

## SATURDAY EXTREMITIES

1:05 PM - 1:10 PM

### **RM2 Ex-Situ Normothermic Perfusion of Human Upper Extremity**

*Cleveland Clinic Foundation, Cleveland*

Presenter: **Vahe Fahradyan, MD**

**Vahe Fahradyan, MD**, Carlos Ordenana, MD, Sayf Al-deen Said, MD, Edoardo Dalla Pozza, MD, Maria Madajka, PhD, Nadeera Dawlagala, MD, Cho Kihyun, MD, Eliana F. R. Duraes, MD, PhD, Majid Rezaei, DDS, Francis A. Papay, MD, Antonio Rampazzo, MD, PhD and Bahar Bassiri Gharb, MD, PhD  
Cleveland Clinic, Cleveland, OH

**Background:** Ischemia time remains a significant limiting factor for successful extremity replantation and transplantation. Compared to the cold storage normothermic ex-situ perfusion is a novel method of a limb preservation by maintaining physiologic cellular metabolism avoiding the deleterious effects of hypoxia and cooling. The purpose of our study was to establish the efficacy of normothermic ex-situ perfusion in preserving the viability and function of human upper extremities.

**Methods:** Ten upper extremities were procured from brain-dead organ donors. Five limbs were perfused using an oxygenated colloid solution at 38°C containing PRBC, plasma and albumin. Five were preserved at 4°C as a control. Electrolytes were kept within physiologic range by partial perfusate exchanges. Limb viability was assessed by muscle contractility, compartment pressure, tissue oxygen saturation, creatine kinase(CK) and myoglobin concentrations, indocyanine green (ICG)angiography and thermography.

**Results:** Perfused arms retained physiological parameters and function up to 51hours with a final weight change of  $-1.26\% \pm 14.15$ , compartment pressure  $21.2 \pm 16.39$ mmHg, mean muscle temperature of  $35.1 \pm 0.86$ °C, and tissue oxygen saturation  $90.54\% \pm 7.98$ . Average values of final myoglobin and CK concentrations were  $51330 \pm 31913.86$ ng/mL, and  $34785.8 \pm 16136.54$ U/L. Thermography and ICG angiography depicted uniform peripheral perfusion throughout the experiment. Electrical stimulation of median, ulnar and radial nerves displayed no muscle contraction at the beginning, however, it recovered gradually and preserved until the end of perfusion.

**Conclusion:** Ex-situ normothermic limb perfusion shows potential in overcoming the present standard of care (cold preservation) improving ischemia time for large segments and envisioning a radical change in the management of traumatic amputations and upper extremity transplantation.

1:10 PM - 1:15 PM

### **RM3 Improved Perfusion of the Ischemic Diabetic Foot after Reconstruction Using Free Flap**

*Asan Medical Center, Seoul*

Presenter: **Jin Geun Kwon, MD**

**Jin Geun Kwon, MD**, Sinyoung Song, MD, Hyun Suk Suh, MD, PhD and JP Hong, MD, PhD, MMM

Asan Medical Center, University of Ulsan, Seoul, Korea, Republic of (South)

**Background:** Previous studies have shown that a 5-year survival rate can be improved by performing a free flap reconstruction of the diabetic foot. Conversely, more than half of patients who had amputation underwent re-amputation. The purpose of this study is to determine whether perfusion of the surrounding territory near the reconstructed flap changes after free flap reconstruction in ischemic diabetic foot patients.

**Methods:** This study is a retrospective analysis of 54 patients with ischemic diabetic foot from June 2015 to December 2017 at Asan Medical Center. All patients underwent angioplasties and hyperbaric oxygen to improve perfusion prior to operation. The patients were divided into 2 groups; Group 1 (n=36) who underwent free flap reconstruction (angiosome based debridement and reconstruction) salvaging the foot and Group 2 (n=18) who underwent partial foot amputation. For each foot, the skin perfusion pressure (SPP) was measured at the same point adjacent to the defect at preoperative and at postoperative 6 months. The results were compared and analyzed using independent t-test.

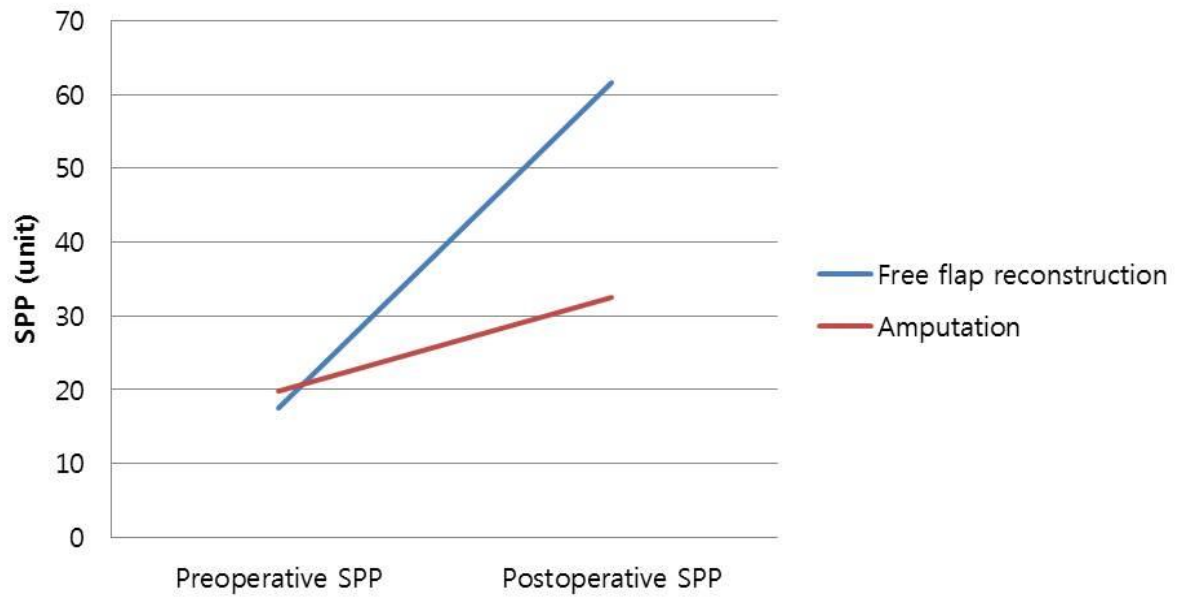
**Results:** The patient age ranged from 31 to 79 years (average- 56.6 years). In the reconstructed group 1, various free flaps were used including anterolateral thigh (n=19), superficial circumflex iliac artery perforator (n=16), and other perforator free flaps (n=2). The preoperative SPP showed 17.58 units in the free flap reconstruction group 1 and 19.73 units in the amputation group 2 without statistical significance between the two. The postoperative SPP showed 61.62 units in the free flap reconstruction group 1 and 32.58 units in the amputation group 2 with statistical significance (p<0.01).

