we are using rats as an animal model. Previously, we demonstrated the technical feasibility of VLNT in a rat, as well as the viability of transferred lymph nodes. The aim of the current study is to assess the re-establishment of drainage into transferred lymph nodes following VLNT.

#### **Methods:**

Seven Sprague-Dawley rats underwent VLNT in order to study the re-establishment of lymphatic drainage into transplanted lymph nodes. The operation consisted of two parts. First, the left groin lymph node basin with superficial epigastric vessels was harvested as a free flap. Second, the flap was re-attached in the left groin of the rat via end-to-end microvascular anastomoses of superficial epigastric vessels. Anastomosis patency was visually assessed immediately post-op and at the time of rat sacrifice. The lymphatic drainage pattern in the transplanted nodes was assessed at 1 month intervals post-op. This was accomplished by injecting the rats in their flanks with fluorescent indocyanine green (ICG). ICG uptake was then detected using a PDE infrared camera. At the time of rat sacrifice, anastomoses were assessed for patency, and the transplanted nodes were evaluated histologically for viability and lymphatic channel characterization.

#### **Results:**

In all 7 rats that underwent VLNT, the anastomoses were patent immediately postop. ICG uptake was not seen in the transplanted lymph node basins during the first two months post-op (**Figure 1A**). In 5 of 7 rats, ICG uptake was demonstrated in the transplanted lymph node basin at an average of 13 weeks, indicating possible lymphatic channel re-establishment (**Figure 1B**). So far, 5 rats have been sacrificed at an average of 8.6 months postop (range 7 to 12.5 months) and were all found to have patent anastomoses. Histological staining and imaging of re-established lymphatic channels are currently pending.

#### **Conclusions:**

We have previously shown feasibility and viability of VLNT in the lower extremity of rats. We now report uptake of ICG in 5 of 7 rats at an average of 13 weeks following transplantation, consistent with the re-establishment of lymphatic drainage into the transplanted lymph nodes after approximately 3 months.

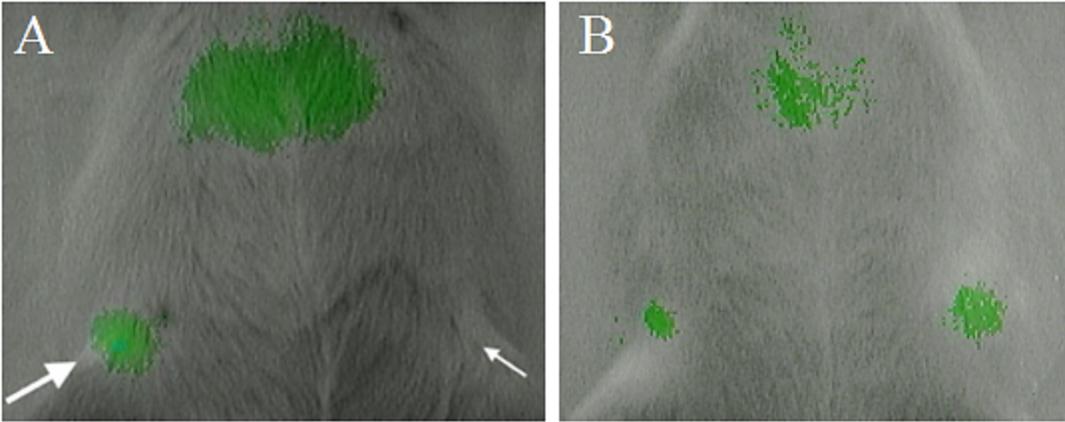


Figure 1. A) Lymphatic uptake of fluorescent ICG at 3 months post VLNT. Uptake is seen in the un-operated right inguinal lymph node (large arrow) but not in the operated left inguinal lymph node (small arrow). Uptake is also seen in the liver as ICG is hepatically metabolized. B) Lymphatic uptake of fluorescent ICG at 6 months post VLNT. Uptake is seen in both the right inguinal lymph node (VLNT) as well as in the un-operated left side.

## **84. Successful Decellularization of a Gracilis Flap: Using Nature's Architecture to Build a Muscle**

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### **Introduction:**

Soft tissue loss as a result of trauma or malignancy represents a major healthcare problem in the United States. Despite the overwhelming need for interventions to improve outcomes following amputation and disabling tissue loss, the capacity to restore function remains limited. Autologous tissue reconstruction represents the predominant approach to dealing with these problems. This approach often fails to restore form, function, and aesthetics. It also comes with a significant cost to the patient with surgical risk and donor site morbidity. Tissue engineering provides us with the opportunity to create an autologous, bio-artificial graft from patient derived cells. Such grafts would provide a great alternative to allogenic grafts since these grafts would overcome the classic drawbacks of tissue reconstruction: immunogenicity, quality and quantity.

### **Materials and Methods:**

An animal model was developed based on literature using Sprague-Dawley rats. Two gracilis muscle flaps per rat were harvested with the femoral artery and vein as the dominant pedicle. The flaps were injected with Heparin PBS in the artery and vein. Subsequently, the flaps were perfused with heparinized saline followed by the perfusion with 1% sodium dodecyl sulfate (SDS) for 72 hours. Flaps were then washed with deionized water and were then perfused with 1% Triton X-100. Finally, the scaffolds were flushed with 0.1% peracetic acid for sterilization. Successful decellularization was confirmed by gross observation, DNA quantification, H&E, Trichrome and Verhoeff's staining, and Electron microscopy assessment of the flaps.

### **Results:**

Decellularization was done over 72 hour period to maximize the results. The process did not affect the ultrastructure of the tissue and the flaps retained their collagen content as observed by H&E, Trichrome and Verhoeff's staining. DNA quantification of tissue samples from the flaps before and after decellularization showed successful removal of 95.7% of the DNA content in the decellularized flaps. Moreover, the vessels were pumped with Medium and 0.4% Trypan Blue Dye solution using a bioreactor to mimic the actual blood flow and pressure which showed an intact vascular network. EM microscopy images confirmed an undamaged extracellular matrix.

### **Conclusions:**

Here we present a novel method to successfully decellularize a muscle flap while preserving the vascular network integrity and the extracellular matrix. The produced flap can be used as a bio-scaffold that can be later recellularized using stem cells. The development of a tissue construct with vascular integrity could have widespread application for reconstruction of wounds where vascularized tissue is needed.

## **85. Increased Lower Extremity Venous Stasis may contribute to Deep Venous Thrombosis Formation after Microsurgical Breast Reconstruction – An Ultrasonographic Study**

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**Background:** Despite guideline-compliant prophylaxis, an increased rate of deep venous thrombosis (DVT) formation has been reported following autologous vs. implant-based breast reconstruction. We hypothesized that tight abdominal fascia closure might decrease lower extremity venous return and promote venous stasis.

**Methods:** An observational crossover study of patients who underwent autologous breast reconstruction using TRAM/DIEP flaps was conducted. Ultrasonographic measurements of the left common femoral (CFV) and right internal jugular vein (IJV) were performed preoperatively, in the post-anesthesia care unit (PACU), and on postoperative day (POD) 1. Parameters of interest included vessel diameter, circumference, area, and maximum flow velocity.

**Results:** Eighteen patients with a mean age and body mass index (BMI) of 52.7 years (range, 29 to 76 years) and 31.3 kg/m<sup>2</sup> (range, 21.9 to 43.4 kg/m<sup>2</sup>) were included, respectively. A 29.8% increase in CFV diameter was observed on POD 1 (p<0.0001). Similarly, a 24.3% and 69.9% increase in CFV circumference (p=0.0007) and area (p<0.0001) was noted, respectively. These correlated with a 28.4% decrease in maximum flow velocity in the CFV (p=0.0001). Of note, none of these parameters displayed significant changes for the IJV, thus indicating, that observed changes in the CFV were not the result of changes in perioperative fluid status.

