

## ASRM Scientific Paper Presentations: Extremities

Sunday, January 14, 2018, 1:15pm – 3:30pm

1:15 PM - 1:20 PM

### RM 38. Indocyanine Green (ICG) Lymphangiography Optimizes the Identification and Management of Lymphatic Leaks in the Groin

*Mayo Clinic in Arizona, Phoenix*

Presenter: William J. Casey III, MD

William J. Casey III, MD(1), Alanna M. Rebecca, MD(1), Lacey Pflibsen, MD(2), Nadine Hillberg, MD(3) and Claire Jensen, PA-C(2)

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#### Background

The treatment of lymphatic leaks and lymphoceles in the groin can be quite challenging. The ideal management in such cases has not been determined. ICG lymphangiography has become an important modality in the evaluation of patients with lymphedema. We postulate that improved visualization of extremity lymphatics using this technology can pinpoint identification of the site of lymphatic leaks and optimize their management and outcomes.

#### Methods

A retrospective review was conducted of all cases in which ICG lymphangiography was performed during the surgical management of a lymphatic leak at Mayo Clinic in Arizona from December 2015 through May 2017. The etiology of the lymphatic leak was an inguinal lymph node dissection in 10 cases, a cardiac procedure requiring femoral vessel cannulation in three cases, and complicated hemodialysis catheter insertion into the femoral vein in one case. Following thorough debridement of the area of the lymphatic leak in the groin, ICG was injected intradermally in the more distal aspect of the affected extremity and the site of lymphatic leak was determined and oversewn. The location of the leak was documented (superficial or deep) and outcomes were reported with regards to healing, infection, time to drain removal, and any adjunct procedures that were performed simultaneously.

#### Results

Fourteen patients underwent ICG lymphangiography during the surgical treatment of a lymphatic leak in the groin over an 18 month period. In all cases, the site of the lymphatic leak was easily identified and oversewn. In seven cases, the site of the lymphatic leak was in the subcutaneous tissue superficial to the femoral vessels, whereas in the other seven cases the leak was identified alongside the femoral vessels in the area of the inguinal lymph nodes. In 9 cases a sartorius muscle flap was used to cover the area of the leak as well as the exposed femoral vessels. All wounds healed without breakdown with no associated infections. Drains were able to be removed at an average of 8 days.

#### Conclusion

In this small pilot study, ICG lymphangiography facilitated the identification of the location of lymphatic leaks in the groin and optimized the management and outcomes in these challenging situations. Further studies regarding the long term outcomes in these cases (including the subsequent development of lymphedema) and the feasibility of immediate lymphaticovenous anastomosis rather than ligation in such cases are planned.

1:20 PM - 1:25 PM

**RM 39. Free Vascularized Metatarsophalangeal Joint for Reconstruction of the Post-Traumatic Metacarpophalangeal Joint with Concomitant Soft-Tissue Defect: Strategies to Improve Outcomes**

*Chang Gung Memorial Hospital, Taoyuan*

Presenter: Marco Pappalardo, M.D.

Marco Pappalardo, M.D.(1) and Yu-Te Lin, MD(2)

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**Background:** Painful, dysfunctional metacarpophalangeal joints (MCPJ) are a difficult reconstructive challenge. No consensus exists regarding an optimal solution. Options include arthrodesis, various implant arthroplasties, and vascularized joint transfers (VJT). When there are associated composite-tissue defects requiring tendon grafts and/or soft-tissue coverage, the complexity increases. Although the second-toe metatarsophalangeal joint (MTPJ) has come to be the preferred VJT donor, it has two potential liabilities ---suboptimal flexion and insufficient soft-tissue coverage. These can both be addressed with creative tissue handling. Because of the MTP's innate hyperextensibility, flipping it 180° volar-to-dorsal or applying 45°rotational osteotomy of the metatarsal head provides the greatest arc of flexion in the reconstructed MCP. To provide adequate coverage at the time of MTPJ transfer dorsal skin flaps based on dorsalis pedis artery or plantar skin from MTPJ transfer can be used. Rather than these relying on these suboptimal solutions, harvesting all of the skin from the toe and filleting it into an islandized skin flap perfused by tibial plantar digital artery (TPDA) provides a relatively unrestricted soft-tissue to cover the neo-MCP joint that is a good match with the adjacent skin without creating an additional donor site.

**Methods:** Twelve patients (nine male and three female), with a mean age of 42.3 years, underwent reconstruction with vascularized second-toe MTPJ transfer for posttraumatic ankylosed MCPJ. The follow-up period ranged from 20.1 to 47.5 months and outcomes were assessed by grip strength and ROM of the reconstructed joints.

**Results:** All of the joints survived without any microvascular compromise. At an average period of 4.5 weeks bony union was achieved in all patients. An average of 2-3 sizable articular branches emanating either from FPMA or TPDA, and running perpendicular to the MTPJ were included with the harvested joint. MTPJ has been rotated 180° around its longitudinal axis in nine cases while in four patients 45° oblique osteotomy technique has been applied. Four large composite defect were reconstructed with the chimeric MTPJ with Toe-Fillet Flap in order to provide additional skin for coverage the neo-MCJP. No evidence of postoperative arthritis was noted. An average ROM of 57.8° (mean flexion, 72.2°) and a grip strength slightly decreased compared to the contralateral side was achieved over the follow-up period.

**Conclusion:** Vascularized second-toe MTPJ allows for restoration of powerful pinch/grasp and ROM of MCPJ in the hand. Improvement of the surgical techniques can result in very favourable functional outcomes enabling more patients to benefit from VJTs.

1:25 PM - 1:30 PM

## **RM 40. Osteochondral joint reconstruction: Is a vascular pedicle needed?**

*Çukurova University, Adana*

Presenter: James P. Higgins, MD

James P. Higgins, MD(1), Farzad Borumandi, MD, DMD(2,3), Heinz K. Bürger, MD(4), Mehmet Emre Benlidayi, DDS, PhD(5), Anna Vasilyeva, MD(6), Leman Sencar, MSc(5), Sait Polat, PhD(5) and Alexander J. Gaggli, DDS, PhD(2)

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### **Background**

Subchondral perfusion of osteochondral grafts has been shown to be important in preventing long-term cartilage degeneration. In carpal reconstruction, subchondral perfusion from the graft bed is limited. This study compares histologic characteristics of cartilage in osteochondral grafts supported by synovial imbibition alone to cartilage of vascularized osteochondral flaps provided support of synovial and vascular pedicle perfusion.

### **Methods**

Two adjacent osteochondral segments were harvested on the medial femoral trochlea in domestic 6- to 8-month-old pigs. Each segment measured approximately 12mmx15mmx17mm. One segment was maintained on the descending geniculate artery vascular pedicle. The adjacent segment was purposefully separated from the pedicle to serve as a nonvascularized graft. A thin layer of methylmethacrylate cement was used to line the harvest site defect to prevent vascular ingrowth to the subsequently replaced specimens. The pigs were maintained on high-calorie feed and returned to ambulation and full weightbearing on the surgical legs. The animals were sacrificed after 6 months; specimens were reharvested, sectioned, and examined. The cartilage was graded by two pathologists blinded to the origin of specimens as vascularized flaps or nonvascularized grafts.

### **Results**

All specimens were assigned scores utilizing the International Cartilage Repair Society grading system. The scoring for chondrocyte viability, cartilage surface morphology, and cell and matrix appearance was significantly higher in the vascularized osteochondral group compared with the graft group.

### **Conclusion**

When deprived of subchondral perfusion from underlying bone, osteochondral vascularized flaps in an intrasynovial environment demonstrate superior cartilage quality and survival when compared to nonvascularized grafts. In locations where perfusion from surrounding bone may be limited(i.e. , proximal scaphoid or proximal lunate reconstruction) articular reconstruction using vascularized osteochondral flaps will yield superior cartilage organization and architecture than nonvascularized osteochondral grafts. The clinical and functional relevance of this finding requires further study.

Table 1. International Cartilage Repair Society Visual Histologic Assessment Scale

Visual Histologic Assessment Scale	Groups		P value
	Vascularized Osteochondral Flaps n=7(%)	Non-vascularized Osteochondral Grafts n=7(%)	
<b>Surface</b>			<b>0.021*</b>
0 Discontinuity/irregularities	0 (0)	5 (71.4)	
3 Smooth/continuous	7 (100)	2 (28.6)	
<b>Matrix</b>			<b>0.020*</b>
0 Fibrous Tissue	0(0)	0(0)	
1 Fibrocartilage	0 (0)	1 (14.3)	
2 Mixture: hyaline/fibrocartilage	2 (28.6)	6 (85.7)	
3 Hyaline	5 (71.4)	0 (0)	
<b>Cell distribution</b>			<b>0.004*</b>
0 Individual cells/disorganized	0 (0)	3 (42.9)	
1 Clusters	0 (0)	3 (42.9)	
2 Mixed: columnar-clusters	6 (85.7)	1 (14.3)	
3 Columnar	1 (14.3)	0 (0)	
<b>Cell population viability</b>			<b>0.005*</b>
0 <10% viable	0 (0)	1 (14.3)	
1 Partially viable	1 (14.3)	6 (85.7)	
3 Predominantly viable	6 (85.7)	0 (0)	

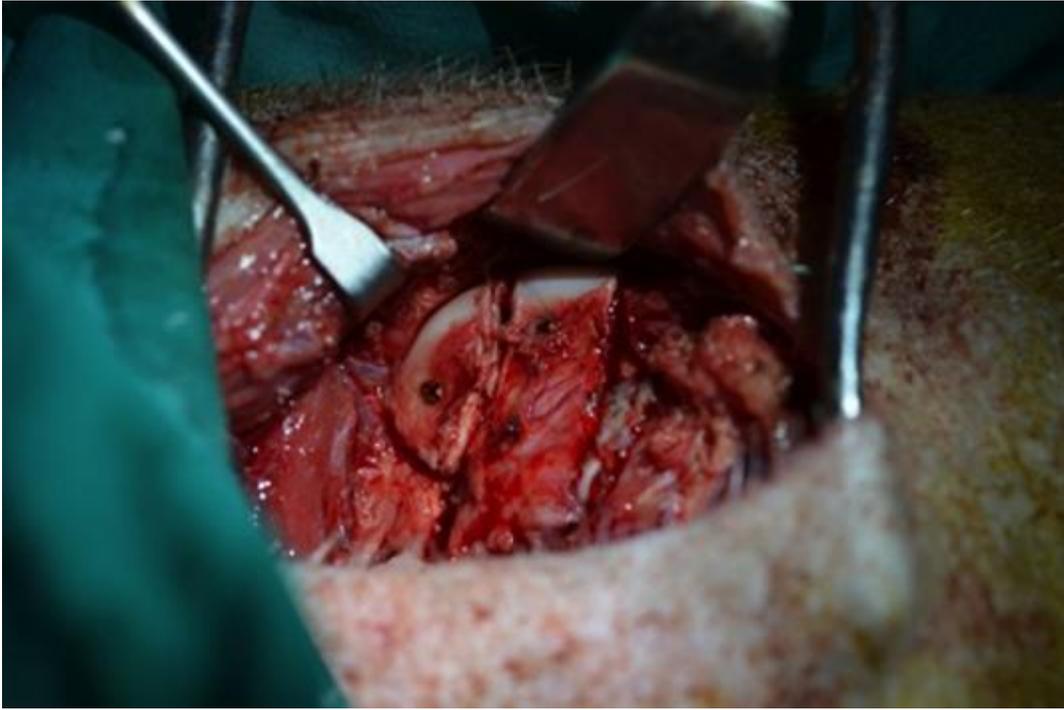


Figure 1: View of medial knee dissection with adjacent harvested segments secured in position with 1.5mm screws. Left, nonvascularized osteochondral flap. Adjacent, to the right, osteochondral flap with descending geniculate vascular pedicle attachments preserved. Distal leg, right.