**Conclusion:** The increase in perfusion of the amputation group 2 is most likely from the angioplasty procedure and hyperbaric oxygen therapy that all patient goes through routinely to maximize the chance of healing. After healing, prevention of additional recurrence is very important concept in holistic management of ischemic diabetic foot.

According to our study, free flap reconstruction improves the perfusion of remnant tissue compared to the amputated group 2. There was a significant increase in perfusion of the reconstructed foot most likely from the well vascularized free flap. This approach may reduce the potential risk of further ischemia while maintaining the healing state of the foot.

**Figure 1.** Improvement of skin perfusion pressure (SPP)

## Improvement of SPP after reconstruction



1:20 PM - 1:25 PM

**RM4 Plantar Reconstruction: Long-Term Outcomes of Free Gracilis Muscle Flaps Versus Free Fasciocutaneous Anterolateral Thigh Flaps**

*Klinikum Bogenhausen Academic Teaching Hospital , Munich*

Presenter: **Niclas Peter Broer, MD, PhD**

**Niclas Peter Broer, MD, PhD**(1), Milomir Ninkovic, MD(1), Dennis Ehrl, MD(2) and Paul Heidekrueger, MD(1)

(1)Klinikum Bogenhausen, Munich, Germany, (2)Klinikum Bogenhausen, München, Germany

Plantar reconstruction: Long-term outcomes of free gracilis muscle flaps versus free fasciocutaneous anterolateral thigh flaps **Background:** When faced with plantar defects, reconstruction of the weight-bearing areas presents unique surgical challenges. Consequently, there exist only few donor sites which fulfill the specific anatomic requirements. While loco-regional flaps can adequately cover smaller defects, they play a limited role when faced with more extensive defects. In these cases, microvascular flap reconstruction usually becomes the next option. Several free flap modalities have been described in this respect, but there remains debate regarding the best suited flap modality. Aim of this study is to compare free muscle (gracilis-) and non-neurotized fasciocutaneous (anterolateral thigh-) flaps for plantar reconstruction in respect to long-term functional outcomes. **Methods:** Over a 7-year period (2011 – 2017), a total of 89 patients received 100 free flaps (ALT n=46; gracilis n=54) for plantar reconstruction at our institution. The data were screened for patients' demographics, as well as intra- and perioperative details. Postoperative complications were accounted for and the two groups compared accordingly. All patients were contacted and asked to participate in a follow-up examination. **Results:** Overall, there were no significant differences between the two groups of patients regarding the rate of major- (23.91% (ALT) versus 16.67% (gracilis);  $p = 0.366$ ) and minor surgical complications (60.87% (ALT) versus 70.37% (gracilis);  $p = 0.318$ ). However, the group of ALT flaps showed a significantly higher need for secondary surgeries (39.13 (ALT) versus 18.52% (gracilis);  $p=0.022$ ). A total of 68 patients returned for long-term follow-up evaluation (mean: 51.2 months, range: 13 – 71, SD: 19.15 months). While the numeric rating scale evaluating pain was low in both groups, the ALT group showed significantly less pain at rest at the recipient- ( $p=0.0004$ ) and donor ( $p=0.010$ ) sites. The scar assessment utilizing the Vancouver scar scale (VSS) revealed significantly better results in the ALT group (mean: 1.75 (ALT) versus 5.67 (gracilis);  $p < 0.001$ ). Additionally, the ALT group showed better depth- ( $p=0.017$ ) and superficial ( $p=0.007$ ) sensation. **Conclusion:** Both the free ALT- and gracilis flaps are well suited for plantar reconstruction, yielding overall similar functional outcomes. However, the ALT flap resulted in less scarring, pain, and better recovery of sensation, and thus presents our preferred reconstructive option.

1:25 PM - 1:30 PM

## **RM5 Timing of Microsurgical Reconstruction in Lower Extremity Trauma: An Update of the Godina Paradigm**

*New York University Langone Medical Center, New York*

Presenter: **Z-Hye Lee, MD**

**Z-Hye Lee, MD**(1), John T Stranix, MD(1), William Rifkin, BA(1), David Daar, MD(1), Lavinia Anzai, MD(1), Daniel J. Ceradini, MD(2), Vishal D Thanik, MD(3), Pierre B Saadeh, MD(3) and Jamie P. Levine, MD(3)

(1)NYU Langone Medical Center, New York, NY, (2)Institute of Reconstructive Plastic Surgery, New York University Langone Medical Center, New York, NY, (3)NYU Langone Health, New York, NY

### **Background**

Marko Godina in his landmark paper in 1986 established the principle of early flap coverage for reconstruction of traumatic lower extremity injuries to minimize edema, fibrosis and infection while optimizing outcomes. The aim of this study was to determine how timing influences perioperative outcomes in free flap reconstruction for lower extremity trauma.

### **Methods**

A retrospective review of our institutional flap registry from 1979-2016 identified 806 lower extremity free flaps. 358 soft tissue free flaps for below knee trauma performed within one year of injury met inclusion criteria. Patients were stratified based on timing of coverage:  $\leq 3$  days (early), 4-90 days (delayed) and  $>90$  days (late). The delayed group was divided into two groups for further subgroup analysis: 4-9 days and 10-90 days. Patient demographics, flap characteristics, and flap outcomes were examined.

### **Results**

The mean age was 38.8 years (range 18-83) and 76% of patients were male. 77 free flaps (21.5%) were performed  $\leq 3$  days after initial injury, 233 (65.1%) were performed within 4-90 days and 48 (13.4%) flaps were performed after 90 days. There was significant difference in the presence of arterial injury between the groups (64.2% early vs. 46.6% delayed vs. 67.6% late;  $p=0.014$ ) and timing within cohort. Univariate analysis demonstrated no association between time to coverage and rates of partial flap failure ( $p=0.11$ ), total flap failure ( $p=0.44$ ), takebacks ( $p=0.79$ ) or major complications ( $p=0.14$ ). Multivariate logistic regression analysis demonstrated that flaps performed within 3 days after injury had decreased risk of major complications (OR 0.40,  $p=0.04$ ), trend towards decreased risk of partial flap failures (OR 0.13,  $p=0.06$ ) and any flap failures (OR 0.41,  $p=0.10$ ) compared to flaps performed between 4-90 days. Our ROC curve demonstrated day 10 to be the optimal day for predicting flap success (AUC=0.56). Multivariate logistic regression analysis demonstrated that flaps performed  $\leq 3$  days vs. 4-9 days had no differences in major complications ( $p=0.08$ ), partial flap failure ( $p=0.92$ ) or total flap failure ( $p=0.35$ ). In contrast, flaps performed 10-90 days from injury compared to  $\leq 3$  days had increased risk of major complications (OR 2.67,  $p=0.002$ ) and total flap failure (OR 3.40,  $p=0.03$ ).

