ASRM Scientific Paper Presentations: Microsurgical Practice & Patient Safety
Monday, January 15, 2018, 1:30pm – 2:45pm

1:30 PM - 1:35 PM
RM 84. **Proficiency and Stress of Medical Students Performing Novel Microsurgical Tasks**
The Methodist Hospital Research Institute, Houston
Presenter: Dmitry Zavlin, MD
Dmitry Zavlin, MD(1), Ashik Khatri, PhD(2), Muhsin Z. Uğur, PhD(2), Ioannis T. Pavlidis, PhD(2), Jeffrey D. Friedman, MD(1), Shayan A. Izaddoost, MD, PhD(3) and Anthony Echo, MD(1)
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Background
Stress is a highly complex mechanism with endless implication on human beings. It plays a constant role in surgical specialties, in particular when performing microsurgical procedures. The Yerkes-Dodson 'law' from 1908 states that a person's performance increases with stress up to a point of sudden collapse. Negatively associated stress could therefore have a detrimental impact on the outcomes of microsurgery. In our study, we aimed to evaluate the proficiency and stress of unexperienced medical students performing standardized microsurgical tasks.

Methods
The student surgical societies of three medical schools were contacted for voluntary study participants. Exclusion criterion was experience in microsurgery. After a brief instruction presentation (week 0), the subjects performed two standardized microsurgical tasks, cutting and suturing, using 4.0x microsurgical loupes during a weekly session in our lab (weeks 1-5). Time was recorded and their skills evaluated by an independent reviewer following a global scale. In addition, the State-Trait Anxiety Inventory (STAI) and the NASA Task Load Index (NASA-TLX) were applied to assess both anxiety and workload.

Results
The 13 medical students (9 male, 4 female) had an average age of 23.3 ± 1.3 years and were either first years (9), second years (2), or third years (2). Ability to finish the cutting task within the 10min time limit was high with 12, 13, 13, 13, and 13 students for weeks 1-5, respectively. Their cutting speed increased using 6:25 ± 2:12 min to only 3:18 ± 1:48 min ($p<0.001$) of the available time at the end of the study. 1, 4, 6, 9, and 11 students finished the suturing task within the allocated 20min during weeks 1-5, respectively ($p<0.001$). Suturing speed increased from 19:57 ± 0:12 to 17:52 ± 2:14 ($p=0.009$), as did the average number of successful stitches: 2.2 ± 1.5 to 5.7 ± 1.0 ($p<0.001$). Surgical score for proficiency rose from 14.5 ± 3.1 to 22.3 ± 3.5 ($p<0.001$). Anxiety before ($p=0.248$) and after ($p=0.125$) each weekly session remained stable. Subjective workload decreased consistently for both tasks throughout the study (suturing: $p=0.002$; cutting: $p=0.001$).

Conclusion
As microsurgical experience progresses, novice surgeons are able to both increase speed as well as proficiency in their work even without external guidance. They furthermore begin to perceive the workload as less of a burden. Continuous microsurgical training in the lab remains vital to condition young microsurgeons to the environment in the operating room.

1:35 PM - 1:40 PM

RM 85. **A Reappraisal of the Surgical Planning of the Superficial Circumflex Iliac Artery Perforator Flap**

Shanghai Ninth People's Hospital, Shanghai JiaoTong University, Shanghai
Presenter: Shaoqing Feng, MD. , Ph.D.
Shaoqing Feng, MD. , Ph.D.
Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

Background: The popularity of the superficial circumflex iliac artery perforator (SCIP) flap has been limited by factors such as variable vascular anatomy and short arterial pedicle (Figure 1). The aim of this article is to delineate flap design and harvest strategies based around either the proximal or distal perforators of the superficial circumflex iliac artery (SCIA) (Table 1), and to propose a set of strategies that can help deal with the limitations of the flap.

Methods: From August 2011 to June 2015, the SCIP flap was used in 80 patients for soft tissue defects at our institution. We utilized vessel imaging navigation to get a detailed overview of the vascular anatomy pre-operatively (Figure 2). Flaps were designed based upon either the proximal or distal perforators of the SCIA. Backup strategies and surgical manoeuvres were suggested to solve the problems emerged in operation (Figure 3).

Results: Fifty-one flaps were raised based on the proximal perforators of the superficial branch of the SCIA while 25 cases were based on the distal perforators from the deep branch, and in 4 cases the pedicle was switched to the superficial inferior epigastric artery (SIEA). In 8 cases the arterial pedicle lengthen technique was employed with a maximum length of 10cm. All donor sites were closed directly with inconspicuous scars.

Conclusion: These surgical strategies simplified the intra-operative decision making and overcame the shortcomings of the SCIP flap. We believe that the SCIP flap will has the great potential to become a new workhorse flap in the field of reconstructive surgery.