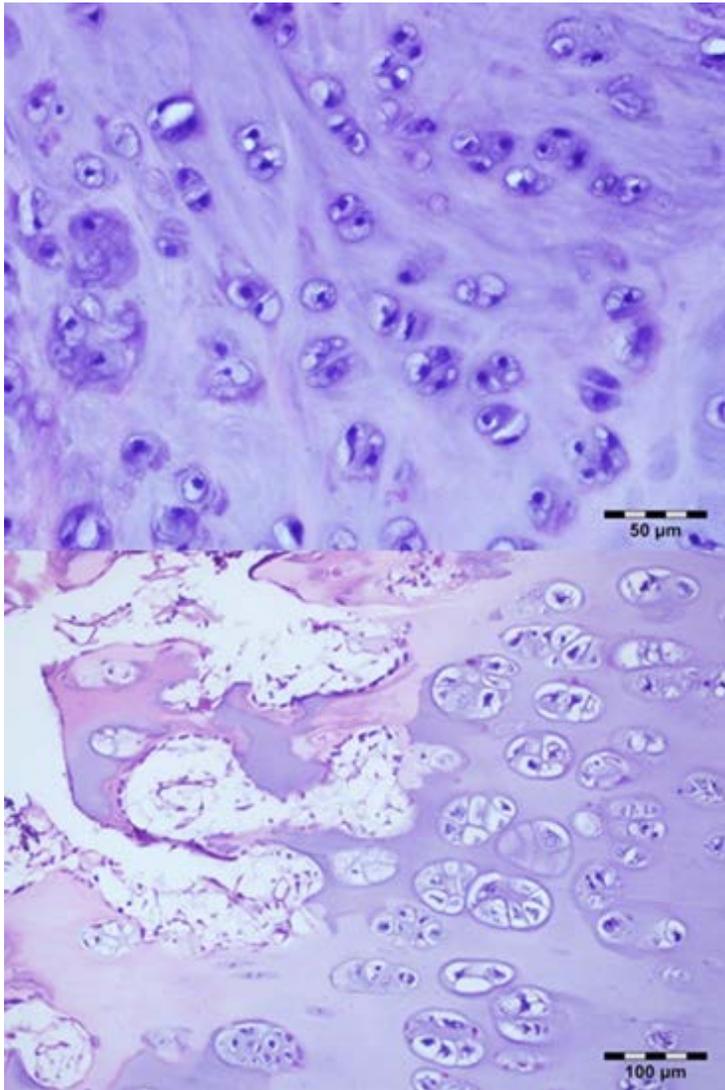


FIGURE 2: (Top)Light microscopic photograph of vascularized cartilage group. Chondrocytes are seen with clearly visible nuclei and basophilic cytoplasm in the lacunae. Isogenous groups are observed in cartilage matrix. Hematoxylin and eosin stain. Bar=50 µm; (bottom)Light microscopic photograph of non-vascularized cartilage graft group. Shrinkage of chondrocytes, large gaps between chondrocytes and capsular matrix, intracytoplasmic vacuolizations are observed. Presence of isogenous groups close to cartilage-bone junction areas are seen. Hematoxylin and eosin stain. Bar=100 µm

1:33 PM - 1:38 PM

## **RM 41. Comparative Study between Versatile Reconstruction using Free Flap after Transmetatarsal Amputation and First Ray preserving Transmetatarsal Amputation**

*Asan Medical Center, Seoul*

Presenter: Youngchul Suh, M.D

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### **Background**

As microsurgical technique's progression we have expanded the possibility of reconstruction in the most difficult diabetic foot ulcerations. Two important components of reconstruction are function and coverage. However, there has been no definite outcome study of saving the first ray when other toes are amputated on the metatarsophalangeal level or the metatarsal level. Thus we looked into the quality of gait in these patients and long-term functional outcome in a retrospective review of patients with diabetes mellitus treated with first ray saving reconstruction at our facility during a 5 year period.

### **Methods**

In retrospective chart review, from 2011 December to 2017 January, total 60 limbs were reconstructed after total or partial transmetatarsal amputation. In group A, 28 limbs were reconstructed after full transmetatarsal amputation. In group B, 32 limbs were reconstructed after first ray saving transmetatarsal amputation. Data collection included age, gender, history of coronary artery disease (CAD), cerebral vascular accident (CVA), hypertension, or endstage renal disease (ESRD). Microvascular technique, vascular status, initial C-reactive protein, ESR, WBC were collected. Pre, post debridement number, time to ambulation, mortality, following major minor amputation, final ambulation status, plantar pressure data were collected.

### **Results**

Mean follow up period was 30.2 months. Total of 2 cases (7.1%) in group A and 4 cases (15.6%) in group B was seen with total flap failure. Partial flap loss were occurred 4 cases (21.4%) in group A and 12 cases (40.6%) in group B without requiring further reconstruction. One mortality was occurred in group A. After complete healing, 1 case of 1<sup>st</sup> ray amputation was noted in group B and 2 cases of syme amputation was noted in both groups. One case of BK amputation was performed in group A. Without including the complications, the final ambulatory score was average 3.62 in group A, 4.23 in group B (Table 1). In dynamic plantar pressure analysis, group B shows statistically significant larger surface area, better force distribution, and smaller gait angle than group A. (Table 2)

### **Conclusion**

Diabetic foot reconstruction remains to be difficult. The question in regard to evaluate the value of first ray saving reconstruction shows better functional outcome. We understand that in the years to follow, there will be deformity of the first ray leading to further amputation but the value of delivering better functional outcome during the period of usage may justify salvaging the first ray if possible. Further long-term follow-up studies are warranted.

Table 1. Outcome of reconstruction

	Group A (n=28)	Group B (n=32)	<i>p-value</i>
Flap failure	2	5	0.315
Partial flap loss	6	13	0.115
Partial flap loss area, mean	15%	20.47%	0.717
Mortality	1	0	
Following 1 <sup>st</sup> ray amputation		1	
Following minor amputation	1 (Syme)	1 (Syme)	0.943
Following major amputation	1 (BK amputation)	1 (BK amputation)	0.943
Final ambulatory function	Mean 3.62	Mean 4.23	0.034
Bedridden (0)			
Wheelchair bound(1)			
Limited household(2)			
Unlimited household (3)			
Limited Community (4)			
Unlimited community (5)			

Independent t-test, statistical significant means  $p\text{-value} < 0.05$

Table 2. Dynamic plantar pressure

	Reconstructed foot		Contralateral foot		<i>P value for group A <math>\Delta</math> vs B <math>\Delta</math></i> <i>(<math>\Delta</math> =reconstructed foot - contralateral foot)</i>
	Group A (n=8)	Group B (n=10)	Group A (n=8)	Group B (n=10)	
Surface area ( $cm^2$ )	77.52	102.2	114.15	112.1	0.007
Force (%)	41.55	46.6	58.45	53.4	0.01
Gait time (sec)	1.58	1.19	1.35	1.52	0.088
Gait angle	17.15	9.16	10.75	11.01	0.001

Mann-Whitney U- test, statistical significant means  $p\text{-value} < 0.05$

1:38 PM - 1:43 PM

## RM 42. Analysis of the Medial Sural Artery Perforator Flap Using Computed Tomographic Angiography

*Indiana University, Div Plastic & Reconstructive Surgery, Indianapolis*

Presenter: Julia A. Cook, MD

Julia A. Cook, MD(1), Sarah E. Sasor, MD(1), Matthew P. Landman, MD(2), Sunil S. Tholpady, MD PhD(1) and Michael W. Chu, MD(3)

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**Background:** The medial sural artery perforator (MSAP) flap is an increasingly popular option for reconstruction. It is commonly harvested as a free flap and is an excellent choice for defects that require a thin, pliable, hairless flap. However, there is a paucity of literature characterizing the MSAP vessel caliber, orientation, and three-dimensional location. The purpose of this study is to describe MSAP anatomy using computed tomographic angiography (CTA).

**Methods:** Lower extremity CTA images performed at a single institution between November 2016 and May 2017 were reviewed. The medial sural artery and all perforators were assessed for caliber, length, branching pattern, and three-dimensional location. The y-axis of the three-dimensional plane was defined by a straight line between the posterior tibial plateau at the midpoint of the gastrocnemius heads and the medial malleolus. A two-tailed z-test was used to compare means. A Gaussian Mixture Model confirmed by normalized entropy criterion was used to calculate perforator cluster locations.

**Results:** One hundred fifty consecutive lower extremity CTAs were analyzed. Sixty percent of patients were male. Average age was 44.8 years. The medial sural artery had a mean caliber of 2.8 mm, which did not differ with laterality or gender ( $p = 0.72$  and  $0.53$ ). Perforator length was significantly longer in the right leg versus the left (115.4 vs. 107.4 mm,  $p = 0.05$ ) and in males versus females (118.0 vs. 100.3 mm,  $p < 0.001$ ). Perforator caliber at both the origin and terminal end was larger on the left (2.3 mm and 1.3 mm) compared to the right (2.2 mm and 1.2 mm,  $p = 0.03$  and  $0.02$ ) and in males (2.4 mm and 1.3 mm) compared to females (2.2 mm and 1.2 mm,  $p < 0.001$  and  $< 0.001$ ).