### **Conclusion**

Early free flap reconstruction performed within 3 days of injury had superior outcomes

compared to delayed reconstruction (4-90 days), consistent with Godina's original findings. However, as an update to his paradigm, this ideal early period of reconstruction can be safely extended to within 10 days of injury without an adverse effect on outcomes.

1:30 PM - 1:35 PM

## **RM6 Vascular Imaging before Free Tissue Transfer for Chronic Lower Extremity Wounds: The Georgetown Protocol**

*MedStar Georgetown University Hospital, Washington, DC*

Presenter: **David E. Janhofer, BS**

**David E. Janhofer, BS**(1), Chrisovalantis X. Lakhiani, MD(2), Paul J. Kim, DPM(2), John S. Steinberg, DPM(2), Cameron Akbari, MD(1), Iram Naz, MD(3), Eshetu Tefera, MS(4), Christopher E. Attinger, MD(2) and Karen K. Evans, MD(5)

(1)MedStar Georgetown University Hospital, Washington, DC, (2)Plastic Surgery, Georgetown University Hospital, Washington, DC, (3)Medstar Georgetown University Hospital, Washington, DC, (4)MedStar Health Research Institute, Hyattsville, MD, (5)Plastic Surgery, MedStar Georgetown University Hospital, Washington, DC

### **Background**

In patients with chronic lower extremity wounds (CLEWs), free tissue transfer (FTT) is often the last option available for limb salvage, making optimized flap planning vital. Preoperative identification of lower extremity (LE) vascular pathology may increase flap survival by optimizing recipient vessel selection. Here we examine our experiences with the implementation of a preoperative vascular evaluation protocol for LE FTT planning.

### **Methods**

A retrospective review was performed of patients who underwent FTT for CLEWs between 2011-2018. From 2011-2014, patients received vascular evaluation sporadically based on symptoms of claudication or venous stasis, among others. In 2014, a standardized protocol including LE arteriography and venous duplex ultrasonography (VDU) was implemented for all patients undergoing FTT. The cohort of patients for whom vascular evaluation was performed in a standardized fashion was compared to the cohort for whom standardized imaging was not performed.

### **Results**

One-hundred thirty-four patients underwent 138 FTT operations. Sixty-five consecutive patients underwent FTT without standardized preoperative vascular imaging and 73 consecutive patients underwent preoperative LE arteriography and VDU. There were 97 males(70.3%) and 41 females(29.7%). Mean age was  $55.2 \pm 14.1$  years(range 19.0-80.0). Mean BMI was  $29.0 \pm 5.53 \text{ kg/m}^2$ . There were 68 diabetics, 32 with known PVD, 66 former/active smokers, and 98 suffering chronic osteomyelitis/infection. Hypertension was more prevalent among the post-protocol cohort (44vs.24 patients,  $p=0.00683$ ). No differences in sex, age, BMI, or other comorbid conditions existed between cohorts.

Among the pre-protocol cohort, 9/65 flaps(13.8%) were lost due to arterial or venous thrombosis. There were 15 limb amputations(23.1%) resulting from flap loss, intractable infection, or critical limb ischemia. Among the post-protocol cohort, abnormal arteriograms were observed in 30 patients(42.0%), including 14(19.2%) requiring endovascular intervention. VDU detected deep

venous thrombosis in 4 patients(5.63%) and venous insufficiency in 32(45.1%). When such vascular pathology was noted, flap anastomosis was performed only to vessels with sufficient flow. Flap loss was reduced to 2/73(4.00%) flaps ( $p=0.0247$ ) and amputation rate to 7/73(9.33%) limbs ( $p=0.0371$ ) in the post-protocol cohort. Ambulation rates were similar between cohorts (89.2% pre-protocol, 86.3% post-protocol, mean follow-up  $21.5\pm 17.5$ months and  $12.9\pm 9.63$ months, respectively)(Table 1).

## Conclusion

Appropriate LE flap recipient vessel selection informed by preoperative vascular imaging can optimize flap survival and limb salvage. The introduction of a preoperative vascular imaging protocol prior to FTT has significantly decreased flap loss and amputations among our CLEW patients.

**Table 1:** Primary outcomes compared between cohorts

	Georgetown protocol (n=73)	No standard protocol (n=65)	<i>p</i> value
Flaps lost	2 (4.00%)	9 (13.8%)	0.0247*
Limb amputations	7 (9.33%)	15 (23.1%)	0.0371*
Ambulatory patients	63 (86.3%)	58 (89.2%)	0.796

\* statistically significant ( $p < 0.05$ )

The Georgetown protocol includes routine preoperative arteriography and venous duplex ultrasonography performed for all patients requiring free tissue transfer for chronic lower extremity wounds ADDIN EN.REFLIST



1:40 PM - 1:45 PM

## **RM7 The Effect of Inequitable Hand Surgeon Distribution on Digit and Thumb Replantation**

*Brigham and Women's Hospital, Division of Plastic Surgery, Boston*

Presenter: **Justin C McCarty, DO**

**Justin C McCarty, DO**(1), Molly P. Jarman, MPH, PhD(1), Joani M Christensen, MD(1), Edward J. Caterson, MD, PhD(2) and Lydia A Helliwell, MD(1)

(1)Brigham and Women's Hospital, Boston, MA, (2)Division of Plastic Surgery, Brigham & Women's Hospital, Boston, MA

**Background:** The rate of digit and thumb replantation after amputation has been decreasing over the last decade. This operation, which requires microsurgical expertise, is performed typically by hand fellowship trained orthopedic and plastic surgeons. We sought to evaluate the effect of the maldistribution of hand surgeons on attempts at replantation after digit and thumb amputation. Our secondary objective was to identify if there was an effect of orthopedic versus plastic surgery trained hand surgeon distribution on replantation rate.

**Methods:** In the State Inpatient Database (SID) and State Emergency Department (SED) for seven states from 2014, we identified all patients who presented to the emergency room with a digit or thumb amputation identified by ICD-9 code and whether they underwent a replant procedure at that hospital or were transferred to another hospital. We identified all board-certified hand surgeons in these seven states and mapped them to their corresponding health referral region (HRR) based. Using logistic regression with adjustment for age, sex, insurance, and Charlson index, we modeled the effect of the number of board-certified hand surgeons in the HRR on replantation rates. Using a separate model, we then compared the effect of orthopedic versus plastic surgery trained hand surgeon distribution on replantation rate.