Table 1 Comparison of flaps based on proximal or distal perforator.

	Flap based on proximal perforator	Flap based on distal perforator
Incision position	Inferior border	Lateral border
Surgical plane	Above the Scarpa fascial plane	Above the deep fascial plane
Original thickness of the flap	Thin (mean, 0.7 cm)	Thick (mean, 1.5 cm)
Original pedicle length	Short (mean, 4.3 cm)	Long (mean, 5.9 cm)
Caliber of perforator	0.3–0.5 mm	0.5–0.8 mm
Numbers of perforators	1–2	1–3
Elongation method through reverse-flow arterial perfusion applicable	Yes	No

Table 1

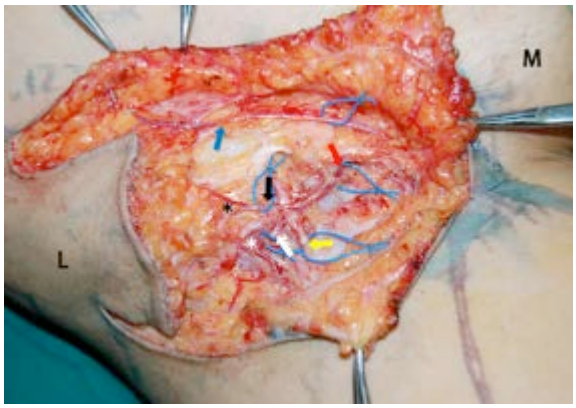

Figure 1

The anatomy of the right groin region. The SCIA (*red arrow*) divides into a superficial branch (*black arrow*) and a deep branch (*white arrow*). The superficial branch gives off several proximal perforators (*black asterisk*) while the deep branch sends out several distal perforators (*white asterisk*). The superficial vein (*blue arrow*) runs from the anterior superior iliac spine to the pubis and must be preserved as the venous drainage of the flap if the concomitant veins are too small. The lateral femoral cutaneous nerve (*yellow arrow*) should not be damaged when dissecting the vessels. *M*, medial side; *L*, lateral side.

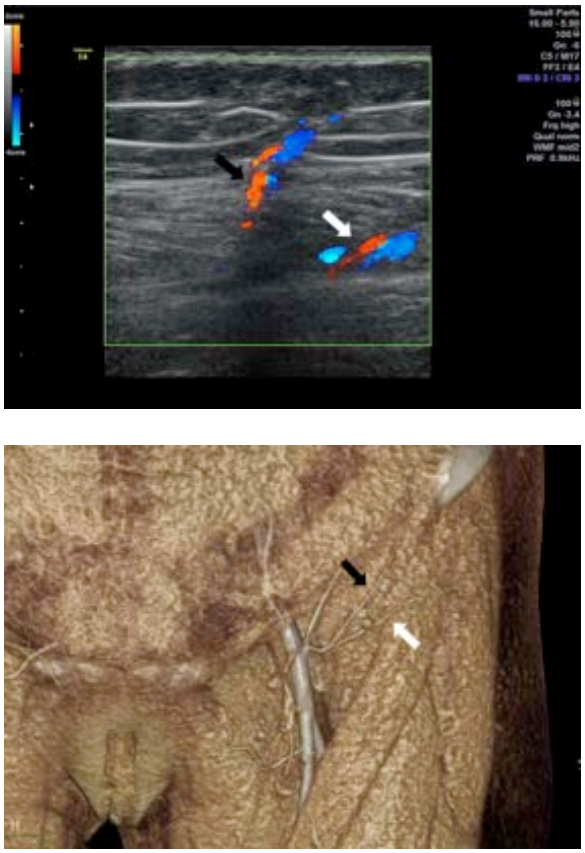

Figure 2

Preoperative color Doppler ultrasound (Above) and CTA image (Below) show the position of the superficial branch (black arrow) and deep branch (white arrow) of SCIA.

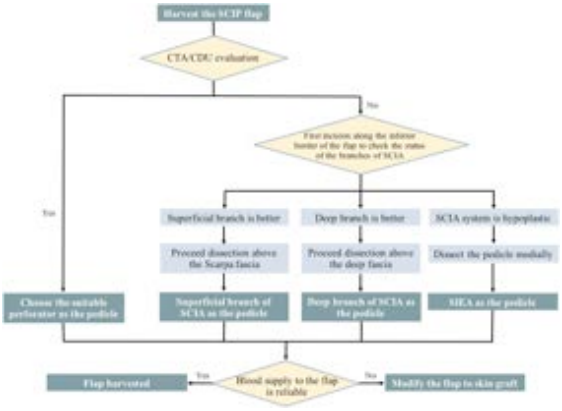

Figure 3

Backup algorithm to the vascular anatomical variation during surgery.