**Conclusion:** Postoperative changes observed in the CFV reflect increased lower extremity venous stasis after microsurgical breast reconstruction and may contribute to postoperative DVT formation.

## 86. Identifying Important Factors in Breast Reconstruction Education

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**Background:** In the era of patient-centered care, shared decision-making processes have been critical to improving the quality of healthcare and reducing its cost. Our aim is to evaluate how women who present for breast reconstruction currently obtain information and how they would prefer to receive it in an effort to appropriately allocate resources for patient education. We report here an update on our previously presented information.

**Methods:** A Pre-Operative and Post-Operative study were given in person to women presenting for breast reconstruction consultation or follow up. Each survey included a list of resources which women were asked to assign a relative value score from 1 to 5. Multiple-choice questions were included that pertain to timing of information review, timing of meeting with a reconstructive surgeon, and interest in sharing their experience or receiving information directly from other women. Both surveys included a free response section.

**Results:** Currently, the Pre-Operative Survey and the Post-Operative Survey have been completed by 25 women and 73 women, respectively. The Pre-Operative Survey shows most women would prefer to receive their information from their reconstructive surgeon, an interactive website, and a pamphlet (average relative value scores of 1.5, 2.7, and 3.3). Most women would prefer to review this information before meeting with their surgeon and believe it should take 30 minutes to 1 hour to review. 60% of women age 61-70 would like to speak with women who have previously undergone reconstruction versus only 43% of women age 41-50 and 36% of women age 51-60. The Post-Operative Survey shows the same importance placed on information resources. 60% of women indicated the best time to meet with their surgeon would have been immediately after meeting with their general surgeon. 53% of women spoke to other women who had undergone reconstruction and found it helpful and informative. The most common free response questions from the post-operative survey indicate that women would like to have more information on immediate post-operative care, better access to pictures of other reconstructed breasts, and more information on breast reconstruction in general.

**Conclusion:** Based on our current information, patients continue to primarily utilize their reconstructive surgeon for guidance over other sources of information. Efforts to develop teaching aids should focus on utilizing interactive websites and pamphlets. Meetings should include a focus on details of post-operative care, specific surgical aesthetic expectations, and an overview of the reconstructive process.

## **87. Mastectomy Skin Necrosis following Breast Reconstruction: A Comparative Analysis between Autologous Reconstruction and Implant-Based Reconstruction**

Stanford University, Stanford, 194, USA

Gloria R Sue, MD; Stanford University, Stanford, CA; Gordon K Lee, MD, FACS; Plastic Surgery, Stanford University, Stanford, CA

**Introduction:** Mastectomy skin necrosis is a significant problem following breast reconstruction. The development of this complication leads to poor wound healing, need for additional treatment, and decreased patient satisfaction. We sought to perform a comparative analysis on this complication between patients undergoing autologous breast reconstruction versus two-stage expander implant breast reconstruction.

**Methods:** A retrospective review was performed on consecutive patients undergoing autologous breast reconstruction or two-stage expander implant breast reconstruction by the senior author from 2006 through 2015. Patient demographic factors including age, body mass index, history of diabetes, history of smoking, and history of radiation to the breast were collected. Our primary outcome measure was mastectomy skin necrosis. Fisher's exact test was used for statistical analysis between the two patient cohorts. The treatment patterns of mastectomy skin necrosis were then analyzed.

**Results:** We identified 204 patients that underwent autologous breast reconstruction and 293 patients that underwent two-stage expander implant breast reconstruction. The incidence of mastectomy skin necrosis was 30.4% of patients in the autologous group compared to only 10.6% of patients in the tissue expander group ( $P < 0.001$ ). A higher body mass index and history of smoking were significantly associated with mastectomy skin necrosis in both groups of patients, while a history of diabetes was significantly associated this complication in only those undergoing autologous reconstruction.

The treatment of this complication differed between these two patient groups. In general, those with autologous reconstructions were treated with more conservative means. While 37.1% of patients were treated successfully with local wound care in the autologous group, only 3.2% were treated with local wound care in the tissue expander group ( $P < 0.001$ ). 29.0% of patients in the autologous group were treated with an operative intervention for this complication, compared to 41.9% in the tissue expander group ( $P = 0.25$ ).

**Conclusions:** Mastectomy skin necrosis is significantly more likely to occur following autologous breast reconstruction compared to two-stage expander implant based breast reconstruction. Patients with autologous reconstructions are more readily treated with local wound care compared to patients with tissue expanders, who tended to require operative treatment for this complication. Patients considering breast reconstruction should be counseled appropriately regarding the differences in incidence and management of mastectomy skin necrosis between the reconstructive options.

## 88. 'Incidentalomas' on 496 Preoperative CT Angiograms for Breast Cancer Patients With and Without Genetic Mutations—Incidence and Impact

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**Purpose:** Pre-operative abdominal CT angiograms (CTA) for free flap breast reconstruction have been shown to accurately detect perforator anatomy, aid planning, and decrease operative time. However, CTA incidental findings are common and can affect patient management. Additionally, we hypothesized that patients with a known genetic mutation might have a higher rate of clinically significant findings. We present the largest series of CTAs reviewed for “incidentalomas” and the comparative rates between these patient populations.

**Methods:** All patients undergoing breast free flap reconstruction at Long Island Jewish Medical Center between 2009 and 2013 were eligible for inclusion. 532 patients were identified. Medical history, imaging studies, and perioperative details were reviewed. Official radiology reports were examined in detail, and any abnormal findings were recorded.

**Results:** Of 532 patients included, 48 did not have a CTA; of these, 12 had an MR angiogram instead, resulting in 496 patients with abdominal imaging. Only 146 (29%) had a negative exam with no additional findings. Twelve patients (2.4%) required additional imaging for specific findings, all of which were found to be benign. Another had a large ventral hernia which required repair prior to reconstruction, resulting in an 8 month delay. Only one patient had a radiographic diagnosis concerning for malignancy, renal cell carcinoma, which required a post-operative ablation by interventional radiology. Over 30 categories of benign abnormalities were seen; 147 patients had a single finding, while 203 had between two and five. Renal (17%) and liver (19%) findings were most common, followed by gynecological (uterine 13%, ovarian (11%) and diverticulosis (15%).

Eighty-three (17%) patients had a known genetic mutation, 59 of which were BRCA (19 unspecified, 22 BRCA-1, 18 BRCA-2). Within this subset, 76 had abdominal imaging, 34 (41%) of which were completely negative. Of the remaining, liver (16%) and renal (13%) findings were again most common, with only 7 each benign ovarian (8%) and uterine (8%) findings, showing no statistical difference compared to non-mutation carriers.

**Conclusions:** Our rate of CTA incidental findings (71%) is consistent with the most recent and largest published studies, but the rate of patients requiring further intervention (2.8%) is lower. Against our hypothesis, we found that incidental findings were no more common or pathological among genetic mutation carriers. Patients undergoing pre-operative CTAs should thus be counseled regarding the high likelihood of incidental findings, but reassured, regardless of mutation status, that ‘incidentalomas’ are most commonly benign with minimal impact on their surgical plan.