**Results:** 5,819 patients presented emergently with a digit or thumb amputation and 58 (0.99%) had attempted replantation. In the seven states, there were 396 hand surgeons, of which 71 (17.9%) had a plastic surgery background. Increased number of board-certified hand surgeons increased the odds of attempted digit or thumb replantation by 1.04 (95%CI:1.02-1.05). When separating hand surgeons by background, the number of orthopedic surgeons in the HRR had no effect on attempted replantation [OR0.98, 95%CI(0.94-1.02)], while increased number of plastic surgeons was positively correlated with attempted replantation [OR1.32,95%CI(1.09-1.59)].

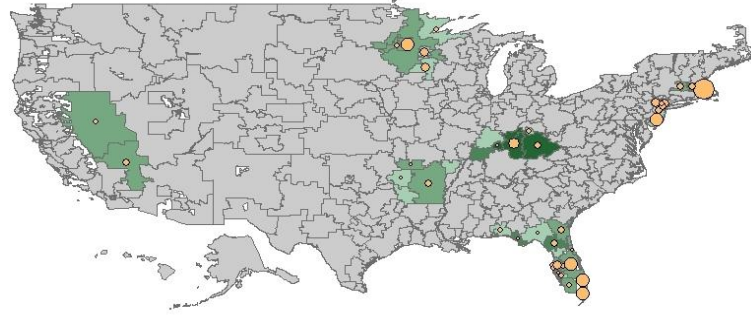
**Conclusion:** Inequitable distribution of hand surgeons may contribute to declining attempts at replantation. Additionally, differences in training between plastic and orthopedic hand surgeons may contribute to the finding that patients in areas with a higher number of plastic surgery trained hand specialists are more likely to undergo attempted replant.

**Amputations per 100,000 Residents**

- Not Observed
- < 10
- 10 - 15
- 15 - 20
- > 20

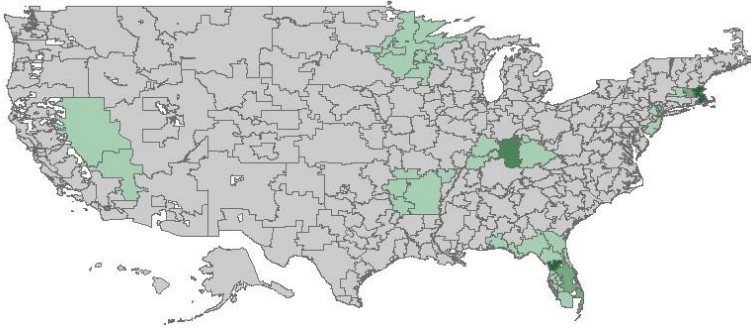
**Number of Hand Specialists**

- 1
- 10
- 100



**Percent Replanted**

- Not Observed
- < 1%
- 1% - 2%
- 2% - 3%
- > 3%



1:45 PM - 1:50 PM

## **RM8 Comparison of Outcomes between Muscle and Fasciocutaneous Free Flaps in Foot and Ankle Reconstruction**

*New York University Langone Medical Center, New York*

Presenter: **Z-Hye Lee, MD**

**Z-Hye Lee, MD**(1), David Daar, MD(1), Lavinia Anzai, MD(1), John T Stranix, MD(1), Vishal D Thanik, MD(2), Jamie P. Levine, MD(2) and Pierre B Saadeh, MD(2)

(1)NYU Langone Medical Center, New York, NY, (2)NYU Langone Health, New York, NY

### **Background:**

The distal lower extremity poses unique reconstructive challenges due to its requirements for durability of the loadbearing plantar surface and for thin, pliable contour in the dorsal foot and ankle region. The purpose of this study is to compare outcomes between muscle and fasciocutaneous flaps in patients undergoing free tissue transfer for foot and ankle wounds.

### **Methods:**

A retrospective review of 806 lower extremity free flap reconstructions (1979-2016) was performed. Soft tissue free flaps used for traumatic injuries of the foot and ankle met inclusion criteria. Endpoints included takebacks, partial flap failure, total flap failure and wound complications. Defects were classified as those primarily involving the non-weightbearing surface (dorsal foot, ankle) vs. weight-bearing surface (plantar).

### **Results:**

165 cases utilizing 14 different flaps (latissimus = 40, rectus abdominis = 33, parascapular = 26, gracilis = 19, serratus = 12, ALT = 12, other = 23) were identified. Muscle flaps (n=110) predominated compared to fasciocutaneous flaps (n=55). Defects involving the non-weight bearing surface were more common (n=86) compared to those involving the weight-bearing surface (n=79). There was no significant difference in use of muscle vs. fasciocutaneous flaps by defect type (p=0.270). In addition, presence of arterial injury (p=0.745), use of end-to-end arterial anastomosis (p=0.333) and number of venous anastomoses (p=0.159) did not differ between muscle vs. fasciocutaneous flaps. The mean follow-up time was 36.4 months (range 0.1 to 165.4 months). Complications occurred in 56 flaps (33.9%): 21 takebacks (12.7%), 11 partial losses (6.7%), 6 complete losses (3.6%), 25 wound breakdowns (15.2%). There were no differences in takebacks, partial flap failure or total flap failure. However, fasciocutaneous flaps had fewer wound complications compared to muscle flaps (7.3% vs. 19.1%, p=0.046). Subgroup analysis for muscle flaps demonstrated lower rates of partial flap failure (p=0.045) and trend towards decreased wound complication rates (p=0.097) in flaps with dual venous outflow. In addition, the latissimus flap was associated with higher partial flap failure (p=0.009) and wound complication rates (p=0.040) compared to the other muscle flaps.

### **Conclusion:**

Compared to fasciocutaneous flaps, muscle flaps demonstrated higher rates of wound complications. While flap selection in foot and ankle reconstruction should remain individualized depending on the nature of the defect, our results support the use of fasciocutaneous over muscle flaps in this region.