Three patterns of MSAP origination were noted: Class I - all perforators originated directly from the medial sural artery (76%); Class II - all perforators originated directly from the popliteal artery (10%); and Class III - perforators originated from both the MSA and the popliteal artery (14%). A Gaussian Mixture Model of the three-dimensional location of perforator termination demonstrated two areas of clustering per pedicle class. Normalized entropy criterion was  $< 1$  for all models.

**Conclusion:** Medial sural artery perforators are larger in caliber and longer in length in males as compared to females. Three classes of perforator origination were identified with perforators terminating in predicted locations. These findings can help with preoperative planning.

1:43 PM - 1:48 PM

## RM 43. Lower Extremity Takebacks: Flap Type Influences Salvage Outcomes

Wyss Department of Plastic Surgery, NYU Langone Medical Center, New York

Presenter: John T Stranix, MD

John T Stranix, MD(1), Z-Hye Lee, MD(1), Adam Jacoby, MD(1), Lavinia Anzai, MD(1), Josh Mirrer, MD(1), Tomer Avraham, MD(2), Vishal D Thanik, MD(3), Jamie P. Levine, MD(4) and Pierre B. Saadeh, MD(1)

(1)NYU Langone Medical Center, New York, NY, (2)Yale School of Medicine, New Haven, CT, (3)Hansjorg Wyss Department of Plastic Surgery, NYU Langone Medical Center, New York, NY, (4)New York University Langone Medical Center, New York, NY

**Background:** Lower extremity free flaps have notoriously high complication rates compared with other anatomic sites. Considering that the higher metabolic demand of muscle compared to fasciocutaneous tissue may result in less tolerance of vascular insults, we compared salvage rates after takebacks between fasciocutaneous and muscle free flaps for lower extremity trauma reconstruction.

**Methods:** Retrospective review of 806 lower extremity free flap reconstructions (1979-2016); 481 soft tissue flaps performed for below knee trauma reconstruction met inclusion criteria. Primary outcome measures were perioperative complications, specifically takebacks and flap salvage rates. Multivariable regression analysis controlled for: age, sex, sublocation (leg vs. foot/ankle), time to coverage (<7 days, 8-90 days, >90 days), and flap type (muscle vs. fasciocutaneous).

**Results:** Lower leg injuries (n=361) were more frequent than foot/ankle (n=165), and muscle flaps predominated (n=362) compared to fasciocutaneous (n=119). Complications occurred in 191 flaps (39.7%) with 45 partial losses (9%) and 37 complete losses (8%). Emergent return to the operating room occurred in 71 flaps (15%; muscle = 44, fasciocutaneous = 27) at a mean  $3.7 \pm 5.4$  days postoperatively. Indications were most commonly for venous congestion (48%), followed by arterial compromise (31%), unknown (10%), and hematoma (10%). Overall takeback outcomes were complete salvage (37%), partial failure (25%), and total failure (38%). Takebacks were associated with the presence of arterial injury (p=0.009) and use of vein grafts (p<0.001), but independent of sublocation (p=0.364) and time from injury to coverage (p=0.969). Fasciocutaneous flaps were associated with increased takeback rates compared to muscle flaps (23% vs. 12.2%, p=0.005) with a trend towards occurring earlier in the postoperative course (1.8 vs. 4.6 days, p=0.078). Despite higher takeback rates, fasciocutaneous flaps were successfully salvaged significantly more frequently than muscle-based flaps (63% vs. 21%, p<0.001). Interestingly, muscle flaps with skin paddles were also salvaged more successfully compared to muscle-only flaps (48% vs. 9%, p=0.002). Regression analysis further illustrated higher takeback rates among fasciocutaneous flaps (RR=2.28, p=0.004), and confirmed that muscle flaps were at much higher risk of failure due to an unsuccessful takeback salvage attempt (RR=9.42, p=0.001).

**Conclusion:** Compared to muscle, fasciocutaneous flaps demonstrated higher salvage rates despite more frequent takebacks for vascular compromise. These findings are likely related to a combination of lower metabolic demand in fasciocutaneous tissue compared to muscle and easier visual recognition of vascular compromise. In the context of higher failure rates among lower extremity trauma free flaps, our results warrant consideration during flap selection for limb salvage.

1:51 PM - 1:56 PM

**RM 44. Functional Status Influences Survival Following Major Amputation for Advanced Diabetic Foot Ulcers**

*MedStar Georgetown University Hospital, Washington*

Presenter: James M. Economides, MD

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(1)Plastic Surgery, MedStar Georgetown University Hospital, Washington, DC, (2)Plastic Surgery, Georgetown University Hospital, Washington, DC, (3)Georgetown University Hospital, Washington, DC

**Background:** Diabetic foot ulceration confers a substantial life-time risk of major extremity amputation and death among individuals with diabetes mellitus. The annual mortality rate for diabetic Medicare beneficiaries who present with an incident diabetic foot ulcer approximates 11% and increases to 22% in the setting of lower extremity amputation. At five years the mortality rate for individuals who have undergone below-knee (BKA) or above-knee (AKA) amputation is reported in the range of 50% to 78%. Despite these statistics, no study has investigated which factors contribute to increased mortality in this high-risk patient population. We posit that postoperative functional status following major extremity amputation influences overall survival. **Methods:** A 5-year retrospective review was conducted for all diabetic patients who underwent non-traumatic major lower extremity amputation at our tertiary referral center for advanced limb salvage. Demographic data, comorbidities, amputation type, functional status, and mortality at final follow-up were collected for all patients. Statistical analyses were performed using Chi square and Student's t tests for data containing categorical and continuous variables, respectively. **Results:** Major amputation was performed in 360 patients who underwent either BKA (n = 286) or AKA (n = 74) during the study period. Mean follow-up was 38 months (r, 3 to 83 months) and 34 months (r, 11 to 64 months) for patients in the BKA and AKA cohorts, respectively. There were no significant differences in comorbidities between cohorts. Ambulation rates at final follow-up were 45% for patients who underwent BKA and 22% for patients who underwent AKA (p = 0.035). Mortality rates were 5% and 15%, respectively (p=0.023). When compared to non-ambulatory patients, mortality rates among ambulators were significantly lower for both BKA (1.9% vs. 25% p=0.043) and AKA (9% vs 20%, p=0.022) cohorts. **Conclusion:** Despite the high reported mortality rates throughout the literature, functional status following major extremity amputation appears to have a significant influence on overall survival. Patients who are ambulatory following both BKA and AKA have a significantly lower rate of mortality when compared to those who are non-ambulatory. As expected, ambulation rates worsen and mortality rates increase as the amputation level becomes more proximal. Interestingly, mortality rates following major extremity amputation at our institution are lower than previously published reports and may reflect intensive postoperative management with a multidisciplinary team specializing in diabetic limb salvage.

1:56 PM - 2:01 PM

## **RM 45. The Optimal Pedicle for Proximal Fibular Epiphyseal Transfer: a Vascular Anatomical Study**

*Mayo Clinic, Rochester*

Presenter: Mohamed Morsy, MD

Mohamed Morsy, MD(1), M. Diya Sabbagh, MD(2), Si-Gyun Roh, M.D.(3), Marissa Suchyta, BA(2) and Steven L Moran, MD(1)

(1)Division of Plastic Surgery, Mayo Clinic, Rochester, MN, (2)Mayo Clinic, Rochester, MN, (3)Chonbuk National University Hospital, Jeonju, Korea, Republic of (South)

### **Background:**

Vascularized proximal fibular epiphyseal transfer has been used to treat the loss of the growth plate in a growing child. Various vessels have been used in the past to support this transfer, but more recently the most successful were the anterior tibial artery and the inferior lateral genicular artery. Although this has been demonstrated clinically, a comparison of the vascular distribution of both vessels was not done. This study aims at comparing the fibular vascular territory of both vessels.

### **Methods:**

Six pairs of lower extremities were used for this study, a total of 12 specimens. Each pair was collected from the same donor to match the 2 groups. Through a posterior midline incision, the popliteal artery was identified at the popliteal fossa. In the right specimens, the anterior tibial artery was cannulated, and in the left specimens, the inferior lateral genicular artery was cannulated. Specimens were injected with ward's red latex. After 24 hours at 4°C, the fibula was extracted with the surrounding periosteum and a cuff of soft tissues, then the length of perfusion was measured as the distal-most presence of the latex from the proximal tip of the fibula.

### **Results:**

Of the 6 pairs of lower extremities, 3 were males and 3 were females. Average age of the donors was 86.7 years, and all of them were Caucasians. Average length of the fibula was 37.1cm. In the 6 right specimens, the average length of perfusion of the anterior tibial artery was 37.1cm, which was equal to the whole length of the fibula in all specimens. In the 6 left specimens, the average length of perfusion of the inferior lateral genicular artery was 5.9cm (range from 4.3 to 10.1cm).

### **Conclusion:**

The anterior tibial artery can supply the whole fibular length, whilst the inferior lateral genicular artery can supply only the proximal portion. Although both arteries can be used as the pedicle for proximal fibular transfer, the inferior lateral genicular artery can perfuse only a limited length of the adjacent fibular shaft. This becomes relevant when a longer length of the fibular shaft should be included with the transfer.

2:01 PM - 2:06 PM

**RM 46. Dual Discontiguous Arterialized Venous Flap Using the Oscillating Venous Plexus: A Working Model for Reliable Arterialized Venous Flap Harvest**

*The Curtis National Hand Center, Baltimore*

Presenter: Chrisovalantis X. Lakhiani, MD

Chrisovalantis X. Lakhiani, MD(1) and Ryan D Katz, MD(2)

(1)Plastic Surgery, Georgetown University Hospital, Washington, DC, (2)Curtis Hand Center, Union Memorial Hospital, Baltimore, MD

## **Background**

Arterialized venous flaps and venous flow-through flaps have conventionally been described as based on a central vein to accommodate both afferent and efferent flow. However, these flaps are not universally reliable and suffer from high partial and total failure rates. To date, capitalization of the avalvular oscillating venous plexus in a dual discontiguous venous system has not been attempted to improve survival outcomes in arterialized venous flaps.