## 89. The Medial Border of the Breast in Relation to the Internal Mammary Perforators

Memorial Sloan-Kettering Cancer Center, New York, 221, USA

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The cutaneous vascular supply of the anterior chest wall is well described. The 2<sup>nd</sup> or 3<sup>rd</sup> internal mammary artery (IMA) perforators are the principal blood supply to the remaining skin flap after a total mastectomy. Traditionally, the medial mastectomy border has been defined as the sternal edge, which results in sacrifice of the IMA perforators. This increases the risk of mastectomy skin flap necrosis, especially in skin and nipple sparing cases, and jeopardizes the reconstructive effort. Thus preservation of these vessels should result in improved perfusion of the mastectomy skin flap and decrease in wound healing complications. The object of this study was to determine if it is oncologically safe to spare these perforators during mastectomy. Mastectomies were performed on 21 breasts (15 patients). During the procedure, the 2<sup>nd</sup>/3<sup>rd</sup> IMA perforator was identified and a sample of tissue medial to the perforator was obtained for pathology. Breast MRIs of these patients were reviewed to see the relation of the 2<sup>nd</sup>/3<sup>rd</sup> IMA perforator to the breast parenchyma. In all but 2 breasts, the MRI did not show any breast parenchyma medial the 2<sup>nd</sup>/3<sup>rd</sup> IMA perforator, and biopsies medial to these perforators showed an absence of breast tissue. In one patient, the MRI showed some breast tissue medial to perforators, but biopsy showed normal adipose tissue. In another patient, the MRI showed that breast tissue was abutting but not medial to the perforator; however, biopsy medial to this perforator was positive for breast tissue. Thus, the medial border of the breast does not extend up to the sternal edge in the majority of cases as is traditionally described, and the IMA perforators (especially the 2<sup>nd</sup> and 3<sup>rd</sup>) should be preserved to improve the perfusion of the mastectomy skin flap. Preoperative MRI provides key information about the location of the 2<sup>nd</sup>/3<sup>rd</sup> IC perforator in relation to the breast parenchyma.

## **90. Achieving Total Skin-Sparing Mastectomy in Women with Large and Ptotic Breasts Using Staged Oncoplastic Breast Reduction Prior to Completion Mastectomy**

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**BACKGROUND:** Total skin-sparing mastectomy (TSSM) and nipple-sparing mastectomy (NSM) have gained in popularity in recent years as these techniques, which necessitate immediate breast reconstruction, have been demonstrated to be oncologically safe and improve patient satisfaction. However, large and ptotic breasts are still relative contraindications for this procedure. We aim to describe our experience with performing planned oncoplastic breast reduction prior to completion TSSM in patients who were not candidates for TSSM initially.

**METHODS:** We reviewed all TSSM cases performed at our institution and identified those performed in women with large or ptotic breasts who underwent oncoplastic breast reduction prior to completion TSSM. At the time of TSSM, patients underwent immediate reconstruction either an autologous flap (pedicled transverse rectus abdominis myocutaneous (TRAM) flap or deep inferior epigastric perforator (DIEP) free flap), or tissue expander (TE) placement. Of those that underwent TE placement, the final stage of reconstruction was either TE-implant exchange or delayed immediate reconstruction with DIEP free flap. Our main outcomes were nipple necrosis, infections, and implant loss.

**RESULTS:** We identified 17 patients who underwent oncoplastic breast reduction prior to TSSM and immediate breast reconstruction with median 11 months of follow-up. Of these, 12 patients had bilateral TSSM while 5 had unilateral TSSM (29 cases total). Of the 5 cases that underwent immediate autologous flap reconstruction (1 pedicled TRAM flap, 4 DIEP free flaps), and 1 case developed partial nipple necrosis (20%), and this was in the immediate TRAM flap. Of the 24 cases that underwent tissue expander (TE) placement, there was no nipple necrosis (0%), 1 infection (4%), and 1 tissue expander loss (4%). Of the 19 cases that completed TE-implant exchange, there was 1 case that developed an infection (5%) and ultimately lost the implant (5%). Of the 2 cases that underwent delayed-immediate reconstruction with DIEP free flaps, there were no postoperative complications.

**CONCLUSIONS:** By utilizing staged oncoplastic breast reduction prior to mastectomy, we have been able to achieve the same aesthetic breast reconstruction result of TSSM and NSM in patients who have large and ptotic breasts. While our experience is currently limited to 17 patients and 29 cases, there have been a limited number of complications, and we will continue to learn more as we offer this to more patients.

## 91. Breast Reconstruction Pre-Operative Risk Assessment: Applying the Risk Calculator to Define High Risk Patients

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**Purpose** –In the last decade an increasing number of patients with breast cancer have undergone breast reconstruction, including those at high risk of complication. Patients with multiple comorbidity factors have been associated with increased complications. However, how should we define a high risk patient and should their reconstruction plan follow the same of a lower risk patient? The BRA Score has been proposed to calculate the pre-operative risk. Our aim was to validate the BRA Score as a pre-operative risk calculator for its practical use.

**Methods** – Patients that underwent different types of breast reconstruction had their pre-operative risk retrospectively calculated per breast using the BRA Score, and the actual complications they developed were collected. From the BRA Score we calculated risk of overall complication based on MROC (Risk-MROC) and TOPS (Risk-TOPS), surgical site infection risk (SSI-Risk), and 30 day reoperation risk (Reop-Risk). Data gathered from patient charts included post-operative overall complications (PO-Comp), surgical site infection (SSI), and reoperations due to complications. The following groups were considered: group 1, reconstructed breasts that developed the predicted complication; group 2, breasts without the complication. The ROC curve was used to evaluate the calculated risk as a complication predictor.

**Results** – Charts of 389 breast reconstructions from 255 patients were evaluated. Compared to Group 2, Group 1 had a significantly higher Risk-MROC ( $20.8 \pm 11.12$  vs  $15.24 \pm 9.16$ ,  $p \leq 0.01$ ), Risk-TOPS ( $19.7 \pm 7.28$  vs  $15.5 \pm 6.56$ ,  $p \leq 0.01$ ), and Reop-Risk ( $7.48 \pm 3.27$  vs  $6.22 \pm 5.22$ ,  $p \leq 0.01$ ); and similar SSI-Risk ( $3.75 \pm 2.3$  vs  $3.94 \pm 2.38$ ,  $p = 0.96$ ). As tests for predicting the PO-Comp, Risk-MROC and Risk-TOPS were adequate, with areas under the ROC curve of 0.662 and 0.669, respectively. For predicting the reoperations, Risk-MROC, Risk-TOPS, and Reop-Risk presented areas of 0.666, 0.691, and 0.652, respectively. A predicted risk of 25.5% using Risk-MROC and Risk-TOPS would provide a specificity of 79% and 89%, respectively.

**Conclusions** – In this patient population, the BRA Score was a helpful tool to predict overall complications and reoperations. The calculator was not found to be useful in predicting surgical site infection. An overall risk of 25.5% derived from either the MROC or TOPS database would provide high specificity in determining a very high risk breast reconstruction patient. Patients with such high pre-operative risk may benefit from modifications in the breast reconstruction treatment plan to lower the complication rate. By using BRA Score, we can reliably predict the possible outcome of the reconstructions which can be used to better counsel the patient.

## **92. The Use of Tumescent Technique in Mastectomy Followed by Breast Reconstruction Increases the Risk of Skin Flap Necrosis: a Systematic Review of Observational Studies and a Meta-Analysis**