1:50 PM - 1:55 PM

## **RM9 Primary Targeted Muscle Reinnervation at the Time of Amputation for Extremity Sarcoma**

*The Ohio State University Wexner Medical Center, Columbus*

Presenter: **Sumanas W Jordan, MD, PhD**

**Sumanas W Jordan, MD, PhD**(1,2), John H Alexander, MD(2), John Byers Bowen, MD, MS(2), Julie M West, PA-C(2), Raphael E Pollock, MD, PhD(2), Thomas Scharschmidt, MD(2), Joel Mayerson, MD(2), Gregory A Dumanian, MD(1) and Ian L Valerio, MD, MS, MBA(2)  
(1)Northwestern University, Chicago, IL, (2)The Ohio State University Wexner Medical Center, Columbus, OH

### **Background**

Although the rates of major limb amputation for malignancy have decreased due to earlier detection and increasingly sophisticated limb salvage techniques, amputation remains the primary treatment for a number of extremity oncology patients. Early collaboration with surgical oncology and orthopedic oncology colleagues to perform targeted muscle reinnervation (TMR) at the time of the index operation may lead to decreased amputation-associated morbidity with minimal additional operative time or risk. Specifically, we hypothesized that primary TMR could decrease, and even prevent, residual limb pain and phantom limb pain.

### **Methods**

A retrospective review of all patients who underwent major limb amputation for cancer with concurrent TMR at The Ohio State University between 2015-2018 was performed. Residual limb pain (RLP) and phantom limb pain (PLP) were assessed separately using Patient-Reported Outcomes Measurement System (PROMIS) pain intensity, pain behavior, and pain interference modules.

### **Results**

Twenty-one oncologic TMR patients were identified. Mean age was 49.7+/- 18.5 years. Seven upper extremity amputations were performed (1 transradial, 2 transhumeral, 4 shoulder disarticulation), and fourteen involved the lower extremity (6 below knee, 8 above knee). Mean follow-up time was 367 +/- 169 days. At last follow-up, 79% of patients were without evidence of disease, 21% developed a local recurrence, 16% developed metastatic disease, from which one patient died 13 months after amputation. 68% reported using a prosthetic full-time. 19 of 21 responded to the pain survey and were compared to normative data from oncologic amputees not treated at our institution (N=60). Demographics and level of amputation were similar between cohorts. Tingling or crawling sensations at the amputation site occurred significantly less frequently and with less intensity among the TMR cohort (p=.001 and .009, respectively). Similarly, the TMR cohort reported less frequent and lesser severity sudden pain episodes compared to the general oncologic amputee (p=.01 and .003, respectively). Mean differences for PROMIS pain intensity, pain behavior, and pain interference for PLP were 4.230 (95%CI -.150, 8.609), 5.133 (95%CI .153, 10.11), and 5.609 (95%CI .093, 11.12), respectively, with lower scores for the TMR cohort. For RLP, PROMIS pain intensity, pain behavior, and pain

interference mean differences were 4.361 (95%CI -.257, 8.980), 5.038 (95%CI .018, 10.06), and 6.214 (95%CI 1.285, 11.144), respectively.

### **Conclusion**

TMR reduced phantom limb and residual limb pain interference and behavior for oncologic amputees beyond a clinically meaningful threshold.

2:00 PM - 2:05 PM

## **RM10 Visualization of the Intradermal Plexus and the Dermis Flap: A New Step Beyond Perforator Flaps**

*Cancer Institute Hospital, Tokyo*

Presenter: **Hidehiko Yoshimatsu, MD**

**Hidehiko Yoshimatsu, MD**(1), Akitatsu Hayashi, MD(2), Takumi Yamamoto, M.D., Ph.D.(3), Yuma Fuse, M.D.(4), Ryo Karakawa, MD(5) and Tomoyuki Yano, MD(5)

(1)Plastic and Reconstructive Surgery, Cancer Institute Hospital of the Japanese Foundation for Cancer Research, Tokyo, Japan, (2)Plastic and Reconstructive Surgery, Kameda Medical Center, Kamogawa, Japan, (3)Plastic and Reconstructive Surgery, Center Hospital of National Center for Global Health and Medicine, Tokyo, Japan, (4)Center Hospital of National Center for Global Health and Medicine, Tokyo, Japan, (5)Cancer Institute Hospital of the Japanese Foundation for Cancer Research, Tokyo, Japan

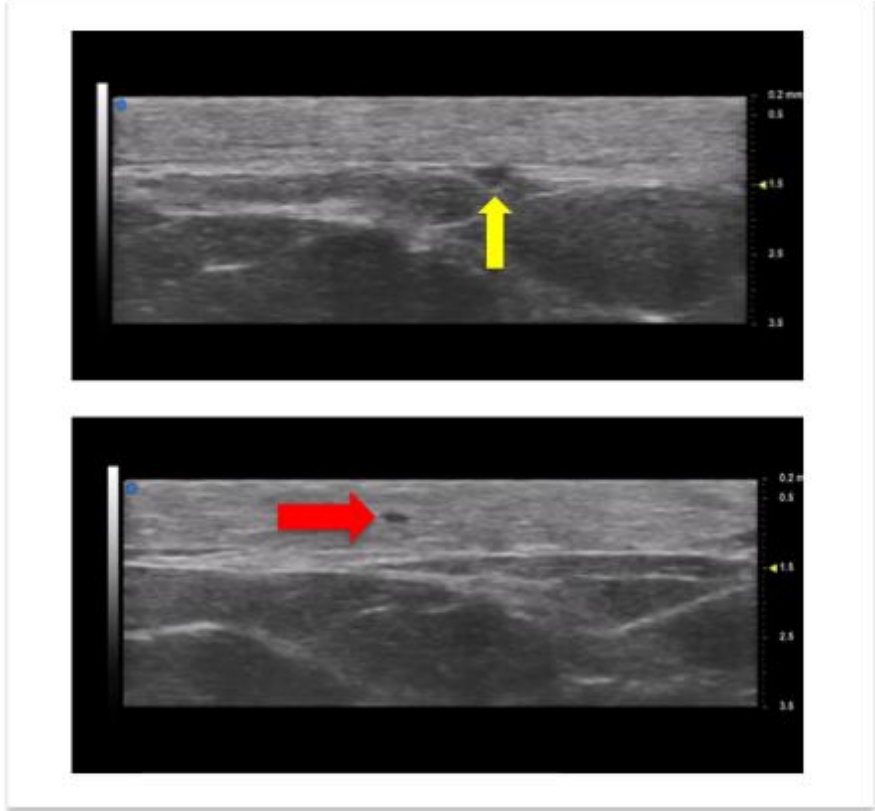
**Background:** Following the advent of free flap transfer, free flaps have evolved from musculocutaneous flaps to perforator-based cutaneous flaps, aiming toward lower donor site morbidity. The widespread use of perforator flaps revealed that the muscle was dispensable for survival of skin paddles in free flap transfers. Taking place of the intramuscular perfusion, the subdermal plexus is now thought to play a significant role in perfusion of the skin paddle lying above the subdermal plexus. In this study, we would like to propose a new concept,

- gintradermal plexus, • h which allows survival of • gdermis flaps. • h

**Methods:** In 20 groin regions from 10 healthy volunteers, perforators from the superficial circumflex iliac artery were identified first using a conventional ultrasonography. After identification of a perforator, it was then traced distally as far as possible using Vevo MD ultrasound device (FUJIFILM Visual Sonics, Amsterdam, the Netherlands) with a 70 MHz linear array transducer. Based on these findings, a • gdermis flap • h was used for reconstruction of small defects in 7 cases. After confirmation of the entrance point of a perforator to the dermis, the adipose tissue was removed using a pair of scissors.