## **Methods**

Fresh cadaveric lower extremities were obtained from our institution's willed body program. Iohexol injection studies were performed in two lower extremities to visualize the location of avalvular oscillating veins of the leg. Indocyanine green angiography was performed to visualize cutaneous perfusion of a dual discontiguous venous flap model, as well as for five flaps harvested as a traditional venous flow-through flap. Images were uploaded into Adobe Photoshop (Adobe Systems, San Jose, CA.) and the total area captured was compared to the total theoretical capture. **Results** between both groups were compared using a student's t-test.

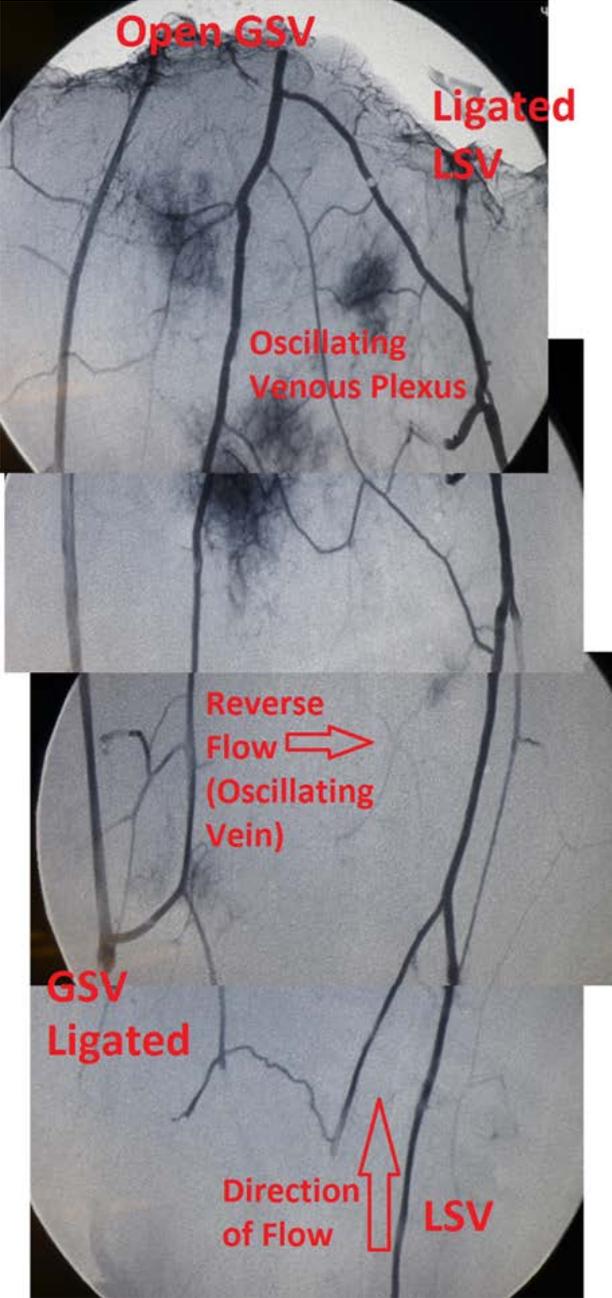
## **Results**

An avalvular oscillating venous plexus was consistently identified between the lesser and greater saphenous veins. The lesser saphenous vein was injected with ICG from its distal portion and ligated proximally in order to direct flow through the oscillating venous plexus to the greater saphenous vein (Figure 1). The mean percentage of theoretical capture was 85.6% in the dual discontiguous venous flap model based on the lesser and greater saphenous veins. This was a statistically significant increase ( $p < 0.001$ ) in cutaneous tissue perfusion compared to the venous flow-through flap based on the lesser saphenous vein (26.0%). Flap sizes with adequate indocyanine perfusion ranged from 8 x 6 – 10 x 14 cm (Figure 2).

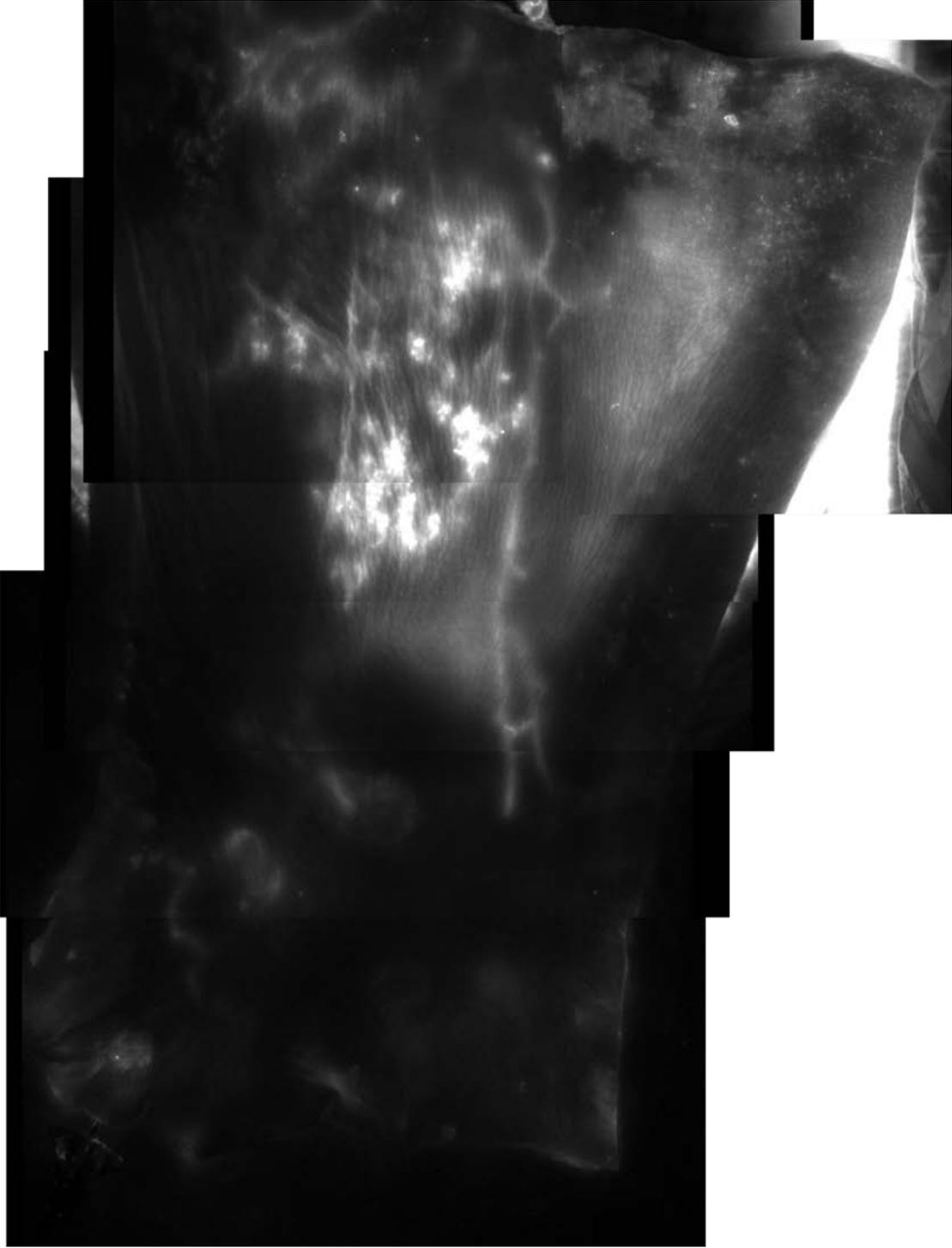
## **Conclusion**

A reliable arterialized venous flap may be an ideal soft-tissue flap. It may provide thin, pliable coverage, with a long vascular pedicle and minimal donor site morbidity. These results indicate that a working model for arterialized venous flap harvest may be accomplished using a dual discontiguous venous system with capture of known areas of avalvular oscillating veins. While further research is needed, this also suggests that capture of the avalvular oscillating plexus could allow for arterialized venous flaps to be harvested from other regions as well.

**Figure 1. Flow Through Omnipaque Visualization of the Superficial Venous System and Oscillating Plexus**



**Figure 2. ICG Microangiography of the Dual Discontiguous Venous Flap with Oscillating Vein Capture**



2:09 PM - 2:14 PM

## RM 47. **The Posterior Capitellum: a New Donor Site of Vascularized Bone Graft**

*Mayo Clinic, Rochester*

Presenter: Mohamed Morsy, MD

Mohamed Morsy, MD(1,2), Si-Gyun Roh, M.D.(3,4), M. Diya Sabbagh, MD(4), Marissa Suchyta, BA(4) and Steven L Moran, MD(2)

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### **Background**

vascularized bone grafts are valuable to treat nonunions and avascular necrosis such as those of the carpal bones. All popular free vascularized bone grafts currently in use for the upper extremity are harvested from the lower extremity. In this study, we are introducing the vascular anatomy of a potential new donor site for vascularized bone graft from the posterior capitellum.

### **Methods**

Eight fresh frozen upper extremities were used for this study. These limbs were injected with ward's red latex, then left to cool for 24-48 hours. An anterior incision at the cubital fossa was done to expose the radial artery and its branches. The radial recurrent artery was identified and dissected along its course. The course, diameter, anatomical relations, length and branches were documented.

### **Results**

Six specimens were right and 2 were left. 6 came from male donors and 2 from female donors. Average age of the donors was 80.8 years, and all were of Caucasian descent. The radial recurrent artery followed a very consistent course in all specimens. It originated from the radial artery at an average distance of 23.4 mm distal to the elbow joint line. The mean diameter at origin was 2.1 mm. It ran proximally between the brachialis and brachioradialis muscles, accompanied by two venae comitantes, until it reached the level of the elbow, where it divided into 2 branches, one accompanied the radial nerve proximally, and the other dived deep to the surface of the humerus, where it travelled laterally between the origin of the extensor carpi radialis longus muscle and the common extensor origin. On the lateral border of the humerus, it gave a branch that anastomosed with a branch of the posterior radial collateral artery, then travelled on the posterior surface of the capitellum arborizing over and supplying it. The average length of the radial recurrent artery was 89mm.

### **Conclusion**

The radial recurrent artery has a very consistent anatomy with a very suitable length as a pedicle. It also has a suitable diameter at origin for microvascular anastomosis. These merits make it a potential pedicle to harvest a vascularized bone flap upon from the posterior capitellum.