1:40 PM - 1:45 PM

RM 86. **Outcomes Following Coronary Artery Bypass Grafting with Microsurgery in Pediatric Patients**

University of Toronto, Toronto

Presenter: Mark Shafarenko, Medical Student

Mark Shafarenko, Medical Student(1), Joseph Catapano, MD, PhD(2), Glen Van Arsdell, MD(3), Ronald M. Zuker, MD, FRCSC, FACS, FAAP(4) and Gregory H. Borschel, MD, FAAP, FACS(2,5)

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Background

Pediatric coronary artery bypass grafting (PCABG) is performed for critical coronary stenosis. PCABG presents unique surgical challenges for surgeons including the small vessel caliber, small areas of vascular access, and the position and distribution of the coronary vasculature. Serious perioperative complications are common, including arrhythmias, myocardial infarction, and sudden death. To reduce technical complications and improve outcomes, the divisions of Cardiothoracic Surgery and Plastic Reconstructive Surgery at our centre have collaborated during these procedures, to utilize the expertise of the plastic surgeon in performing microvascular anastomosis. We provide a detailed technical description and report our institutional experience for all patients who have undergone PCABG procedures, separately analyzing how these outcomes compare to patients in which microvascular techniques were used.

Methods

The records of all patients who underwent PCABG procedures (either as primary or secondary procedures) from 2000-2017 were retrospectively reviewed. Variables assessed included basic demographic data, diagnosis, pre-operative echocardiography and angiography, details of PCABG and any associated procedures, perioperative complications, graft patency, and clinical and functional outcomes. Left ventricular ejection fraction was compared pre-and post-operatively using a Student's *t* test.

Results

Outcomes were evaluated for a total of 24 patients. The median age was 8.39 years (range, 0.27-16.21 years) and the median weight was 24.2 kg (range, 4.6-71 kg) at operation. Three male and three female patients had microsurgical involvement, comprising the six youngest patients in the cohort, with a median age at operation of 2.01 years (range, 0.27-4.43 years) and a median weight at operation was 10.75 kg (range, 4.6-12.2 kg). Three major anastomotic complications occurred requiring reoperation, although none occurred in the microvascular group. Median follow up was 3.54 years (range, 0.1-12 years) and 5.25 years (range, 1.92-12) for the entire cohort and the microvascular group, respectively. Three patients were symptomatic according to subjective report at last follow-up and two deaths occurred in our series, all in the group without microsurgical involvement. All grafts were patent in both groups. Differences between pre-and post-operative ejection fraction were not statistically different between patients with and without microsurgical involvement.

Conclusion

Our results demonstrate the positive impact of collaboration between cardiac and microvascular surgeons during PCABG procedures, and the subsequent reduction in complications that can be expected. This highlights the broad utility of microsurgical expertise and how these techniques may be used to improve patient outcomes. Larger studies in the future with age-matched controls are required to determine whether microsurgical involvement in PCABG improves outcomes.

1:48 PM - 1:53 PM

RM 87. **Cost Analysis of the Use of a Enhanced Recovery Protocol in Microsurgical Breast Reconstruction**

Hofstra Northwell School of Medicine, Lake Success

Presenter: Kevin Chen, MD

Kevin Chen, MD(1), Matthew A DelMauro, MD(1), Michael Jin, BS(2) and Alex Keller, MD(1)

(1)Northwell Health, Hofstra Northwell School of Medicine, Lake Success, NY, (2)Hofstra Northwell School of Medicine, Hempstead, NY

Background:

With the increased use of microsurgical techniques for breast reconstruction, enhanced recovery protocols for postoperative care in these patients have also gained traction in order to decrease morbidity and increase effectiveness of care. Benefits of these postoperative protocols have been well documented in other surgical specialties[1], however those benefits are only beginning to be revealed in the microsurgical population. The authors sought to evaluate the cost effectiveness of such a protocol in microsurgical breast reconstruction.

Methods:

Retrospective analysis was used on all free flap reconstructions performed by the senior author (A.K.) at a single tertiary center. Postoperative care for all patients was guided by a standardized and comprehensive postoperative protocol (Figure 1). Control group data was collected using pooled complication probabilities and length of stay from literature review through MEDLINE and Cochrane databases. Intraoperative costs were assumed to be equal, and postoperative costs were calculated by decision tree analysis using complication rates, Medicare reimbursement for each complication, and national averages for per day cost of hospital stay.