**Results:** In all volunteers, extremely small arteries and veins with a mean diameter of 0.2 mm could be observed entering the dermis layer using ultrasonography with 70 MHz. After entering the dermis, the small arteries and veins gave off branches, composing • gintradermal plexus. • h Dermis flaps survived completely in all clinical cases. The average thickness of the skin paddle was 0.9 mm. Removal of the adipose tissues took less than 30 minutes in all cases. In 1 case, the flap became congested within 24 hours after the surgery. An additional venous anastomosis alleviated the congestion.

**Conclusion:** Small arteries and veins entering and running inside the dermis were visualized with ultrasonography in real time for the first time. Based on this • gintradermal plexus • h theory, virtually almost all subdermal adipose tissues could be discarded without special care described in previous reports. Although flaps used in this case series were relatively small, thinning time was significantly shorter. Extremely thin flaps are pliable, and thus especially useful for coverage of the extremities and the external ear canal.



2:05 PM - 2:10 PM

**RM11 Use of Transverse Branch of the Superficial Circumflex Iliac Artery for a Landmark for Effortless Identification and Dissection of the Deep Branch of the Superficial Circumflex Iliac Artery**

*Cancer Institute Hospital, Tokyo*

Presenter: **Hidehiko Yoshimatsu, MD**

**Hidehiko Yoshimatsu, MD**(1), Ryo Karakawa, MD(2), Tomoyuki Yano, MD(3), Takumi Yamamoto, M.D., Ph.D.(4) and Yuma Fuse, M.D.(5)

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**Use of Transverse Branch of the Superficial Circumflex Iliac Artery for a Landmark for Effortless Identification and Dissection of the Deep Branch of the Superficial Circumflex Iliac Artery**

**Background:** After introduction of the superficial circumflex iliac artery (SCIA) perforator flap by Koshima in 2004, its use has gradually become common. The deep branch of the SCIA need to be included when a large flap is necessary, or when at least one of the following anatomical structures perfused by the deep branch is elevated with the skin paddle: the sartorius muscle, the iliac bone, and the lateral femoral cutaneous nerve. There have been very few reports on the dissection of the deep branch of the SCIA. In this study, we introduce a new simple technique for identification and dissection of the deep branch of the SCIA.

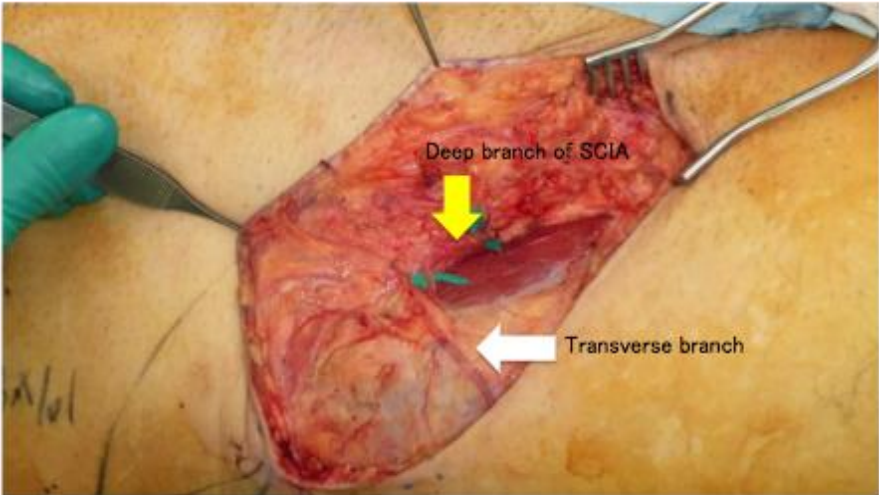
**Methods:** Twenty-six patients with soft tissue defects or both soft and bony tissue defects underwent reconstructions using a SCIP flap based solely or partly on the deep branch of the SCIA. The deep branch of the SCIA gives off a branch to the lateral direction, caudal and medial to the anterior superior iliac spine (ASIS). This branch was named the • gtransverse branch • h and was used as a landmark for identification and dissection of the deep branch of the SCIA. For identification of the deep branch, an incision was made lateral to the ASIS. The incision was made straight down all the way to the deep fascia, above which a flap was elevated to expose the ASIS. At this point, a triad of vessels composed of the transverse branch of the deep branch and its venae comitantes could be seen trough the deep fascia. This transverse branch was carefully dissected proximally for 1 to 3 cm, until it converged into the deep branch.

**Results:** Flaps survived completely in all cases. In cases iliac bone flap, satisfactory bone union was confirmed with computed tomography. There were no complications at the donor site.

**Conclusion:** When the transverse branch of the deep branch of the SCIA is used as the landmark, the identification and dissection of the deep branch of the SCIA are significantly facilitated, even in obese patients. To the best of our knowledge, this is the first report elaborating on the dissection of the deep branch of the SCIA for procurement of SCIP flaps. By



adopting this method, elevation of a large SCIP flap or a chimeric SCIP flap can be performed with confidence.



2:10 PM - 2:15 PM

## **RM12 A Reconstructive Algorithm after Thigh Soft Tissue Sarcoma Resection Including Predictors of Free Flap Reconstruction**

*Mayo Clinic, Rochester*

Presenter: **Sarah M Elswick, M.D., M.B.A.**

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### **Background**

The reconstruction of major defects of the thigh after oncologic resection plays a vital role in limb salvage. Our goal was to evaluate our institution's experience on thigh sarcomas to develop evidence-based recommendations to guide the reconstructive surgeon, specifically focusing on factors that would predict need for free flap reconstruction.

### **Methods**

We reviewed all major thigh defects following sarcoma resection from 1997 to 2014 at our institution. Patient demographics, comorbidities, operative characteristics, multi-modality therapies, and outcomes were analyzed. Factors that predicted the use of a free flap were determined.