Figure 1: course of the radial recurrent artery anteriorly

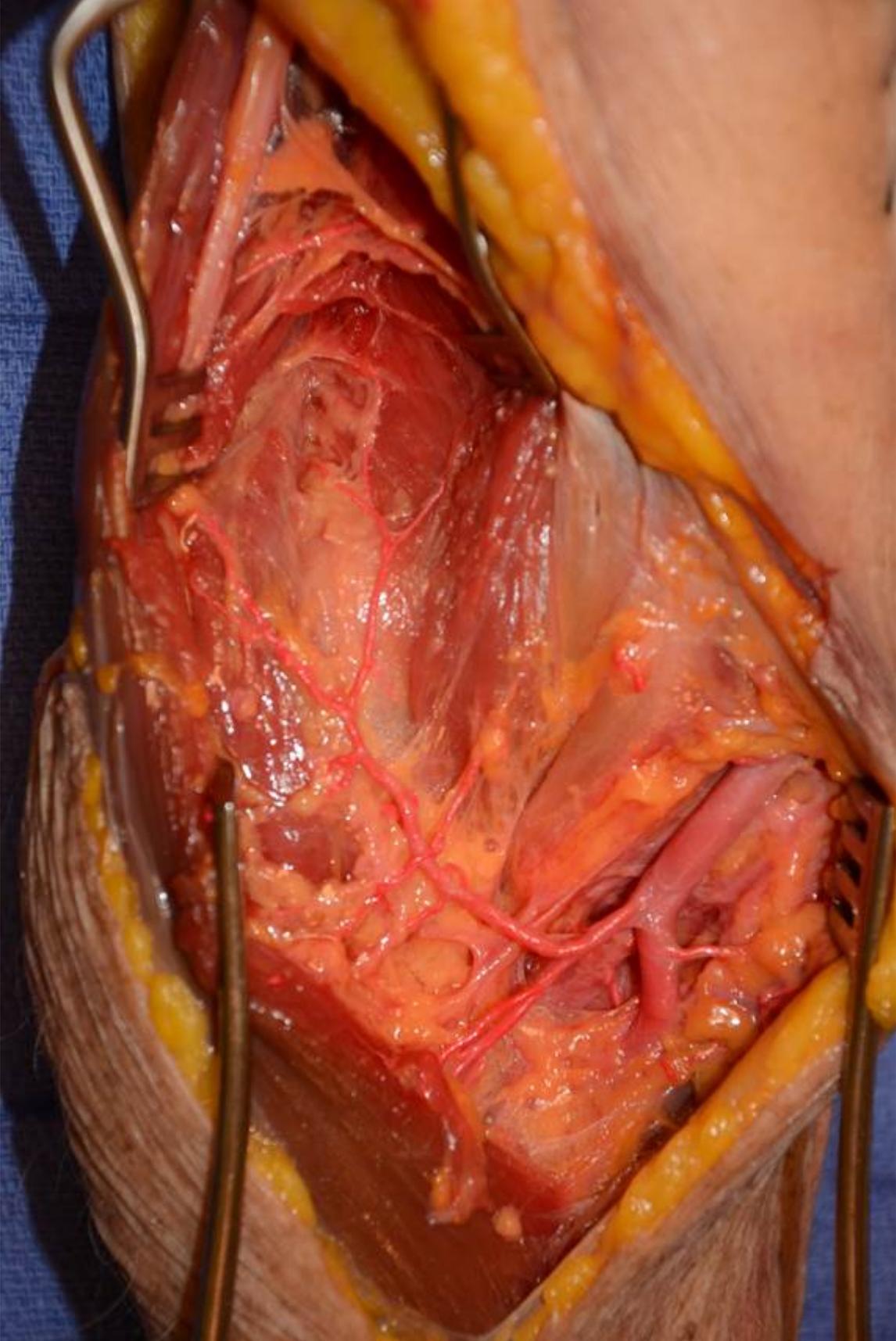


Figure 2: anastomosis with the posterior radial collateral artery

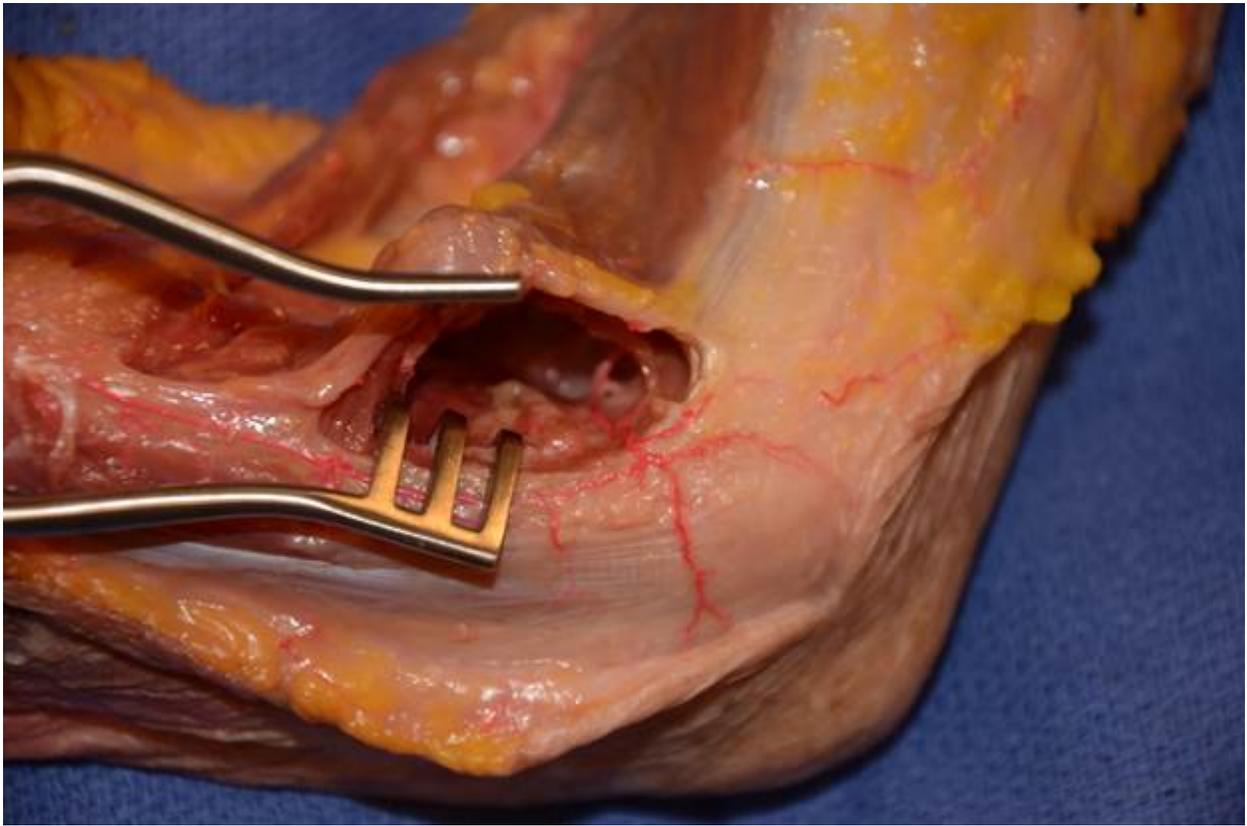


Figure 3: terminal branches of the radial recurrent artery over the posterior capitellum



2:14 PM - 2:19 PM

**RM 48. Comparison of phrenic nerve versus spinal accessory nerve for shoulder abduction restoration in acute brachial plexus injury**

*Chang Gung Memorial Hospital, kweishan, Taoyuan City*

Presenter: Jennifer An-Jou Lin, M.D.

Jennifer An-Jou Lin, M.D.(1), Johnny Chuieng - Yi Lu, M.D.(2), Tommy Nai-Jen Chang, M.D.(2) and David Chwei-Chin Chuang, M.D.(2)

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**Background**

Shoulder abduction is a critical function to restore in acute brachial plexus injury. Using spinal accessory nerve (XI) as a neurotizer in nerve transfer for shoulder restoration is a popular choice. However, the phrenic nerve has proven to be a reliable donor in our experience. The aim of this study is to determine if the phrenic nerve shows comparable results to the spinal accessory nerve for shoulder abduction.

**Methods**

In this study, we retrospectively evaluated 192 patients with acute brachial plexus injuries from the years 2004 to 2013 at a single center. These patients were divided into three main groups, with Group A using phrenic nerve, Group B using spinal accessory nerve and Group C using both nerves for nerve transfer to restore shoulder abduction. Group A and B were further divided into 3 separate subgroups depending on the target nerves (A1/B1 transfer to suprascapular nerve only; A2/B2 transfer to distal C5 = suprascapular nerve plus posterior division of upper trunk) and combining other cervical roots as donor nerves (A3/B3 combining C5 or C6 root with nerve graft to distal target). The maximum degree of shoulder abduction and recovery of elbow extension were recorded, with at least 2 years of follow up postoperatively. Successful outcome was set at achieving at least 60 degrees on shoulder abduction.

**Results**

Phrenic nerve (Group A) and XI (Group B) yielded similar outcomes with no significant difference. Phrenic nerve achieved an average of 78.3 degrees in maximum shoulder abduction with 67% achieving satisfactory outcome. XI achieved an average of 67.6 degrees in maximum shoulder abduction, with 60% achieving satisfactory outcome. In comparing all six groups, group C achieved the best outcome, with a maximum of 85.2 degrees and 87% yielding satisfactory results. This was followed by group A3, which achieved 83.8 degrees maximally, and 73% achieving satisfactory outcome. However, there was no significant difference between these six groups. In addition, there was no significant difference when neurotizing different targets.

**Conclusion**

Phrenic nerve presented comparable, if not superior, results when compared to XI for shoulder abduction. Phrenic nerve is a reliable and convenient donor nerve to use when dissecting in the proximal neck region, and therefore we recommend the use of the phrenic nerve as primary option for nerve transfer to restore shoulder function. Furthermore, preservation of XI nerve allows more flexibility in secondary reconstruction such as functioning free muscle transplantation if primary nerve reconstruction fails.