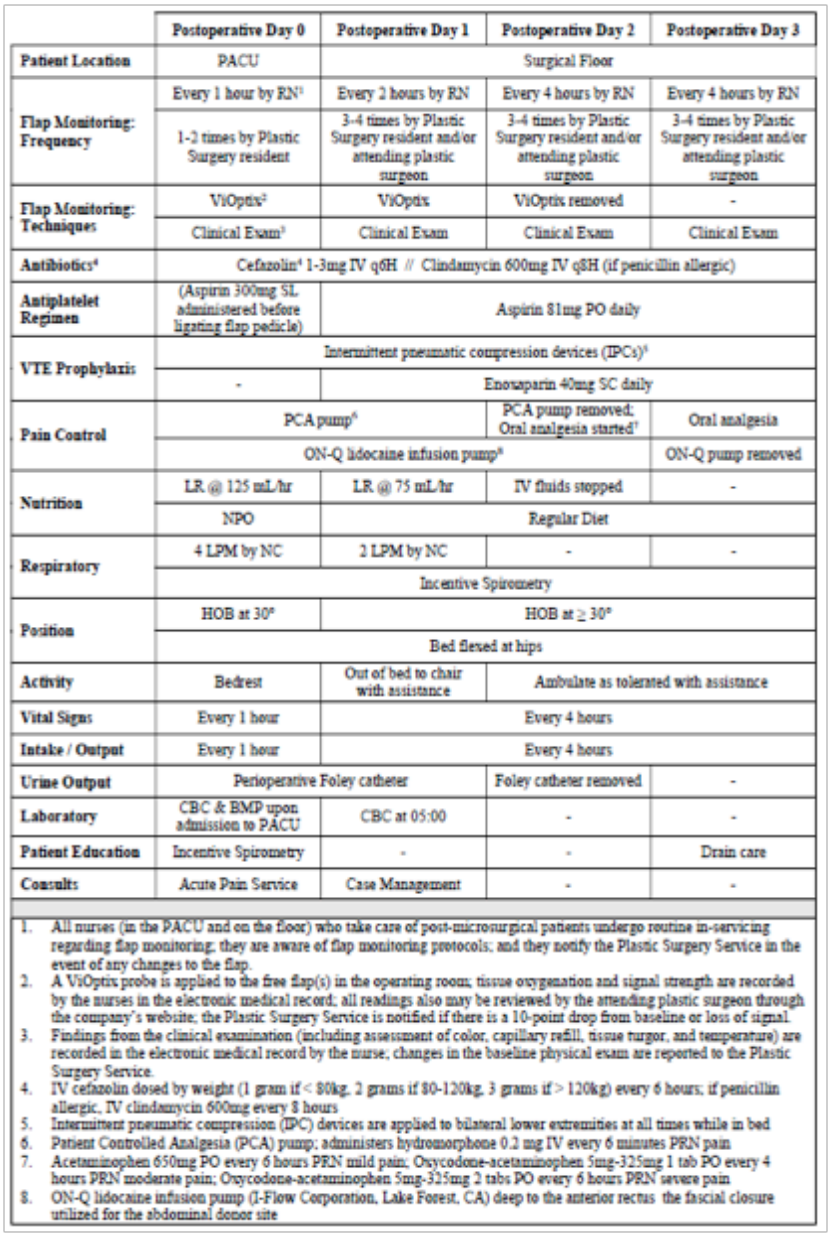
Results

We looked at 289 consecutive microsurgical breast reconstruction patients of the senior author (A.K.) for a total of 499 flaps. The average length of stay was 3.24 days, rate of total complications requiring return to OR was 5.9%, and calculated postoperative costs were $8278. Comparatively, the control group average length of stay was 4.13, the incidence of complications requiring return to OR was 12.4%, and calculated postoperative costs were $10729. The difference in postoperative costs of a patient in the enhanced recovery protocol compared to one in the control group was $2451.

Conclusion:

The use of an enhanced recovery pathway in the postoperative care of patients undergoing microsurgical breast reconstruction is cost effective. In an increasingly cost conscious healthcare landscape, the use of our enhanced recovery protocol improves costs by decreasing hospital stay and carrying a lower rate of complication compared to historical averages.

Figure 1:



	Postoperative Day 0	Postoperative Day 1	Postoperative Day 2	Postoperative Day 3
Patient Location	PACU	Surgical Floor		
Flap Monitoring: Frequency	Every 1 hour by RN[1]	Every 2 hours by RN	Every 4 hours by RN	Every 4 hours by RN
	1-2 times by Plastic Surgery resident	3-4 times by Plastic Surgery resident and/or attending plastic surgeon	3-4 times by Plastic Surgery resident and/or attending plastic surgeon	3-4 times by Plastic Surgery resident and/or attending plastic surgeon
Flap Monitoring: Techniques	ViOptix[2]	ViOptix	ViOptix removed	-
	Clinical Exam[3]	Clinical Exam	Clinical Exam	Clinical Exam
Antibiotics[4]	Cefazolin[4] 1-3mg IV q6H // Clindamycin 600mg IV q8H (if penicillin allergic)			
Antiplatelet Regimen	(Aspirin 300mg SL administered before ligating flap pedicle)	Aspirin 81mg PO daily		
VTE Prophylaxis	Intermittent pneumatic compression devices (IPCs)[5]			
	-	Enoxaparin 40mg SC daily		
Pain Control	PCA pump[6]		PCA pump removed; Oral analgesia started[7]	Oral analgesia
	ON-Q lidocaine infusion pump[8]			ON-Q pump removed
Nutrition	LR @ 125 mL/hr	LR @ 75 mL/hr	IV fluids stopped	-
	NPO	Regular Diet		
Respiratory	4 LPM by NC	2 LPM by NC	-	-
	Incentive Spirometry			
Position	HOB at 30°	HOB at ≥ 30°		
	Bed flexed at hips			
Activity	Bedrest	Out of bed to chair with assistance	Ambulate as tolerated with assistance	
Vital Signs	Every 1 hour	Every 4 hours		
Intake / Output	Every 1 hour	Every 4 hours		
Urine Output	Perioperative Foley catheter		Foley catheter removed	-
Laboratory	CBC & BMP upon admission to PACU	CBC at 05:00	-	-
Patient Education	Incentive Spirometry	-	-	Drain care
Consults	Acute Pain Service	Case Management	-	-

1. All nurses (in the PACU and on the floor) who take care of post-microsurgical patients undergo routine in-servicing regarding flap monitoring; they are aware of flap monitoring protocols; and they notify the Plastic Surgery Service in the event of any changes to the flap.
2. A ViOptix probe is applied to the free flap(s) in the operating room; tissue oxygenation and signal strength are recorded by the nurses in the electronic medical record; all readings also may be reviewed by the attending plastic surgeon through the company's website; the Plastic Surgery Service is notified if there is a 10-point drop from baseline or loss of signal.
3. Findings from the clinical examination (including assessment of color, capillary refill, tissue turgor, and temperature) are recorded in the electronic medical record by the nurse; changes in the baseline physical exam are reported to the Plastic Surgery Service.
4. IV cefazolin dosed by weight (1 gram if < 80kg, 2 grams if 80-120kg, 3 grams if > 120kg) every 6 hours; if penicillin allergic, IV clindamycin 600mg every 8 hours
5. Intermittent pneumatic compression (IPC) devices are applied to bilateral lower extremities at all times while in bed
6. Patient Controlled Analgesia (PCA) pump; administers hydromorphone 0.2 mg IV every 6 minutes PRN pain
7. Acetaminophen 650mg PO every 6 hours PRN mild pain; Oxycodone-acetaminophen 5mg-325mg 1 tab PO every 4 hours PRN moderate pain; Oxycodone-acetaminophen 5mg-325mg 2 tabs PO every 6 hours PRN severe pain
8. ON-Q lidocaine infusion pump (I-Flow Corporation, Lake Forest, CA) deep to the anterior rectus the fascial closure utilized for the abdominal donor site

References

1. Adamina M, Kehlet H, Tomlinson GA, Senagore AJ, Delaney CP. Enhanced recovery pathways optimize health outcomes and resource utilization: a meta-analysis of randomized controlled trials in colorectal surgery. Surgery. 2011 Jun;149(6):830–40.

1:53 PM - 1:58 PM

RM 88. **Standard Fixed Enoxaparin Dosing for Venous Thromboembolism Prophylaxis in Microsurgical Free Flap Patients Results in Subprophylactic Peak Anti-Factor Xa Levels**

University of Pittsburgh, Pittsburgh

Presenter: Shoshana Woo Ambani, MD

Shoshana Woo Ambani, MD, Lee J Varelas, BS, Michael L Gimbel, MD, Vu T Nguyen, MD, Carolyn De La Cruz, MD, Jignesh Unadkat, MD, T. Oguz Acarturk, MD, James M Russavage, MD, Ernest K Manders, MD and Mario G. Solari, MD

University of Pittsburgh, Pittsburgh, PA

Background: Inadequate enoxaparin dosing for venous thromboembolism (VTE) chemoprophylaxis as determined by anti-factor Xa levels (aFXa) has been shown to increase the risk of downstream VTE events in the general plastic surgery population. Free flap patients comprise a high-risk subset of this population, likely due to older age, cancer diagnoses, and longer operative times. This study investigates the adequacy of standard fixed enoxaparin dosing in patients undergoing free tissue transfer.