Johns Hopkins University, School of Medicine, Baltimore, 210, USA

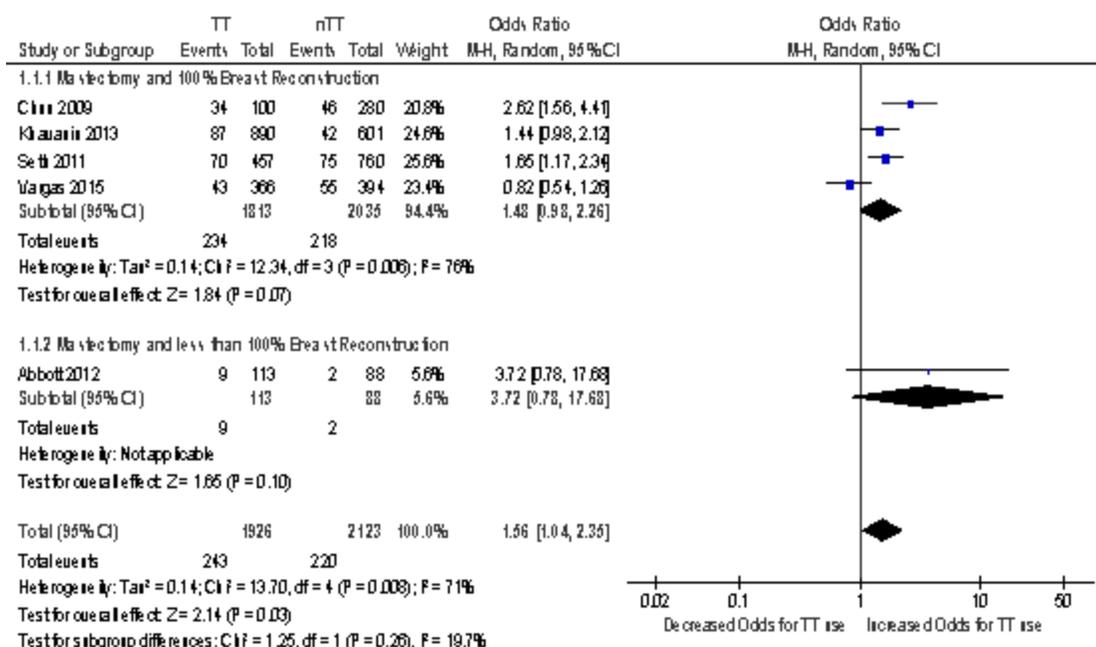
Charalampos Siotos, MD<sup>1</sup>; Jeff Aston, BS<sup>1</sup>; David Euhus, MD<sup>2</sup>; Stella M. Seal, MLS<sup>3</sup>; Michele A. Manahan, MD<sup>4</sup>; Gedge D. Rosson, MD<sup>3</sup>; (1)Johns Hopkins University, Baltimore, MD, (2)Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, MD, (3)Department of Plastic and Reconstructive Surgery, Johns Hopkins University School of Medicine, Baltimore, MD, (4)Department of Plastic and Reconstructive Surgery, Johns Hopkins University, Baltimore, MD

**Introduction:** Postoperative skin necrosis in surgical patients is costly to hospitals and healthcare providers. Tumescent dissection technique is commonly used in mastectomy and immediate breast reconstruction, as it helps reduce blood loss; however, it may increase the risk of mastectomy skin flap necrosis. In this context, we have conducted a systematic review of the literature to better understand the relationship between tumescent mastectomy technique and complication rates.

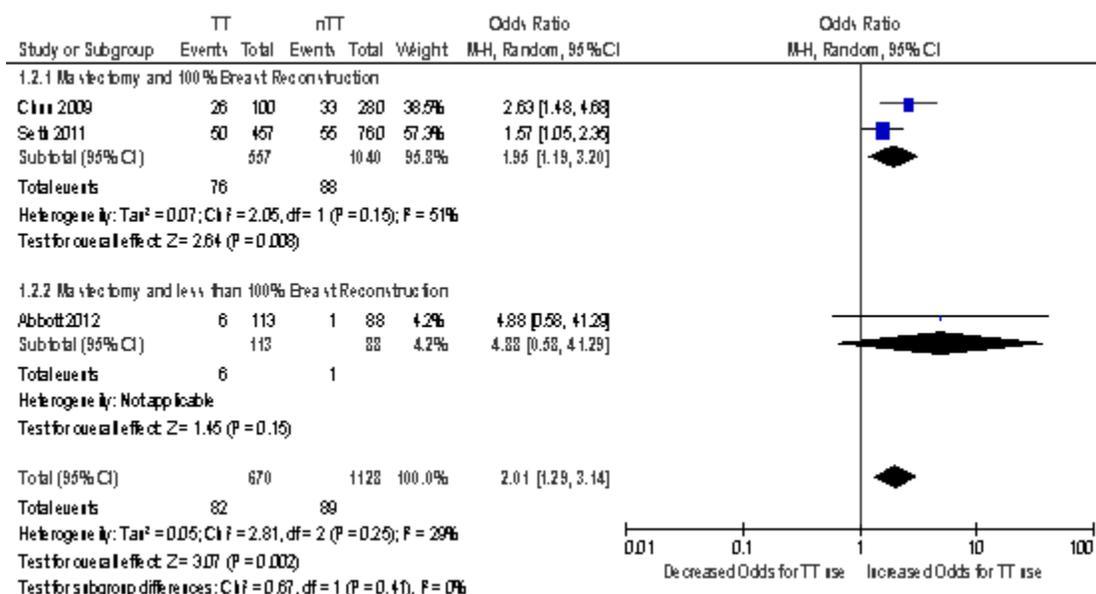
**Materials and Methods:** We screened PubMed(1966-2016), Scopus(2004-2016), Embase(1966-2016) and Web of Science(1964-2016) for relevant articles through April 14, 2016. We included studies on the use of tumescent technique in the context of mastectomy with or without immediate breast reconstruction. The primary outcome we evaluated was the rate of skin flap necrosis; the secondary outcomes were the rates of breast hematomas and infections. Due to the heterogeneity of the studies, we performed a meta-analysis using the random effects model.

**Results:** After screening, we evaluated five studies including 3,982 mastectomies. Mastectomies performed under the preoperative application of tumescent solution had statistically higher rates of skin flap necrosis overall ( $p=0.03$ ), major ( $p<0.01$ ) and minor skin necrosis ( $p=0.03$ ). However, the rates of hematoma and infection were not correlated with the use of tumescent technique.

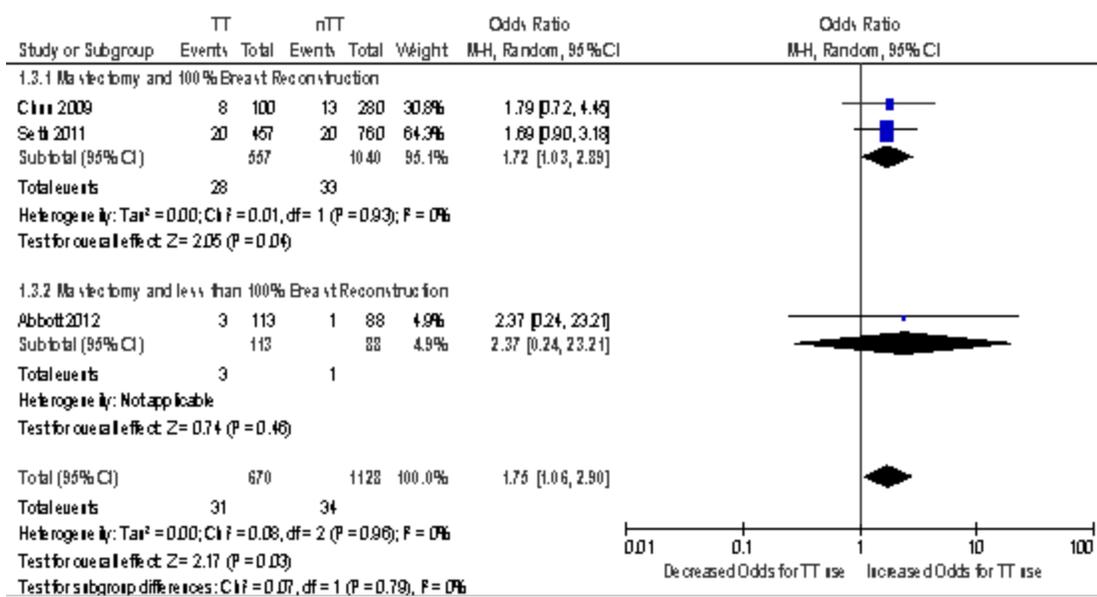
**Conclusions:** Our systematic review of the literature provides a better understanding of the consequences of the application of tumescent technique in mastectomy. Our findings suggest that tumescent technique may increase the risk of skin necrosis both with and without breast reconstruction.