2:19 PM - 2:24 PM

## RM 49. **Dual Venous Drainage does not Improve Perforator Flap Performance in Lower Extremity Reconstruction**

*Beth Israel Deaconess Medical Center, Harvard Medical School, Boston*

Presenter: Mattos David, MD, MBA

Mattos David, MD, MBA(1), Shawn Diamond, MD(1), Akhil K Seth, MD(2), Qing Z Ruan, MD(1), Anmol S Chattha, BS(1) and Matthew L Iorio, MD(3)

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**Background** Routine use of dual venous drainage for all anterolateral thigh flaps has been proposed to decrease flap related complications as compared to single venous anastomosis. We sought to determine if the number of venous anastomosis affected flap complications, specifically in the context of lower extremity perforator flap reconstruction. **Methods** Retrospective review of patients who underwent free microvascular tissue transfer with ALT flaps containing at least two perforators from May 2010 to March 2017. All patients operated on after September, 2014 were subject to the same early dangling protocol. Patients were divided into groups dependent on whether they received a single venous anastomosis versus two or more anastomoses. A univariate analysis determined differences amongst the two groups. A multivariate analysis identified independent risk factors associated with patient, donor site, and or flap complications. Subgroup analysis was also performed to determine if flap area, thickness and volume affected flap outcomes. **Results** Forty-four patients met inclusion criteria. Of these, 19 (43.2%) underwent single venous anastomosis while 25 (57.8%) underwent two venous anastomoses. Thinner patients with BMI ( $26 \pm 5$  vs  $30 \pm 6$ ) ( $p=0.016$ ) and longer elapsed time from injury to reconstruction (724 days vs 387 days) ( $p=0.045$ ) were more likely to undergo single venous anastomosis. Patients were otherwise evenly matched. Average flap area in single versus double venous anastomosis groups was: (168cm vs 152cm) ( $p=0.63$ ) while (36% vs 44%) ( $p=0.44$ ) of flaps were elevated in a suprascapular plane. Twenty-six patients were subject to an early dangle protocol in contrast to 18 (41%) who were managed with a prolonged time to limb dependence. The number of venous anastomoses performed did not independently affect flap complication rates (15.8% v 20%) ( $p=1$ ). There was one venous thrombosis per group (5.3% vs. 4.0%) ( $p=1$ ). No difference in systemic complication rates, specifically deep venous thrombosis occurred. In subgroup analysis, early dangling, increasing area and thickness did not influence rates of either complete or partial flap loss. Return to full weight bearing and ambulation occurred in 88% of all individuals. **Conclusion** The number of venous anastomoses in perforator flaps of the lower extremity did not influence postoperative complications and or soft tissue loss. Increased flap area and thickness along with an early dangling protocol did not compromise single venous flaps. Routine use of more than one venous anastomosis can be avoided.

2:27 PM - 2:32 PM

### RM 50. 3-2-1 Runoff Risk Assessment: Prognostic Value of Arterial Injury in Traumatic Limb Salvage

Wyss Department of Plastic Surgery, NYU Langone Medical Center, New York

Presenter: John T Stranix, MD

John T Stranix, MD(1), Z-Hye Lee, MD(1), Adam Jacoby, MD(1), Lavinia Anzai, MD(1), Josh Mirrer, MD(1), Tomer Avraham, MD(2), Vishal D Thanik, MD(3), Pierre B. Saadeh, MD(1) and Jamie P. Levine, MD(4)

(1)NYU Langone Medical Center, New York, NY, (2)Yale School of Medicine, New Haven, CT, (3)Hansjorg Wyss Department of Plastic Surgery, NYU Langone Medical Center, New York, NY, (4)New York University Langone Medical Center, New York, NY

**Background:** Increasing trauma severity has been associated with increased free flap complications. Since degree of lower extremity arterial injury likely parallels trauma severity, the impact of decreasing arterial runoff on traumatic lower extremity free flap outcomes was investigated.

**Methods:** Retrospective review of 806 lower extremity free flap reconstructions (1979-2016); 310 soft tissue flaps performed within 90 days of injury met inclusion criteria. Primary outcome measures were perioperative complications. Multivariable regression analysis controlled for: age, sex, time to coverage (<14 days, 15-42 days, 43-90 days), and flap type (muscle vs. fasciocutaneous).

**Results:** Open tibial injuries were more common than foot (65% vs. 35%) and muscle flaps predominated (78%) over fasciocutaneous (22%). More than half were performed in the acute period: 0-14 days (57%), 15-42 days (26%), 43-90 days (17%). Arterial injury was common (38%) and correlated with larger flap size ( $p=0.019$ ), presence of bone gap ( $p<0.001$ ), antibiotic bead use ( $p=0.046$ ), and external fixation ( $p=0.002$ ). Arterial runoff patterns were: 3-vessel (61%), 2-vessel (18%), 1-vessel (12%), and 0-vessel (9%). Major complications occurred in 99 flaps (32%) with 48 takebacks (16%), 37 partial losses (12%), and 26 total failures (8%). Regression analysis demonstrated the presence of any arterial injury was associated with increased risk of complications ( $RR=1.61$ ,  $p=0.042$ ), takebacks ( $RR=2.31$ ,  $p=0.021$ ), and flap failures ( $RR=2.22$ ,  $p=0.010$ ). Decreasing arterial runoff linearly correlated with increased risk of complications ( $RR=1.49$ ,  $p=0.048$ ), any flap loss ( $RR=2.31$ ,  $p<0.001$ ), partial flap loss ( $RR=1.89$ ,  $p=0.022$ ), and total flap failures ( $RR=2.33$ ,  $p=0.010$ ). Compared to 3-vessel runoff, 2-vessel limbs had higher rates of flap failure ( $RR=2.08$ ,  $p=0.041$ ), and 1-vessel limbs were at even higher risk of flap failure ( $RR=3.67$ ,  $p=0.001$ ).

**Conclusion:** Arterial injury was common among limb salvage patients and indicated higher trauma severity. Further, decreasing vessel runoff directly correlated with increased reconstructive complication rates in a stepwise fashion with flap failure risk doubled among 2-vessel limbs and 3.6 times higher for 1-vessel limbs compared to those with normal arterial runoff. Thus, degree of arterial injury represents a practical method for stratification of lower extremity trauma severity with significant prognostic value and direct reconstructive implications. We therefore propose a 3-2-1 runoff risk assessment scale for free flap salvage of lower extremity trauma.

2:32 PM - 2:37 PM

## **RM 51. Distal Perforator-Only Propeller (D-POP) Anterolateral Thigh Flap for Reconstructions around the Knee**

*The Christie NHS Foundation Trust, Manchester*

Presenter: Damir Kosutic, MD PhD FRCS (Plast), Consultant Plastic and Reconstructive Surgeon

Damir Kosutic, MD PhD FRCS (Plast), Consultant Plastic and Reconstructive Surgeon(1) and Shanshan Jing, MBBS Spr in Plastic and Reconstructive Surgery(2)

(1)The Christie NHS Foundation Trust, Manchester, United Kingdom, (2)The Christie NHS, Manchester, United Kingdom

### **Background**

Soft tissue reconstruction around the knee are challenging from functional and aesthetic perspective. While loco-regional options remain limited, free flaps produce unnecessary additional scarring and longer hospitalization. We present a new technique of using the most distal perforator-only propeller anterolateral thigh flap (D-POP ALT) for soft-tissue defects around the knee joint following excision of skin malignancies.

### **Methods**

Fourteen patients (4 males, 10 females), with a mean age of 53 years (range: 41-65) had Distal Perforator-Only-Propeller (D-POP) ALT flap reconstruction of the defect following wide local excision of melanoma around the knee joint between July 2014 – September 2016. The most distal perforator on the line between SIAS and upper lateral border of patella was identified and marked with audible-Doppler and POP ALT flap was designed around it in eccentric fashion, depending on characteristics of the defect. Flaps were propelled into the defects while the donor-sites were closed directly.

### **Results**

The largest flap raised measured approximately 25 x 6cm. Perforator was found between 4 and 9 cm proximal to the upper lateral border of patella in all cases. Perforator was septal in 10 cases and intramuscular in 4 cases. Healing was uneventful in all cases and patients were ambulatory almost immediately post-operatively. No flap monitoring was required and all patients were discharged on post-operative day 1. Excellent functional and aesthetic outcomes were observed in long-term follow up.

### **Conclusion**

From our early experience, this technique is simple, reliable and versatile. A thin and pliable flap with a large surface area can be safely raised based on the most distal (D-POP) ALT perforator, providing a superior and affordable reconstruction whilst maintaining both function and aesthetics, compared to alternatives.

2:37 PM - 2:42 PM

## RM 52. Donor Site Morbidity of The Medial Femoral Condyle Flap

*Mayo Clinic, Rochester*

Presenter: Mohamed Morsy, MD

Mohamed Morsy, MD(1,2), Ghassan Mehio, M.D.(3), Cenk Cayci, M.D.(3), M. Diya Sabbagh, MD(3), Steven L Moran, MD(1) and Brian T. Carlsen, MD(1)

(1)Division of Plastic Surgery, Mayo Clinic, Rochester, MN, (2)Assiut University, Assiut, Egypt, (3)Mayo Clinic, Rochester, MN

### **Background:**

The medial femoral condyle (MFC) free vascularized bone flap is a valuable alternative to other types of vascularized bone grafts. The donor site morbidity and functional outcomes after flap harvest have not been fully appreciated. Herein, we report the postoperative outcomes and analyze the impact of increasing the size of the flap on the knee donor site morbidity.

### **Methods:**

A retrospective chart review of patients who underwent MFC flap between 2001 and 2012 at our institution was done. The size of the flap was stratified, based on the largest dimension, into 3 groups. Demographics, outcomes, and complications related to the flap donor site were recorded and analyzed. Subsequently, functional status was assessed by administering a validated condition-specific measure: the Lower Extremity Functional Scale (LEFS) questionnaire. A univariate logistic regression analysis was done and results were analyzed.

### **Results:**

A total of 75 patients were identified. Mean age was  $29.5 \pm 15.2$  years (range: 14-72). Mean follow-up time was 13 months postoperatively. Overall Complication rate was 18.6%. Donor site paresthesia in the saphenous nerve distribution was the most common complication. Increasing size of the flap did result in a significant elevation in complication risk ( $p < 0.05$ ). A total of 47 patients completed the LEFS questionnaire. Average LEFS score was  $72.12 \pm 14.18$  (range 28-80). 51% ( $n=24$ ) scored 80 points, indicating a normal level of function on average.