Methods: In this prospective cohort study, all patients undergoing free flap reconstruction receiving standard fixed enoxaparin dosing for VTE prophylaxis within a 9-month period were followed. Patients were included only if steady state peak aFXa levels were appropriately drawn 3-5 hours after the 3rd postoperative enoxaparin dose. Levels were deemed adequate if within the 0.2-0.4 IU/mL range for BID enoxaparin dosing, or the 0.3-0.5 IU/mL range for daily dosing. Patients were followed for 90-day VTE or bleeding-related events.

Results: Thirty-eight patients met inclusion criteria, with 20 undergoing head and neck (H&N) reconstruction, and 18 undergoing breast reconstruction. There were 22 females (60%) and 16 males (40%). Mean age was 57.3±11.4 (range 33-81), BMI 27.1±5.4 (range 18.7-37.8), weight 77.2±19.7 kg (range 49-135), Caprini score 6.2±1.3 (range 4-10), and surgery time 10.2±2.6 hours (range 5.8-18.2). Starting postoperative day #1, all H&N patients received enoxaparin 30mg SQ BID, while all breast patients received enoxaparin 40mg SQ daily. Twelve breast patients (67%) also received a preoperative dose of enoxaparin. The average peak aFXa level for all patients was subprophylactic at 0.15±0.11 IU/mL (range 0-0.4), 0.010±0.09 IU/mL for H&N patients and 0.20±0.10 IU/mL for breast patients (p=0.0025). Only 5 patients (13%) achieved target aFXa levels, while 33 (87%) were inadequate. Controlling for age, gender, Caprini score, surgery time, and surgical surface area, significant predictors of low aFXa levels were the H&N case type (p=0.030) and higher weight (p=0.0002). Lower weight was the only predictor of achieving target aFXa levels (p=0.0243). The 90-day incidence of VTE was 8% (n=3), flap thrombosis 3% (n=1), and bleeding events 0%. All VTE events occurred in male H&N patients (2 PE's, 1 DVT).

Conclusion: The majority of free flap patients (87%) did not achieve target peak aFXa levels with standard fixed enoxaparin dosing for VTE prophylaxis. H&N patients may be at higher risk than breast patients. Personalized VTE prophylaxis regimens for the microsurgical population, involving weight-based enoxaparin dosing and postoperative dose adjustments, are likely warranted for improved coverage.

1:58 PM - 2:03 PM

RM 89. **Does the Caprini Risk Assessment Model Predict Perioperative Microvascular Thrombosis In High-Risk Patients Undergoing Free Tissue Transfer for Lower Limb Salvage?**

Medstar Georgetown University Hospital, Washington

Presenter: Michael V. DeFazio, MD

Michael V. DeFazio, MD(1), Francis D Graziano, BS(2), Elizabeth Moroni, MHSA(2), Chrisovalantis X. Lakhiani, MD(1), Eshetu Tefera, MS(3), Christopher E. Attinger, MD(1) and Karen K. Evans, MD(1)

(1)Plastic Surgery, Georgetown University Hospital, Washington, DC, (2)Georgetown University School of Medicine, Washington, DC, (3)MedStar Health Research Institute, Hyattsville, MD

Background

The 2005 Caprini Risk Assessment Model (RAM) is a validated tool for stratifying venous thromboembolism risk in plastic surgery patients. While its efficacy in assessing microvascular risk has been suggested previously, data regarding the predictive potential of this model in the setting of microthrombotic complications are limited. The goal of this study was to evaluate the utility of the 2005 Caprini RAM for predicting perioperative microvascular thrombosis in a subset of patients undergoing microsurgical lower extremity reconstruction for advanced limb salvage.

Methods

A single-center, retrospective review was conducted for all consecutive patients who underwent lower extremity free tissue transfer (FTT) between May 2011 and April 2017 by the senior author (K.K.E.). Total Caprini scores were calculated for each patient, in accordance with the 2005 Caprini RAM guidelines, and were used to stratify patients into low (score < 4 points), moderate (score 5 to 7 points), and high-risk (score, > 8 points) cohorts. Logistic regression analysis was performed to examine the relationship between Caprini risk category as well as individual component variables and the development of perioperative microvascular thrombosis, free flap success, and limb salvage.

Results

Total Caprini scores were generated for 120 patients who underwent FTT for complex lower extremity reconstruction. Of these, 49 patients (41%) were categorized as low-risk, 42 (35%) as moderate-risk, and 29 (24%) as high-risk patients. There were no significant differences in overall rates of flap success (94% vs. 88% vs. 79%, p=0.15) or ultimate limb salvage (18% vs. 9% vs. 22%, p=0.34) between cohorts. Compared to low-risk patients, those in the high-risk cohort were significantly more likely to develop microvascular thrombotic complications in the postoperative period (OR, 6.1; p=0.034). Rates of intraoperative thrombosis were statistically similar among cohorts; however, the odds of developing an intraoperative event increased by 20% with every unit increase in Caprini score above 0 (p=0.035). On regression analysis, high Caprini-risk stratification was the only significant predictor of perioperative microthrombotic complications (OR, 5.1; p=0.013). Neither Caprini risk category nor individual component predictors were significantly associated with free flap success or ultimate limb salvage.