### **Results**

There were 159 major thigh reconstructions after sarcoma resection followed for an average of 31 months. Eighty seven percent of patients underwent radiation and 42% chemotherapy. Reconstruction was achieved by primary closure (15%), skin grafting (15%), local fasciocutaneous flaps (7%), local muscle or myocutaneous flaps (34%), regional pedicled flaps (25%), and/or free tissue transfer (4%). For the proximal third of the thigh the most common flaps were pedicled thigh muscle and rectus abdominis flaps; for the middle third of the thigh it was pedicled thigh muscle flaps; and for the distal third it was pedicled gastrocnemius muscle flaps. Factors shown to be predictive of requiring a free flap included wide defects (average size 13.6 cm for free flaps versus 8.9 cm for all other type of reconstruction,  $p = 0.03$ ) and location in the middle third of the thigh ( $p = 0.001$ ). Patient gender, BMI, comorbidities, recurrent tumors, tumor histology, radiation, chemotherapy, area of the defect, circumferential location of the defect, and exposed structures were not found to impact the use of a free flap. There were no significant differences in complications rates between free flap and non-free flap reconstruction.

### **Conclusion**

There are multiple options for reconstructing defects from thigh soft tissue sarcoma resection. When primary closure and skin grafts are not an option, most defects can be closed with pedicled

local or regional muscle or fasciocutaneous flaps. Free flap reconstruction is rarely required but can be necessary when defects are wide or located in the middle third of the thigh.

2:20 PM - 2:25 PM

### **RM13 Patency and Flow Dynamics of Recipient Arteries after Microvascular End-to-Side Anastomosis for Free Tissue Transfer**

*The Curtis National Hand Center, Medstar Union Memorial Hospital, Baltimore*

Presenter: **Matthew David Treiser, M.D., Ph.D.**

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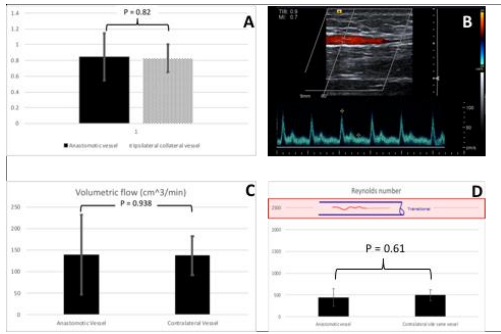
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**Background:** Microvascular anastomoses are performed via the end-to-end (ETE) or end-to-side (ETS) technique. ETE anastomoses sacrifice downstream in-line perfusion of the recipient vessels, whereas ETS anastomoses, in theory, maintain distal in-line flow of the recipient vessel. The proposed benefit of the ETS technique depends on patency of the distal vessels and subsequent flow parameters, but maintenance of distal perfusion has not been demonstrated in a rigorous fashion. The current study utilizes multiple modalities to evaluate the long-term patency and maintenance of flow dynamics of the recipient artery following end-to-side arterial anastomosis.

**Methods:** We attempted to recruit all 123 patients that had a successful extremity free flap via ETS anastomoses to a non-critical vessel (ulnar, radial, anterior tibial, or posterior tibial) between 2003-2017. Fifteen patients were successfully enrolled (12% recruitment rate). Patency of the participants' recipient artery distal to the anastomosis was assessed utilizing pulse volume recordings and Duplex ultrasound imaging. Resistance indices, flow velocities, vessel diameters, volumetric flow measurements, and calculation of turbulent flow dimensionless numbers (Reynolds number) were measured. Comparisons were made to the ipsilateral collateral vessel as well as to the vessels on the non-operative contralateral limb utilizing paired t-tests.

**Results:** 15 flaps were examined for patency, with downstream flow identified in 14/15 patients (93% patency). Flow resistive indices ranged from 0.70-1.27 with no statistical difference in resistive indices comparing the anastomotic vessel ( $0.859 \pm 0.300$ ) and the collateral vessel ( $0.853 \pm 0.179$ ) of the ipsilateral extremity ( $p = 0.82$ ) (Figure 1A). Ultrasound flows (Figure 1B) were similar, with the anastomotic vessel demonstrating downstream volumetric flows of  $139 \pm 92.0$  versus  $137 \pm 41.6$   $\text{cm}^3/\text{min}$  within the same vessel of the non-operative contralateral limb ( $p = 0.94$ ) (Figure 1C). The anastomotic vessel had Reynolds numbers well below the turbulent threshold with values of  $448 \pm 202$  and  $493 \pm 127$  for the anastomotic and non-operative contralateral limb, respectively (Figure 1D). These values indicate the presence of laminar flow.

**Conclusion:** End-to-side anastomosis to non-critical vessels resulted in a 93% long-term recipient vessel patency rate with no statistically significant changes in volumetric flows, resistive indices, or fluid dynamics in the vessels that remain patent. These results support that ETS anastomoses allow for free tissue transfer with low risk of changing extremity flow profiles, providing compelling evidence to use ETS anastomoses for free tissue transfer when technically feasible.



2:25 PM - 2:30 PM

## **RM14 Lower Extremity Flap Re-Elevation Does Not Impact Reconstructive Outcomes**

*Mayo Clinic, Rochester*

Presenter: **Jennifer N Grauberger, BA**

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**Background:** Flap re-elevation is an important component of ongoing reconstruction of the lower extremity and may be necessary for secondary or staged reconstructive procedures. However, the effects of surgical re-elevation on long term flap viability and complication rates in the lower extremity are not well known. We hypothesized that flap re-elevation is not associated with higher rates of adverse flap outcomes.

**Methods:** A retrospective review of a consecutive series of free and pedicle flaps performed for lower extremity reconstruction was undertaken (August 2008 – November 2017). Statistical analyses were conducted using Fisher's exact test, Wilcoxon signed-rank test, likelihood ratio test, and the log-rank test where appropriate.

**Results:** A total of 207 unique flaps were identified, of which, 63 (30.4%) were re-elevated (median number of re-elevations = 1 (IQR 1-2)). The most common wound etiologies were infectious (N = 90 (43.5%)), traumatic (N = 56 (27.1%)), and oncologic (N = 45 (21.7%)). Flaps covering traumatic injuries were more often re-elevated (41.3% vs 20.8%,  $p = 0.0105$ ). Reasons for flap re-elevation included irrigation/debridement or tissue excision (46.0%), antibiotic spacer or orthopedic hardware removal (31.7%), and hardware or bone graft placement (31.7%). A higher percentage of free flaps were re-elevated than pedicle flaps (69.8% vs 30.2%,  $p = 0.0009$ ). The median time from flap inset to re-elevation was 95 days (IQR = 36-244). Collectively, more re-elevated flaps experienced a major complication (including osteomyelitis, bony non/mal-union, flap loss, and limb loss) than non-re-elevated flaps (20.6% vs 10.4%,  $p = 0.0782$ ). The rates of osteomyelitis (3.9% vs 4.8%,  $p = 0.7015$ ), bony non/mal-union (0.5% vs 1.6%,  $p = 0.3134$ ), and flap loss (4.8% vs 4.2%,  $p = 1.000$ ) were similar between re-elevated and non-re-elevated with the exception of limb loss frequency on univariate analysis (14.3% vs 4.9%,  $p = 0.0256$ ). After adjusting for patient comorbidities, traumatic wound etiology, fasciocutaneous versus muscle flap composition, and free versus pedicle flap, re-elevated flaps had statistically similar odds of flap loss (OR = 0.674 (0.120-3.030),  $p = 0.6160$ ), limb loss (OR = 2.880 (0.968-8.860),  $p = 0.0570$ ), and major complications overall (OR = 1.760 (0.729-4.170),  $p = 0.2060$ ).