### **Conclusion:**

The MFC flap has overall acceptable donor site morbidity with good level of function post-operatively. Larger flaps are associated with more complications. Adequate knowledge of the anatomy and branching patterns of the saphenous nerve allows for careful dissection and preservation of the saphenous nerve and its branches intraoperatively which may ultimately lower the occurrence nerve related complications.

2:45 PM - 2:50 PM

## RM 53. **Bone Perfusion Evaluation in Cadavers Using Indocyanine Green Fluorescence Angiography**

*Medical University of Vienna, Vienna*

Presenter: Hidehiko Yoshimatsu, MD

Hidehiko Yoshimatsu, MD(1), Johannes Steinbacher, MD(2), Takuya Iida, M.D.(3) and Chieh-Han Tzou, M.D.(4)

(1)Plastic and Reconstructive Surgery, University of Tokyo, Tokyo, Japan, (2)Division of Plastic and Reconstructive Surgery, Department of Surgery, Medical University Vienna, Vienna, Austria, (3)University of Tokyo, Tokyo, Japan, (4)Division of Plastic and Reconstructive Surgery, Department of Surgery, Medical University of Vienna, Vienna, Austria

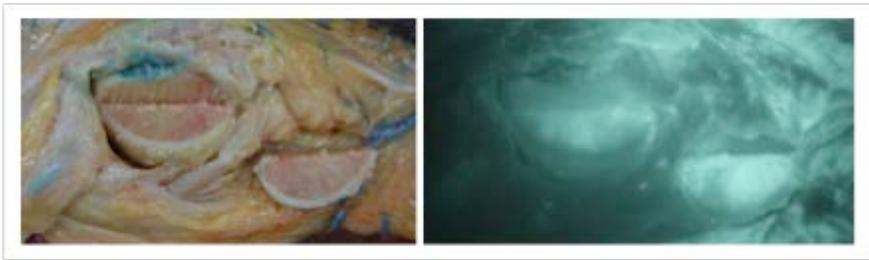
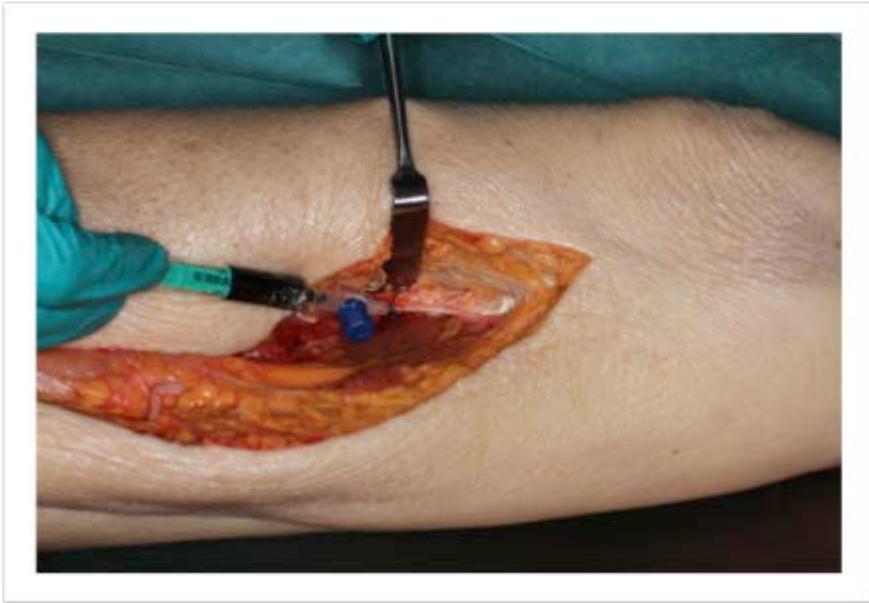
**Background:** Although use of new flaps has been reported every year since the introduction of the perforator concept, reports on new vascularized bone flaps have been limited: one of the reasons is that bone perfusion evaluation methods in cadaver studies have yet to be established. The aim of this report is to introduce and validate the feasibility of indocyanine green (ICG) fluorescence angiography for evaluation of bone perfusion in the femoral medial condyle in cadavers.

**Methods:** In 4 fresh non-embalmed cadavers (2 female), the descending genicular artery (DGA) was dissected and carefully cannulated bilaterally. A 10 mL solution containing 5 mL ICG solution and 5 mL methylene blue solution was injected into the DGA. After the injection, the medial femoral condyle was cut with an oscillating saw. A photo was taken of the cut ends of the bone. The cut ends of the bones were observed using a near-infrared camera. Images corresponding to the previously taken photos of the cut ends were captured for comparative analysis.

**Results:** After injection of methylene blue and ICG, the blue dye could be seen in the periosteum in all specimens, but not inside the cortex or the cancellous region of the bone. When observed with ICG fluorescence angiography, however, the cancellous region was highlighted through small perforators penetrating the periosteum.

**Conclusion:** Perfusion inside the medial femoral condyle in cadavers was confirmed using ICG fluorescence angiography. Our method can be especially beneficial in confirming the bone perfusion of a new bone flap based on a particular artery, both in cadavers as well as in patients, because ICG can be injected into specific arteries. ICG fluorescence angiography can also be used to evaluate the specific perfused region, the

□ gbone angiosom



2:50 PM - 2:55 PM

**RM 54. Long Term Patient Reported Outcomes Following 239 Free Flap Lower Extremity Reconstructions for Traumatic Injuries**

*Erasmus MC, University Medical Center Rotterdam, Rotterdam*

Presenter: Marc A.M. Mureau, MD, PhD

Sabine A. Egeler, MD(1), Tim de Jong, MD, PhD(2), Luijsterburg Teun, MD, PhD(3) and Marc A.M. Mureau, MD, PhD(4)

(1)Beth Israel Deaconess Medical Center, Boston, MA, (2)Plastic and Reconstructive Surgery, Erasmus MC, University Medical Center Rotterdam, Rotterdam, Netherlands, (3)Erasmus MC, University Medical Center Rotterdam, Rotterdam, Netherlands, (4)Plastic and Reconstructive Surgery, Erasmus MC Cancer Institute, University Medical Center Rotterdam, Rotterdam, Netherlands

**Background:** Reconstruction of severe lower extremity injuries using free flaps has become a reliable approach. Knowledge on long-term surgical outcomes, limb function, and quality of life (QoL) and a relation with timing of reconstruction is limited. Therefore, the aims of the present study were to investigate the differences in long-term patient-reported QoL and subjective lower limb function between early and delayed free flap reconstruction with and without osteomyelitis and to identify independent predictors for good and poor outcomes per patient group.

**Methods:** In a retrospective study of 239 patients, undergoing a free flap reconstruction of an open lower extremity fracture between 1993 and 2014, three groups were studied: 1) early free flap reconstruction within 6 weeks, 2) delayed reconstruction after 6 weeks and 3) delayed reconstruction with osteomyelitis. Patient-reported outcomes were assessed with the Short-Form 36 (SF-36) and the Lower Extremity Functional Scale (LEFS). Independent variables predicting outcomes were identified using multivariate analyses.

**Results:** Flap survival rates were 96.1%, 91.4% and 98.5% for groups 1, 2 and 3, respectively. Hundred-and-eight patients (mean follow-up, 9.7 years) completed the questionnaires. SF-36 physical component scores (PCS) were significantly lower in all three groups compared to Dutch norms, as was the mental health score in group 3. Group 1 reported the best long-term lower limb function and QoL, group 3 the poorest. Chronic pain was a statistically significant independent predictor for poorer PCS and LEFS scores in group 1 and in group 2. Delayed union was an independent predictor for poorer LEFS outcomes in group 3. Furthermore, cardiovascular disease was an independent predictor for poorer QoL in group 1, as were smoking and female sex in group 2. Complications and delayed unions had no statistically significant effect on mean SF-36 and LEFS scores.

**Conclusion:** Patients with a microsurgical reconstruction of a severe lower limb trauma many years later still significantly differed in QoL compared to the general population. No statistically significant differences were found between the groups studied, however, there were considerable better outcomes in the early lower limb reconstruction group for QoL and self-reported lower limb function. Patients with osteomyelitis in the postoperative period had poorer QoL, mental health and limb function compared to both other groups. Chronic pain after microsurgical lower extremity reconstruction predicted poorer long-term QoL and limb function. These results suggest that awareness and early adequate treatment of postsurgical pain may contribute to improving long-term patient-reported outcomes.

2:55 PM - 3:00 PM

**RM 55. The Efficacy of Negative Pressure Wound Therapy and Antibiotic Beads as Infection Prophylaxis in Post-Traumatic Lower Extremity Salvage**

*University of Southern California, Keck School of Medicine, Los Angeles*

Presenter: Karen Burt, BS

Karen Burt, BS(1), Ido Badash, BA(1), Hyuma A Leland, MD(2), Daniel J. Gould, M.D., Ph.D.(1), Alexis Rounds, BS(1), Ketan M Patel, MD(3) and Joseph N Carey, MD(1)  
(1)Keck School of Medicine of the University of Southern California, Los Angeles, CA, (2)Keck School of Medicine, University of Southern California, Los Angeles, CA, (3)Division of Plastic and Reconstructive Surgery, Keck School of Medicine of USC, Los Angeles, CA

**Background:** Antibiotic beads are the gold standard for staged debridements prior to definitive soft tissue reconstruction during attempted limb salvage. The impact of negative pressure wound therapy (NPWT) as an alternative or supplement to antibiotic beads in preventing infection is unclear. This study compares outcomes in trauma patients receiving NPWT, antibiotic beads, or both treatments prior to soft tissue reconstruction of the lower extremity.

**Methods:** This study is a retrospective review of patients requiring soft tissue reconstruction following traumatic lower extremity open fractures in an urban Level 1 trauma center conducted between August 2007 and December 2015. Patients with soft tissue infection or osteomyelitis prior to NPWT and/or antibiotic bead application were excluded.

**Results:** In 72 patients with 73 lower extremities having open fractures that required soft tissue reconstruction, 26 received only NPWT, 24 only antibiotic beads, and 23 both treatments. There was no significant difference in time from injury to definitive soft tissue coverage, time from injury to NPWT/bead placement, or length of NPWT/beads use between groups. Infection rate was 26.9% with NPWT only, 0.0% with antibiotic beads only, and 8.7% with antibiotic beads and NPWT in combination. Patients receiving antibiotic beads alone were significantly less likely than those receiving NPWT alone or combined NPWT/beads to develop an infection ( $p < 0.01$ ,  $p < 0.01$ ) or a complication ( $p < 0.01$ ,  $p < 0.01$ ). In patients receiving NPWT, development of infection was associated with longer periods from initiation of NPWT to definitive soft tissue coverage ( $p < 0.01$ ); this finding was independent of time from injury to soft tissue coverage but correlated with number of operations. Overall limb salvage rate was 95.9% and was not significantly different between groups.