Conclusion

The results of this study support the utility of the 2005 Caprini RAM as an adjunct for predicting perioperative microthrombotic complications following microsurgical lower extremity reconstruction. These data should be used to counsel patients regarding their relative risk of microvascular thrombosis and may provide a basis for determining the appropriate strategy for perioperative anticoagulation in the future.

2:06 PM - 2:11 PM

RM 90. **How Standard and Advanced Microsurgery Trainings Influence Microsurgeons Musculoskeletal Symptoms and Workload: A Randomized Controlled Trial**

Mayo Clinic, Rochester

Presenter: Amro M Abdelrahman, MBBS

Amro M Abdelrahman, MBBS(1), Bethany R. Lowndes, PhD, MPH(1), Anita T Mohan, MRCS MBBS(2), William Anding, .(3), Jordyn Koenig, (B.S.)(1), Valerie Lemaine, MD(2), Shelley S. Noland, MD(4), Karim Bakri, MBBS(1), Steven L Moran, MD(2), Samir Mardini, M.D.(5) and Susan Hallbeck, PhD(1)

(1)Mayo Clinic, Rochester, MN, (2)Division of Plastic Surgery, Mayo Clinic, Rochester, MN, (3)Microsurgery Lab, Mayo Clinic, Rochester, MN, (4)Department of Orthopaedics and Sports Medicine, Mayo Clinic, Phoenix, AZ, (5)Plastic Surgery, Mayo Clinic, Rochester, MN

Background: Microsurgery has positively impacted patient outcomes and satisfaction. However, the effect of performing microsurgery on microsurgeon's musculoskeletal health and workload has yet to be studied. Performance-limiting musculoskeletal injuries and illnesses could impact patients' access to microsurgery. Thus, exposures to postural risk factors during standard and advanced microsurgery trainings were studied.

Methods: A randomized controlled trial was conducted in a microsurgery skills laboratory. Participants completed pre-training familiarization and testing, then were randomized to standard or advanced microsurgery training (two sessions each) of two femoral arteries anastomoses (from cutting the artery till the last knot). During the advanced microsurgery training, participants completed the first training session through a narrow cylinder and the second training session though a higher cylinder with the rat tilted 22o from horizontal. Then, participants completed a post-training test. A body-part discomfort questionnaire was completed before and after each session. The questionnaire focused on severity (none, slight, or substantial) of pain, stiffness, or numbness in several body areas and technical problems (mental fatigue, trouble concentrating, irritability and tremor). After each session, the participant completed the NASA-TLX (Task Load Index) with 6 subscales (with 0-20 scale). Chi squire test, t-tests and one way ANOVA on the dependent variables by the training (standard vs. advanced) were performed with $\alpha = 0.05$.

Results: 11 participants (standard=6, advanced=5) completed 44 microsurgery sessions (82% right-handed and 18% are ambidextrous). Demographics and microsurgery experience did not differ significantly between standard and advanced groups (). After the sessions, left arm stiffness and neck stiffness worsened significantly ($p=0.04$ and 0.01, respectively) and mental fatigue and tremor increased significantly over pre-session assessments ($p=0.01$, $p<0.01$, respectively). After microsurgery training sessions, NASA-TLX sub-scales exceeded 50% of scale range (performance and musculoskeletal health hazard threshold) 39-75 % of the time. NASA-TLX subscales did not differ between the standard and advanced ($p>0.05$) except for the frustration level in the first training session (standard=5.67±4.72, Advanced=11±2.12, $p=0.045$). The mental demand and frustration decreased significantly from the first advanced training to the post-training test (95%CI (0.14-9.86), $p=0.04$; (95%CI (0.67-12.13), $p=0.03$, respectively). The effort decreased significantly from pre-training test and the second training to the post-training test (95%CI (0.47-8.72), $p=0.03$, both).

Conclusion:

Microsurgeons reported a high rate of arm and neck stiffness, mental fatigue, tremor and workload after microsurgery. Musculoskeletal symptoms and workload may impact microsurgeon health and microsurgery patient access; thus, ergonomic improvement of the microsurgery layout is necessary.