Forest plot for 5 studies providing skin necrosis overall rates among mastectomies with (TT) and without (nTT) tumescent technique



Forest plot for 3 studies providing major skin necrosis rates among mastectomies with (TT) and without (nTT) tumescent technique



Forest plot for 3 studies providing minor skin necrosis rates among mastectomies with (TT) and without (nTT) tumescent technique

### **93. Soft Tissue Reconstruction in the Salvage of Total Knee Arthroplasty: Earlier is Better**

University of Pennsylvania, Philadelphia, 227, USA

David L. Colen, MD; Tiffany C Liu, BA; Michael Lanni, BS; Valeriy Shubinets, MD; Gwo-Chin Lee, MD; Stephen Kovach, MD; University of Pennsylvania, Philadelphia, PA

**BACKGROUND:** Over 670,000 knee replacements are performed annually in the United States. The most feared complication after this procedure is periprosthetic infection, occurring in 1-5% of cases, resulting in the failure of the prosthesis and in severe cases, knee fusion or even limb loss. Compromised soft tissue coverage after total knee arthroplasty (TKA) predisposes patients to prosthetic failure and must be addressed, yet the role of a plastic surgeon remains unclear in revisional knee arthroplasty. The goal of this study is to evaluate outcomes after soft tissue reconstruction in patients with compromised or infected knee prostheses and elucidate the optimal role of a plastic surgeon in prosthesis salvage.

**METHODS:** A retrospective review of all patients requiring soft tissue reconstruction by the senior author after total knee arthroplasty was completed, collecting data regarding patient demographics, surgical history, operative course, and functional outcomes. Logistic regression was done to determine factors that were associated with the primary outcome, prosthesis salvage versus knee fusion or amputation.

**RESULTS:** A total of 73 knee replacements in 72 patients required soft tissue reconstruction between 2008 and 2016; follow up averaged 1.8 years (range=1 month to 6.3 years) and 1 patient was lost to follow up. Sixteen knees (21.9%) required local fasciocutaneous flaps, 33 knees (45.2%) required medial gastrocnemius muscle flap, and 13 required a free flap (17.8%). Overall salvage rate was 61.1% (n=44), and was increased in patients who had soft tissue reconstruction prior to attempt at TKA revision (71.4%, n=21); 2 patients maintained an articulating antibiotic spacer (2.8%), 8 patients underwent knee fusion (11.1%), and 18 patients eventually underwent amputation (25%). Most patients had undergone multiple attempts at wound closure prior to the index operation for soft tissue reconstruction (mean=4.2); each additional operation prior to soft tissue reconstruction both decreased the likelihood of TKA salvage (OR=0.68, p=0.011) and increased the risk of amputation (OR=1.42, p=0.02).

**CONCLUSIONS:** Failed revision of TKA has devastating implications. Early intervention with soft tissue reconstruction, however, significantly improves the likelihood of successful knee salvage. Therefore, there may be a benefit to involving a plastic surgeon early in the course of TKR complications to optimize genicular soft tissues and improve outcomes.

## 94. Validating Literature and Introducing Algorithm for the Surgical Management of Lymphedema Using the MINORS Scoring System

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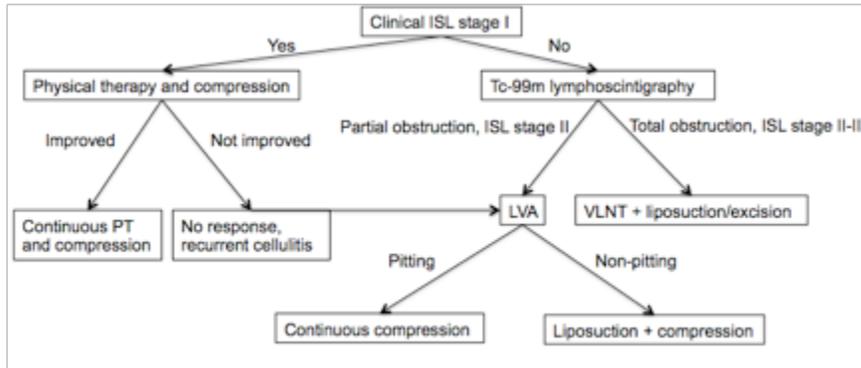
**Background:** While conservative management of lymphedema remains an essential first-line approach, surgical treatment has proven effective in select patients. Existing reviews of the surgical management of lymphedema describe non-validated strategies. The Methodological Index for Non-Randomized Studies (MINORS) scoring system, an instrument designed to assess the validity of non-randomized studies, was applied to existing lymphedema surgery literature with the aim of creating a treatment algorithm.

**Methods:** A systematic review of contemporary peer-reviewed literature (2000-May 2016) was performed to examine outcomes of the surgical treatment of lymphedema. The resulting articles fell into four groups: those describing excision, liposuction, lymphovenous anastomoses (LVA), and vascularized lymph node transfer (VLNT). The MINORS score was calculated for each article to identify the highest scoring (most validated) ones. Highly validated articles (>12/16 or >19/24 for non-comparative or comparative studies respectively) were reviewed and the following data was extracted: number of patients, International Society of Lymphology (ISL) stage of patients, surgical procedure, length of follow-up, volume or circumference reduction, measurement technique, reported complications, and additional interventions.

**Results:** A total of 77 articles matched study criteria (7 excision, 8 liposuction, 31 LVA, 31 VLNT) and were assigned MINORS scores based on 8 or 12 methodological items with a maximum score of 16 or 24 for non-comparative or comparative studies respectively. The average MINORS scores using non-comparative criteria were 13.4 (range: 8 to 16) for excision, 12.6 (range: 9 to 15) for liposuction, 13.3 (range: 10 to 16) for LVA, and 14.0 (range: 9 to 16 for VLNT). Having an aim, an endpoint, and an unbiased method for evaluating outcomes were three criteria that most commonly increased MINORS score. Lack of appropriate follow-up and loss to follow-up most commonly decreased MINORS score. Studies scoring >12/16 or >19/24 were considered valid for use in creating a management algorithm. The resulting algorithm is presented in Figure 1.

**Conclusion:** The MINORS criteria can help design validated non-randomized lymphedema studies; it can be applied to lymphedema outcomes research to isolate the highest quality studies to guide clinical practice. A particular focus on patient follow-up will help improve the validity of lymphedema surgery research. When the appropriate procedure is selected and traditional treatments such as compression are continued after surgical intervention, both reductive and physiological approaches can safely and effectively treat lymphedema.

Figure 1: Lymphedema Treatment Algorithm



## **95. Novel Perfusion Diagnostics In Reconstructive Surgery Towards Prediction Of Free Flap Failure**

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Free flap necrosis has a frequent occurrence and results in high morbidity, however there is still no quantitative method to image and measure perfusion during the operation. Optical techniques could be the answer to this problem. These techniques image perfusion directly during surgery and give a high-resolution and high-contrast image comparable to microscopy. In this study we test the feasibility, validity and reproducibility of four optical techniques: Optical Coherence Tomography (OCT), Sidestream Darkfield Microscopy (SDF), Laser Speckle Contrast Imaging (LSCI) and Fluorescence Imaging (FI).

During free flap surgery OCT (10x10mm) and SDF (1x0.65mm) images were obtained from proximal to distal of the supplying artery. Widefield LSCI (15x20cm) images and FI (10x10cm) movies, using indocyanine green (ICG) as fluorophore, were made of the free flap. Perfusion parameters – blood flow velocity, vessel density, flux and influx of ICG – were compared statistically between the four different area's with a paired t-test.

Techniques were previously validated in terms of velocity and vesseldiameter in a microvascular tissue phantom with full blood of a healthy volunteer.

OCT, LSCI and FI were feasible to image perfusion during surgery. OCT produced 8 3D-images of 10x10x3 mm, showing tissue layers and blood vessels in a high-resolution. SDF was not feasible to show perfusion. LSCI produced 10 color-coded images with a significant difference in flux (perfusion units) between the distal (tip) and proximal part of the free flap ( $p=0.01$ ). FI produced a movie in which influx of ICG was visible and significantly different between the distal and proximal part of the free flap ( $p<0.001$ ).