**Conclusion:** Antibiotic beads may be more effective than NPWT in preventing infections in patients awaiting soft tissue coverage of wounds. Utilizing these treatments together did not improve infection rates significantly. Limb salvage was successful in most cases regardless of infection prophylaxis method.

3:03 PM - 3:08 PM

**RM 56. Reconstruction Both of the Degloving Multi-digits Defect and Foot Donor Site Using Toes Transfer and Free Perforator Flaps at the Same Stage**

*Ningbo sixth Hospital , Ningbo*

Presenter: Xin Wang, MD

Xin Wang, MD and Jia Dong Pan, MD, MA

Ningbo 6th Hospital, Ningbo, China

**Background** To explore the surgical indications, techniques and curative effects of a variety of composite foot tissue flap transfer and the donor foot reconstruction with the free perforator flap transfer at the same stage.

**Methods** From February 2012 to August 2015, 32 fingers in 10 cases were reconstructed. Many pedis compound flaps (wrap around flap + dorsal pedis flap , wrap around flap + second toe, wrap around flap of the big and second toe, wrap around flap + dorsal pedis flap + second toe or its wrap around flap) with the same vessel pedicle as to big toe wrap-around flap and perforator flaps were designed and transferred to reconstruct both recipient and donor site. Fingers reconstruction including thumb: three fingers (6 fingers in 2 cases), four fingers (8 fingers in 2 cases). Fingers reconstruction except thumb: three fingers (18 fingers in 6 cases). Secondary foot skin defect: resurfaced with free ALTP (16 feet) and SCIP (4 feet). Free thoracic dorsal artery perforator flap (TDAP) was also used to repair the hand wound in degloving injury hand in addition to toe transfer (2 cases).

**Results** All reconstructed fingers and flaps for hand survived at last besides one of them was salvaged by take-backs. Most of flaps for foot survived except partial necrosis in 1 foot. The follow-up ranged from 5 to 18 months (mean, 10 months). All patients are satisfied with the appearance and function of reconstructed thumb, finger and foot. According to evaluation criteria from Chinese Medicine Association for hand surgery: excellent in 7 cases, good in 3 cases. According to the Maryland foot function score standard: excellent in 8 cases, good in 2 cases.

**Conclusion** These described procedures not only can get the excellent outcome of reconstructed fingers based on minimal morbidity in the donor site but also provide a new treatment option for degloving hand that need multiple fingers reconstruction.



3:08 PM - 3:13 PM

## **RM 57. Functional Outcomes in Gustillo III Lower Extremity Reconstruction are Independent of Timing of Reconstruction**

*University of Manitoba, Winnipeg*

Presenter: Joshua Vorstenbosch, MD, PhD

Joshua Vorstenbosch, MD, PhD(1), Michal Adam Brichacek, MD, BSc(2), Kim R. Dalke, MSc(1) and Edward Buchel, MD(3)

(1)University of Manitoba, Winnipeg, MB, Canada, (2)Department of Surgery, Division of Plastic Surgery, University of Manitoba, Winnipeg, MB, Canada, (3)Plastic Surgery, University of Manitoba, Winnipeg, Canada

### **Background**

Gustillo III fractures are complex injuries requiring both plastic and orthopedic surgical attention. Often, patient stability secondary to co-morbid trauma and wound contamination delay reconstruction. While previous studies have noted that early soft tissue coverage of open lower extremity fractures reduce subsequent infection and non-union rates, the relationship between timing of reconstruction and functional outcomes remains obscure. The present study investigates the association between timing of soft tissue reconstruction and functional outcomes of patients with open lower extremity injuries.

### **Methods**

A retrospective chart review of all patients undergoing soft tissue reconstruction for open lower extremity injuries (Gustillo III) from 2011-2016 at our institution was conducted. Patients were stratified by timing of reconstruction and compared to flap outcomes, orthopedic outcomes, surgical complications, and functional outcomes.

### **Results**

Thirty-one patients met the eligibility criteria for this study this study. Soft tissue reconstruction was performed at less than one week (7 patients, 22.6%), between one and six weeks (17 patients, 54.8%), and after six weeks (7 patients, 22.6%). There was no statistically significant difference in flap failure, post-operative osteomyelitis, post-operative soft tissue infection, and union rates between these three groups. Bivariate correlation of continuous variables revealed no statistical significance between time to reconstruction and rates of bony union, time to partial weight bear, time to full weight bear, and time to return to work.

### **Conclusion**

Timing of reconstruction of Gustillo III lower extremity injuries with soft tissue loss is independent of functional outcomes or post-operative complications. No differences were observed between the timing of reconstruction and flap viability or bony union. Delayed reconstruction does not affect time to weight bear or return to work, and is appropriate for patients unfit for immediate reconstruction.

3:13 PM - 3:18 PM

## **RM 58. Free Flaps for Heel Reconstruction**

*Mayo Clinic, Rochester*

Presenter: Waleed Gibreel, MD

Waleed Gibreel, MD(1), Brian Carlsen, MD(2), Steven L. Moran, MD(2) and Karim Bakri, MBBS(1)

(1)Mayo Clinic, Rochester, MN, (2)Department of Surgery, Division of Plastic Surgery, Mayo Clinic, Rochester, MN

### **Background**

Heel reconstruction is challenging due to the unique functional requirement of this weight-bearing area.

### **Methods**

A retrospective review of all patients who underwent free tissue transfer for heel reconstruction between October 2007 and February 2017.

### **Results**

A total of 145 patients were identified who underwent free flaps for foot and ankle reconstruction. Fifteen (12%) free flaps were performed for weight-bearing heel reconstruction in 15 patients (73% male) at a mean age of 33.8 years. Median follow-up was 13.7 months [IQR 8, 65]. Median BMI at the time of surgery was 28 (IQR 25.3, 30.5). Significant medical comorbidities existed in 9 (60%) patients. The majority of reconstructions were performed for chronic wounds with secondary calcaneal osteomyelitis (n=7), open calcaneal fractures with exposed bone or hardware (n=5), skin cancer excision (n=2), or degloving injury with exposed bone (n=1). Calcaneal defects were noted in 7 (47%) patients.

The gracilis flap was most commonly used (n=9), followed by the latissimus dorsi (n=5) and musculocutaneous anterolateral thigh flap (n=1). The posterior tibial vessels were recipients in 11 cases, and the anterior tibial vessels were used in 4 patients. End-to-side anastomosis was most common (n=9), with end-to-end anastomoses used in the remainder (n=6).

Arterial and venous thrombosis occurred in one flap (gracilis) that was successfully salvaged. All flaps were skin-grafted (immediate in 12 and delayed in 3). Total skin graft loss occurred in 2 latissimus flaps. Delayed wound healing created persistent superficial wounds in 7 (47%) flaps and this was most commonly seen at the interface between the skin graft and the native skin (n=5). . Of the 7 persistent wounds, 5 patients completely healed at a median of 5 months (IQR 3, 7) and 2 wounds persisted at 6 and 38 months of follow up. Recurrent wounds occurred in 5 (33%) flaps at a median of 5.5 months (IQR 1.25, 9.75). Two wounds healed with local wound care, one required flap re-advancement, one continued to recur after short periods of interval healing, and one eventually progressed to recurrent osteomyelitis. All patients were able to ambulate while wearing a pressure-relieving foot orthoses.

### **Conclusion**

Although reasonable results could be achieved with free muscle flaps and skin grafts, there is a high rate of delayed wound healing and recurrent ulcerations.

3:18 PM - 3:23 PM

**RM 59. Does Increased Caprini Score Predict a Higher Rate of Flap Failure in Free Tissue Transfer to the Lower Extremity?**

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**Background** Free tissue transfer is a commonly utilized tool for reconstruction of lower extremity defects. Risk assessment for DVT formation and its relationship to the potential for post-operative free flap venous congestion and overall flap failure has not been adequately evaluated in a U.S. population. We aim to use the Caprini Risk Assessment Model to evaluate the association between deep venous thrombosis (DVT) risk and post-operative flap venous congestion following lower extremity free tissue transfer. **Methods** A retrospective analysis was conducted of all patients who underwent lower extremity free flap reconstruction at a single institution between 2007 and 2016. Patient characteristics, including Caprini score, peri-operative details, and post-operative outcomes were collected from the medical record. The primary outcome was the occurrence of flap venous congestion as associated with individual Caprini score. Secondary outcomes included flap failure, number of vascular anastomoses, and venous thromboembolic events. Patient characteristics, peri-operative details, and Caprini scores were compared between patients with and without complications using Student's t tests and Chi square tests for continuous and categorical variables, respectively. Multivariable logistic regression evaluated each outcome as a function of Caprini scores. **Results** One hundred sixteen patients who underwent lower extremity free flap reconstruction were identified. Mean age was 44.5 years. The majority of patients were male (76.7%) and required reconstruction due to acute trauma (68.1%). The remainder of patients underwent free flap reconstruction for chronic wounds due to osteomyelitis (26.7%) and oncologic defects (5.2%). The mean Caprini score for the entire cohort was 14.9 and was higher among patients with evidence of flap venous congestion (16.8 versus 14.4,  $p=0.021$ ). Caprini scores were also higher among patients with free flap failure (17 versus 14.6,  $p=0.044$ ). After controlling for multiple vascular anastomoses, each one-point increase in Caprini score was associated with increased odds of flap venous congestion (OR 1.13,  $p=0.021$ ) and 18% higher odds of flap failure (OR 1.18,  $p=0.016$ ). The majority of patients received a single arterial anastomosis (93.9%) and a single venous anastomosis (71.5%). Multiple attempts at venous anastomosis were not associated with flap failure ( $p=0.828$ ). There was no significant difference in Caprini scores between those who developed VTE events and those who did not (16.4 versus 14.8,  $p=0.377$ ). **Conclusion** In patients with significantly elevated Caprini scores, there was an association between individual risk for DVT potential and flap venous congestion, as well as flap failure following free tissue reconstruction of lower extremities.