**Conclusion:** Re-elevated flaps of the lower extremity were found to have similar rates of flap viability, limb salvage, and major post-operative complications, demonstrating that re-elevation is a safe procedure to perform in ongoing reconstruction.

2:30 PM - 2:35 PM

## **RM15 Is the Medial Sural Artery Perforator Flap a New Workhorse Flap? a Systematic Review and Meta-Analysis**

*Hansjörg Wyss Department of Plastic Surgery, NYU Langone Health, New York*

Presenter: **David A Daar, MD, MBA**

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**Background:** The medial sural artery perforator (MSAP) flap offers thin, pliable tissue with a relatively long pedicle. Compared to other thin fasciocutaneous flaps, its relatively low donor site morbidity makes the MSAP flap a valuable option for the reconstructive microsurgeon. This study systematically evaluates the literature on use of MSAP flaps with regards to flap characteristics, indications, recipient site defects, and postoperative outcomes.

**Methods:** A systematic literature review was performed using PubMed, Embase, and Cochrane CENTRAL to identify all cases of MSAP flap reconstruction. Descriptive and meta-analysis were performed on pooled outcomes. Multivariate logistic regression identified factors associated with increased complication rates.

**Results:** Thirty-five studies encompassing 526 MSAP flaps were included. Average age was  $49.2 \pm 15.5$  years with primarily (75.6%) male patients. The majority of flaps were used for oncologic (47.6%) and traumatic (31.8%) defects. The most common recipient location was the oral cavity (45.5%), followed by foot and ankle defects (25.1%). Average flap width and length were  $6.0 \pm 2.3$ cm and  $9.8 \pm 3.6$ cm, respectively, with an average pedicle length of  $10.1 \pm 6.6$ cm. Meta-analysis of 504 flaps revealed the overall complication rate for the MSAP flap to be 14.3% (Q value=22.16,  $p=0.877$ ,  $I^2= -39.9$ ), indicating lack of inter-study heterogeneity. Use of chimeric MSAP flaps was associated with a significantly higher rate of complications (OR=3.92,  $p=0.039$ ). Additional pooled outcome analysis of 520 flaps revealed a total flap failure and partial flap failure rate of 3.1% (n=16) and 3.1% (n=16), respectively.

Donor site complication rate was 1.9% (n=10) overall. Out of 247 MSAP flaps for which both the donor site closure method and flap dimensions were known, 68% were closed primarily versus 32% covered with STSG. Average dimensions for flaps whose donor site was closed with a STSG (8.0cm by 12.2cm) were significantly larger than those closed primarily (5.0cm by 8.9cm,  $p<0.0001$ ). Among those that underwent primary closure, a flap width greater than 5.75cm had an OR=5.3 (95% CI, 1.3-21.8;  $p=0.014$ ) of having a donor site complication.

**Conclusion:** This is the first systematic literature review and meta-analysis demonstrating the efficacy and safety of the MSAP flap. Our results emphasize the utility of the MSAP flap as a potential workhorse flap for various recipient sites requiring thin, pliable tissue and a relatively long pedicle. With a favorable donor site that can be closed primarily in a flap width of nearly 6cm, the potential benefits of this flap cannot be understated.

2:35 PM - 2:40 PM

**RM16 Long Term Outcomes of Free Tissue Transfer in Patients with Peripheral Vascular Disease and Limb Threatening Defects: Flap Success, Limb Salvage and Ambulation Rates**

*Medstar Georgetown University Hospital, Washington*

Presenter: **Richard Youn, MD**

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Title: Long term outcomes of free tissue transfer in patients with peripheral vascular disease and limb threatening defects: flap success, limb salvage and ambulation rates. **Background:** Patients with peripheral vascular disease (PVD) and limb threatening defects from trauma, infection or diabetic foot ulceration are likely to face amputation. The presence of PVD can be a risk for free flap failure and ultimate limb loss, however its effect in patients undergoing microsurgical reconstruction is unknown. We present our experience with free tissue transfer (FTT) in a high-risk population of lower extremity patients with documented PVD, identified through preoperative angiograms. **Methods:** Between November 2014 to June 2018, 83 patients with identified PVD underwent FTT for nontraumatic, lower extremity reconstruction by a single surgeon. Pre-operative angiograms were used on all patients. Demographic data, comorbidities, as well as microsurgical success, limb salvage and ambulation rates for patients with one to three patent lower extremity arteries below the knee were compared. Chi-squared and Fisher-exact tests as appropriate were used to compare groups with statistical significance defined as  $p < 0.05$ . **Results:** Preoperative angiograms were performed on 83 patients with PVD, identifying 16 (19.3%), 20 (24.1%), and 45 (54.2%) patients with one, two or three patent vessels to the lower extremity, respectively. 51.8% had diabetes (51.8%), hypertension (56.6%), and 45.8% were either current or former smokers. While microsurgical success rates were similar between patients with one, two or three patent vessels (87.5% vs. 95% vs. 97.8% respectively;  $p = 0.2650$ ), flap survival improved with greater number of patent vessels. On average, limb salvage (mean follow-up 11.9 months) also improved with increasing number of patent vessels (81.3% vs. 85% vs. 91.1%;  $p = 0.5397$ ) and were associated with higher rates of patients ambulating after reconstruction with at least 2 patent vessels (75% vs. 90% vs. 86.4% for 1, 2, or 3 patent vessels, respectively;  $p = 0.4250$ ). **Conclusion:** Although PVD in the lower extremity, determined by the number of patent vessels below the knee, appears to affect lower extremity free flap survival, high rates of success can still be achieved. In our series of 83 patients, flap survival rates were greater than 87% even in the most severe PVD patients (1 patent vessel) with greater than 80% achieving limb salvage and 75% being able to ambulate following reconstruction. Success rates improved with increasing numbers of patent vessels. This information should be used to help counsel patients regarding the risks and benefits of microsurgical reconstruction, as high rates of flap survival, limb salvage, and ambulation can still be achieved despite severe peripheral vascular disease.