OCT, LSCI and FI are feasible to image perfusion during surgery. Quantitative parameters – velocity, vessel density, flux and perfusion influx – were obtained with these techniques. Future prospective studies are necessary to determine threshold values of these quantitative parameters to predict free flap failure.

## **96. Lymphovenous Bypass Number Correlates With Improved Surgical Outcomes In Upper Extremity Lymphedema**

UPMC, Pittsburgh, 227, USA

Mark Asher Schusterman II, MD; University of Pittsburgh Medical Center, Pittsburgh, PA; Carolyn De La Cruz, MD; Department of Plastic Surgery, University of Pittsburgh Medical Center, Pittsburgh, PA

**Background:** Lymphedema remains a significant cause of morbidity for patients worldwide. In certain cases, surgery has been shown to reduce limb volume significantly. More specifically, lymphovenous bypass has been shown to provide improvement in patients with early-stage, upper extremity lymphedema. However, no studies have examined a possible correlation between the number of anastomoses and overall volume improvement. We report our results using lymphovenous bypass for upper extremity lymphedema and examine the effect of the number on anastomoses on reduction of excess volume.

**Methods:** Retrospective review of our prospectively maintained database was performed for all patients who underwent LV bypass at our center. Exclusion criteria were follow-up of less than 3 months or incomplete medical records. Primary data-points included limb volume measurements and number of anastomoses. Volume measurements were calculated using sequential circumference measurements taken preoperatively and at 1, 3, and 12 months postoperatively. Postop volume measurements were compared to preoperative measurements and the number of anastomoses was compared to overall improvement by calculating Pearson's correlation coefficient.

**Results:** 13 patients met our criteria (average age = 60 years). All patients developed upper extremity lymphedema after either axillary lymph node dissection or sentinel lymph node biopsy for either breast cancer (n = 12) or melanoma (n = 1). All patients had stage 1 (n = 6) or 2 (n = 7) disease. Average OR time was 6 hours and the average number of anastomoses was 3.6 (range 2-6). All but one patient reported subjective improvement of their disease by one month postop. On average, the excess volume of the diseased limb was reduced by 30.45% at 1 month (n = 13), 32.5% at 3 months (n = 10), and 17.8% at 12 months (n = 6). Lastly, the number of anastomoses showed a significant positive correlation to excess volume reduction at 12 months after surgery ( $p = 0.013$ ).

**Conclusions:** Our results using LV bypass show both quantitative and qualitative improvement in excess volume. Furthermore, the number of anastomoses showed a positive correlation to improvement of excess volume at 1 year after surgery. Further follow-up and larger studies are required to analyze predictive factors for success.

## **97. Microsurgical Toe-to-Hand Transfer for Reconstruction of Tripod-Pinch in Patients with Multiple-Digit Amputations Proximal to Their Functional Length: Long-Term Outcome Study**

Chang Gung Memorial Hospital and Chang Gung University, Taipei, 256, Taiwan

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### **Introduction:**

Long-term outcomes that evaluate functional improvement and quality of life using validated tools are lacking in spite of nearly 50-year of experience in microsurgical toe transfers.

### **Methods:**

We conducted a retrospective cohort study. Patients who had *at least* two-digit amputation unilaterally or four-digit amputation bilaterally, proximal to the midlevel of proximal phalanx of the finger or interphalangeal joint of the thumb, including metacarpal and metacarpal-like hands, and received toe transfers were identified and asked to return for evaluation.

Recorded data included physical tests such as grip and pinch strength, and the Jebsen-Taylor test. Quality of life measures were assessed with a translated and validated Chinese version of The Michigan Hand Outcomes Questionnaire (MHQ).

### **Results:**

24 patients (28 hands) were enrolled in the study. 79% of the patients were right-handed. 20 patients had unilateral hand reconstruction vs. 4 had bilateral reconstruction with toe transfers. 9 hands received single toe transfer, 10 two-toe transfer, and 9 three-toe transfer. Tripod-pinch was restored in 17 hands, while 9 hands could do bipod-pinch, and 2 hands could not pinch. Mean follow-up was 22 years (range, 5-35 years).

When reconstructed hands were compared with contralateral normal hands (20 Vs. 20), toe transfer hands achieved 69%, 71.5%, 80.5%, 81.95%, 145% of the contralateral hand in overall function, ADL, aesthetics, satisfaction, and pain, respectively. Differences between both hands were statistically significant except in pain ( $P < .001$ ,  $< .001$ , 0.035, 0.0018, 0.39, respectively). The means of ADL of both hands and normal work scores were 89.6 and 77.5, respectively.

When tripod-pinch hands were compared with bipod-pinch hands (19 Vs. 7), tripod-pinch hands had higher MHQ scales compared with bipod-pinch hands, and scored less in pain scale. The difference was only statistically significant in ADL ( $p=0.043$ ) with large effect size 1.4.

Functional testing showed that patients regained on average 46.98%, 64.77%, and 64.17% of grip strength, key-hole pinch, and tripod pinch of the contralateral normal hand, respectively. Reconstructed hands were 0.8 seconds faster than the contralateral normal hands on Jebsen Taylor test, but  $p$ -value was 0.88.

### **Conclusion**

This is the largest series on long-term outcomes after free toe transfers. Good functional and aesthetic reconstruction can be achieved by microsurgical toe-to-hand transplantation in spite of devastating hand amputations. Functionally better and more precise prehensile hand through effective restoration of tripod-pinch should be aimed at, in this era of advanced microsurgical techniques, due to notable functional improvement and enhanced quality of life.

## **99. Outcomes Following a Standardized Lower Extremity Free Flap Postoperative Pathway and Dangle Protocol**

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### **Background**

Microsurgical reconstruction has become an essential part of limb salvage, particularly in the distal lower extremity. However, the optimal postoperative care pathway for patients with lower extremity free flaps remains unclear within the literature, particularly the timing of extremity dangling and dependency. This study evaluates outcomes following the use of an accelerated and standardized protocol for lower extremity free flap reconstruction.

### **Methods**

Retrospective review of patients that underwent lower extremity free flap reconstruction from 10/2014-3/2016 at the Beth Israel Deaconess Medical Center was performed. Postoperative pathway and protocol consisted of admission to the intensive care unit postoperative day (POD) 0 with hourly flap checks and bedrest, floor transfer and diet advancement POD 1, out of bed to chair and dangling of lower extremity 5 minutes three times a day (TID) with visual flap checks on POD 2, and increase in dangling to 10, 15, and 20 minutes TID on POD 3, 4, 5 respectively. Hospital discharge was timed for as early as POD 6 depending on social and rehabilitation needs. Clinical and operative factors, and complication rates were recorded, with an average 7.1 months of follow-up.

### **Results**

Data analysis revealed 18 patients that underwent lower extremity free flap reconstruction, with an average age and BMI of 55.0 years and 27.3, respectively. Clinical history of smoking (n=5), diabetes (n=6), peripheral vascular disease (n=4), or hypertension (n=7) were documented preoperatively. The most common sources of wounds were malignancy (n=7), trauma (n=6), and chronic infection (n=5). The majority of flaps were anterolateral thigh flaps (n=15), with the remaining being a free gracilis, latissimus dorsi, and medial artery perforator. Forty-four percent of anastomoses were done end-to-side with an average operative time of 439 minutes. Mean hospital stay was 7.7 days (range 6-12 days) with a 16.7% (n=3) rate of total complications. There were no partial or complete flap losses.

### **Conclusions**

Free flap reconstruction of lower extremity soft tissue defects can be performed safely and effectively utilizing a standardized pathway for postoperative care and extremity dangling. Utilizing a defined postoperative protocol for in these complex patients allows for enhanced, consistent care from the entire reconstructive team. In particular, with no established timeline for dangling within the literature, incremental advancement of lower extremity dangling starting on POD 2 does not increase rates of flap loss while potentially decreasing time to hospital discharge.

## **100. Using 3-D photography to evaluate symmetry following unilateral breast reconstruction and contralateral symmetry procedures**

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### **Purpose**

Patients with unilateral breast cancer who are candidates for total mastectomy and reconstruction often are inclined to choose bilateral mastectomy in part because of a desire for improved symmetry after reconstruction. We hypothesize that bilateral mastectomy for the primary purpose of achieving symmetry is poor indication for prophylactic surgery because satisfactory symmetry can be achieved by coupling properly selected primary reconstructive methods with conventional surgical techniques to modify the volume and shape of the contralateral breast. To test this idea we computer analysis comparing pre- and postoperative 3-D digital images of a group of patients who underwent unilateral mastectomy and reconstruction with contralateral symmetry procedures and a group of patients who underwent bilateral mastectomy and reconstruction. As a secondary endpoint we assessed the number of procedures and amount of time necessary to achieve the final result.

### **Methods**

In 2013, 32 patients underwent breast reconstruction for unilateral or bilateral mastectomy defects. Group one (18 patients) underwent unilateral mastectomy and reconstruction combined with a contralateral procedure for symmetry. Group 2 (14 patients) consisted of bilateral mastectomy and reconstruction patients. 3-D digital images (Vectra Imaging, Canfield, City, State, USA) were obtained pre- and post-breast reconstruction and analyzed using these imaging using the accompanying Mirror Software. Breast dimensions were compared between the right and left sides by measuring the distance from the sternal notch to nipple, base diameter, position of the inframammary fold, and estimated volume. The average number of procedures for Group 1 was  $2.83 \pm 1.20$  and for group 2 was  $2.07 \pm 0.83$ . Average time to complete the reconstruction for Group 1 was  $386 \pm 390$  days and for Group 2 was  $167 \pm 139$  days.

### **Results**

Measurements demonstrate significant alterations in symmetry after unilateral mastectomy and reconstruction that are significantly improved with contralateral symmetry procedures. There was an increased number of procedures and corresponding increased length of time required to complete reconstructions in Group 1 compared to Group 2. However, the final results of reconstruction demonstrated acceptable symmetry between the two groups.

### **Conclusions**

Using 3-D imaging as tool to objectively assess symmetry following breast reconstruction, our early results demonstrate that it is possible to achieve acceptable symmetric shape and volume with unilateral reconstruction and contralateral symmetry procedures. Moreover, our study suggest that 3-D may prove a valuable tool in objectively assessing surgical outcomes.

## 101. Post-Operative Quality of Life Outcomes in Older Patients Who Underwent Mastectomy With or Without Breast Reconstruction

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**Background:** Breast reconstruction has been shown to improve the Quality of Life (QoL) of women who undergo mastectomy. While several studies demonstrated that breast reconstruction in older women ( $\geq 65$  years) is not associated with higher postoperative morbidity, there is a paucity of literature reporting on the QoL outcomes of this population. The purpose of this study is to assess the QoL of women who did (BR) or did not (nBR) undergo breast reconstruction following a mastectomy at age 65 years or older.

**Methods:** Following IRB approval, we identified women aged 65 years or older at time of mastectomy who did or did not undergo breast reconstruction between 2004 and 2013 at our facility. Eligible patients were contacted and asked to complete a Breast-Q by mail or over the phone. Data abstracted retrospectively from patients' medical records included demographics, comorbidities, cancer treatment, and method of reconstruction. We compared QoL outcomes between study groups (BR vs. nBR) using Wilcoxon rank sum test for continuous outcomes and Chi-square test for categorical outcomes. We then fitted multiple linear regression and multivariable logistic regression models to adjust for confounding. We fitted multivariable models in a stepwise, forwards, fashion including variables based on clinical significance and changes in estimates.

**Results:** We identified 104 patients eligible for study inclusion: 47 nBR patients (45.2%) and 57 BR patients (54.8%). After adjusting for age, BMI, history of chest radiation, chemotherapy, radiotherapy, diabetes, lung disease, and depression or anxiety, we found no statistically significant difference in QoL between study groups in the domains of Satisfaction with Breast ( $p=0.99$ ), Psychosocial Well-being ( $p=0.31$ ), Sexual Well-being ( $p=0.91$ ), and Chest Physical Well Being ( $p=0.46$ ). Sub-group analysis on type of reconstruction showed that autologous BR patients had a statistically significant mean increase in Satisfaction with Breasts and Psychosocial Well-Being of 20.4 points (95% CI: 6.05 to 34.72,  $p=0.007$ ) and 14.80 points (95% CI: 0.74 to 28.87,  $p=0.04$ ), respectively, compared to nBR patients.

**Conclusion:** These findings suggest that performing an autologous breast reconstruction in older women might be associated with better satisfaction with breasts and better psychosocial well-being. Larger prospective studies are needed to confirm these findings, especially given the increasing older population. These results may help surgeons when counseling older women with breast cancer on their breast reconstruction options and possible post-operative QoL.

### **103. Lessons Learned from Post-Extubation Adversities in Head and Neck Microsurgical Reconstruction: 4-year Perspective**

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**Introduction:** Airway management is a critical part of microsurgical head and neck reconstruction. However, reports on the risk factors for post-extubation adversities, associated complications, and management guidelines are lacking. The present study was conducted to address these concerns thoroughly.

**Methods:** Patients that underwent microsurgical head and neck reconstruction using endotracheal anesthesia and peri-operative extubation that subsequently developed post-extubation adversity over a 4-year period (January 2012 until March 2016) were reviewed. Their course was documented with medical, surgical, and subsequent interventions noted. We attempted to identify risk factors relating surgical variables to the airway outcome.

**Results:** 18 patients had post-extubation adversities (Etiology: 13 cancers, 3 patients with prior segmental mandibular defects reconstructed with soft tissue flaps presenting with mandibular deformity/soft-tissue deficiency/plate exposure, 2 osteoradionecrosis). Average patient age was 55.2 years old. 12 patients were primary microsurgical reconstruction and 6 patients had previous microsurgical reconstruction. The defects included: 5 buccal, 1 hemiglossectomy, 10 segmental mandibulectomy, and 2 marginal mandibulectomy with mouth floor. 8 ALT, 1 AMT, and 9 fibula flaps were utilized. All patients had endotracheal intubation for initial airway management. All cases with previous microsurgery had radiotherapy and trismus. 10 patients had unilateral neck dissection and 8 had bilateral neck dissection. The average time to extubation was 1.6 days after the index operation (Range: 1 to 8 days). The average time to airway related complication was on post-operative day 3 (Range: 1 to 8 days post-operation). The etiologies of post-extubation airway distress include: tongue ptosis (6), bulky flap (3), laryngeal edema (2), upper airway stenosis (1), CO<sub>2</sub> retention (1), hematoma (1), poor sputum clearance (1), subjective dyspnea (1), and multifactorial (2). Management ranged from 10 re-intubations with subsequent extubation, 5 re-intubations with conversion to elective tracheostomy, and 3 emergent tracheostomies. Complications included: 1 pneumothorax requiring chest tube placement, 3 pneumonias, and one patient with cardiac arrest, ECMO, and death.

**Discussion/Conclusion:** Although airway management strategies can be employed to avoid tracheostomy, complications still happen. When performing complex secondary bony mandibular reconstructions, a cautionary approach and possible pre-operative tracheostomy should be employed. The triad of previous microsurgery, radiotherapy, and trismus is notorious for airway complications and was found in a 33% of the patients. To ensure safety, management strategies including pre-operative tracheostomy and delayed endotracheal weaning protocols with fiber-optic laryngoscope airway evaluation should be considered.

## **104. The Preferred Reconstruction Method of an Oncologic Facial Through-and-Through Defect with Right Mouth Angle Involvement: 240 Microsurgeons' Decision**

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### **Introduction**

Through-and-through defects with mouth angle involvement pose a clinical challenge and the best reconstructive option is still in debate, as local/pedicle or free flaps are both applicable. The purpose of this study was to analyze the decisions made by international microsurgeons when facing this clinical scenario.

### **Materials and Methods**

A case with an oncological through-and-through facial defect with right mouth angle involvement following squamous cell carcinoma excision was presented via an online questionnaire. Responses regarding treatment options were collected from international microsurgeons and a total of 240 microsurgeons replied. The data was recorded and then further studied by geographic area and microsurgeons' level of experience (greater or less than 5 years as a staff surgeon). All of the collected data was analyzed by SPSS.

### **Results**

A total of 212 microsurgeons (88.3%) chose a free flap as their method of reconstruction, while 28 (11.5%) chose a local/pedicle flap as their preferred method in the given case. Amongst those who indicated a preference to use a free flap (n=212), 100 (47.2%) chose a radial forearm flap, 91 (42.9%) chose an anterolateral thigh (ALT) flap, and 6 (2.8%) chose a medial sural artery perforator (MSAP) flap.

### **Conclusion**

For a case with an oncological through-and-through facial defect with right mouth angle involvement, use of a free flap is the preferred method for reconstruction. There is still debate surrounding the best free flap to use in this context, and the radial forearm and ALT flaps are still very popular, while use of the MSAP flap is not as prevalent as initially thought.



Fig. 52 y/o healthy male suffered from right buccal cancer s/p tumor excision and neck dissection, defect: 8x6 cm facial through and through involved right mouth angle, what do you prefer for reconstruction?

## 105. Extracranial to Intracranial Flow through Flaps

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### Introduction:

Extracranial-intracranial bypass is indicated in ischemic disease such as moyamoya, certain intracranial aneurysms, and other complex patient conditions. Soft tissue transfer is indicated for craniofacial trauma and tumors and in cases of indirect cerebral revascularization. Fascial, skin, omental, and muscle flaps have been used for these indications. In this report, we present our series of flow through flaps for cerebral revascularization in conjunction with soft tissue reconstruction.

### Methods:

A retrospective review of a prospectively maintained database was performed. Five patients were identified who required direct arterial bypass in conjunction with a soft tissue procedure for indirect revascularization or soft tissue reconstruction.

### Results:

Indications for arterial bypass included intracranial aneurysm (n=1) and moyamoya disease (n=4). Indications for soft tissue reconstruction included infected cranioplasty (1) and indirect cerebral revascularization for moyamoya disease (4). Flaps included flow through radial forearm fascial flaps (2), a flow through radial forearm fasciocutaneous flap (1) and flow through pedicled temporoparietal fascial flaps (2). The superficial temporal vessels (3) and facial vessels (3) were used as the recipient site pedicle. Flow through reperfusion was established into the middle cerebral artery (3) and anterior communicating artery (2). There were no intraoperative complications. All flaps survived and there were no donor site complications. Postoperative imaging demonstrated graft patency in 4/5 patients. In one case of flow through TPF flap, the direct graft failed, but the indirect flap remained vascularized.

### Conclusions:

Flow through flaps can be safely used for conditions where combined arterial bypass and soft tissue procedures are required. Early outcomes have not demonstrated any major complications. Long-term results with direct and indirect re-vascularization are pending.

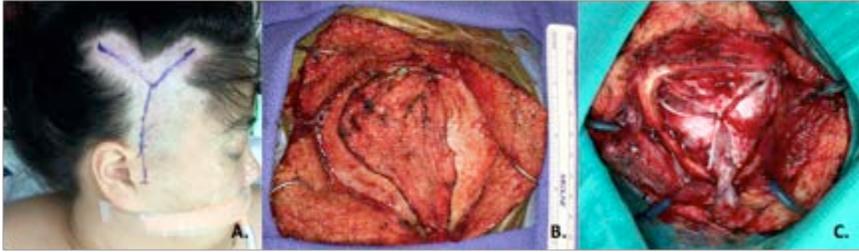


Figure 1. A. Pre-operative markings B. Superficial temporal fascial flap C. Inset of flap and dural closure

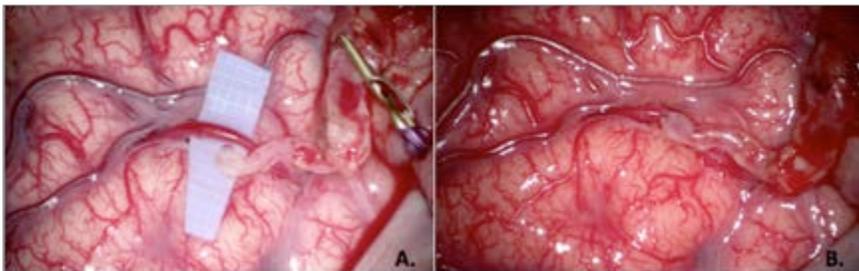


Figure 2. A. Cortical MCA branch dissected out with the prepared distal STA adjacent to it B. STA to M4 completed anastomosis

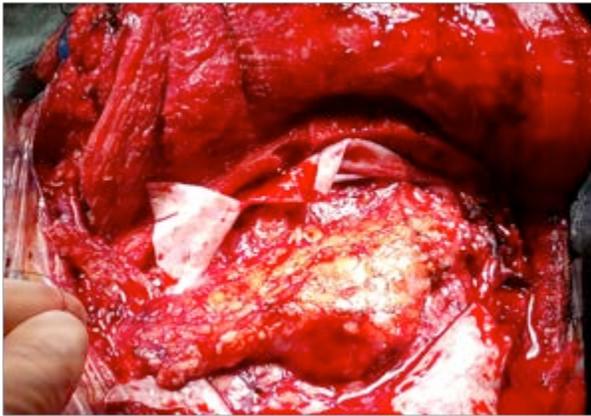


Figure 3. Flow through radial forearm fascia flap anastomosed to STA and V and bypass to anterior cerebral artery

## **106. Facial Paralysis and Reconstruction -- Comparison among CFNG-, XI- and V3-innervated Gracilis for Facial Reanimation**

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The goal of treatment of facial paralysis (FP) or postparalysis facial synkinesis (PPFS) is to achieve symmetric face at rest without twitching, and synchronous movement at smile without synkinesis. Using functioning free muscle transplantation (FFMT) for both deformities is our preferred option for treatment. Gracilis is the author first choice of muscle selection. Three motor neurotizers: cross face nerve graft (CFNG), spinal accessory nerve (XI) and masseter nerve (V3) are chosen for different patients. From 1986-2015, 389 cases of facial paralysis underwent gracilis FFMT at Chang Gung Memorial Hospital. 312 patients (80%) its innervated nerve comes from CFNG; and 53 patients (14%) from XI, and 20 patients from V3. A new smile score system (tooth exposure score, 0-4), recovery stage system (cortical adaptation stage, stage I-V), synkinesis severity scale (I-III), tickle test, and subjectively patient's questionnaire and satisfaction score (from 1 to 5) for outcome assessment.

CFNG-innervated gracilis can achieve most synchronous and natural smiling when longer observation (>3 years) was followed. This is especially true and first choice in children and patients less than 60 years old with facial paralysis reconstruction, although longer rehabilitation is required. The effectiveness of using XI-innervated free muscle for facial reanimation in a one stage procedure has proven a good alternative treatment, which has become second popularity for unilateral facial paralysis reconstruction. V3-gracilis only showed excellent teeth exposure when smiling, but were nerve spontaneous. It is better indicated in aged patients (>65 Y/O), or failed primary reconstruction, or malignant tumor resection which needs long term observation and/or treatment. A "Sugar cane concept" was proposed for making comparison between CFNG- and V3-innervated gracilis for facial reanimation.