2:11 PM - 2:16 PM

RM 91. **Preliminary analysis of surgeon body posture and musculoskeletal risk based on patient positioning during microsurgical breast reconstruction**

Mayo Clinic, Rochester

Presenter: Amro M Abdelrahman, MBBS

Lowndes R. Bethany, PhD, MPH(1), Amro M Abdelrahman, MBBS(1), Anita T Mohan, MRCS MBBS(2), Jordyn Koenig, (B.S.)(1), Susan Hallbeck, PhD(1), Shelley S. Noland, MD(3) and Valerie Lemaine, MD(2)

(1)Mayo Clinic, Rochester, MN, (2)Division of Plastic Surgery, Mayo Clinic, Rochester, MN, (3)Department of Orthopaedics and Sports Medicine, Mayo Clinic, Phoenix, AZ

Background: ASRM surgeons recently reported the negative impact from their job on their physical health and work related injuries. In addition to typical operating room (OR) workload, microsurgeons are constrained by the position of the microscope. During microsurgical breast reconstruction with internal mammary artery recipient vessels for anastomosis, we observed variation in surgeon preference for positioning the patient's upper extremity. Therefore, this quality improvement project aimed to determine the impact of patient's upper extremity position on surgeon body posture.

Methods: A convenience sample of seven subjects (4 females) participated in a quality improvement project. To simulate assisting, the microscope and table were adjusted to three standardized heights based on the 5^{th} percentile female, 95^{th} percentile female (~50% male), and 95^{th} percentile male statures. At each of these heights, participants were asked to assume the position required to view the simulated surgical site through the microscope and hold the microsurgery tools at this simulated site for three different arm board conditions (Arm **Tucked**, **In**, and **Out**). The three conditions were repeated with the participant adjusting the bed and microscope height as well (to simulate the primary surgeon). Side and posterior view pictures were captured for each of the 12 positions and analyzed using the validated Rapid Upper Limb Analysis (RULA) to determine musculoskeletal health risk from lowest risk (1) to highest risk (7), where 5-6 is a medium risk with changed advised soon. RULA scores were compared between different arm positions using ANOVA.

Results: The RULA score and neck score were significantly lower for Tucked compared to Out and In ($p<0.001$ and $p=0.013$, respectively). The trunk score was statistically different between all three positions with the lowest score for Tucked ($p<0.001$).

Conclusion: Preliminary results have demonstrated the absence of an arm board during microsurgical breast reconstruction offers a significant improvement in surgeon and assistant's posture. Further investigation is required to better define the musculoskeletal health impact of this posture difference, but highlights potential changes that can be adopted in the OR to positively impact injury prevention and career longevity.

Table 1. Mean and standard deviation for RULA scores by arm position

		Total Score (1-7)	Neck Score (1-6)	Trunk Score (1-6)
Arm Position	Arm Out	5.5 (0.98)	3.3 (1.00)	3.3 (0.55)
	Arm In	5.0 (1.37)	3.2 (1.01)	2.7 (0.55)
	Arm Tucked	3.9 (1.33)	2.5 (1.05)	2.0 (0.59)
Risk Category Key	(1-2) No Risk	(3-4) Low Risk	(5-6) Medium Risk, Change Soon	(7+)High Risk, Change Immediately

2:16 PM - 2:21 PM

RM 92. **Comparison of resident performance, workload and cognitive load after modified microsurgical simulation compared to standard practice sessions**

Mayo Clinic, Rochester

Presenter: Anita T Mohan, MRCS MBBS

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Background: This pilot study investigates how the use of advanced training sessions in microsurgery can translate to improved performance and decrease workload and better prepare trainees for the dexterity, physical and mental workload that is required in the OR.

Methods: A prospective randomized-control study was conducted among surgical residents/fellows at Mayo Clinic. Four sessions were completed over an 8-week period. In session 1 all participants performed two standard femoral artery anastomoses in a rat and then randomized to a control or intervention group. Sessions 1,2 and 3 were identical in the control group. The intervention group completed two anastomoses at two different depths using a 3D printed cylinder (session 2), and then this task was repeated at a set angle (session 3). All participants completed a single standard anastomosis in the final session. Performance was scored using the Stamford SMaRT validated assessment tool with two expert reviewers. Trainee Reaction time was calculated through secondary task (RCAT) and NASA-TLX (Task Load Index) with 6 domains of physical and mental workload at each session. We compared results of session 1 and 4 in both groups.

Results: Sixteen participants were included in the study. There were no differences in demographics, including prior microsurgical experience. SMaRT scores in session 1 were comparable with an average increase of 2.5 by session 4 ($p>0.05$). Although reaction time did not differ between the study groups after session one, the reaction time after the fourth was significantly faster in the advanced training group ($p=0.04$). NASA-TLX in all participants showed a reduction in physical demand, effort and frustration between the first and last session but was not significant. Overall workload NASA-TLX scores between control and intervention were identical post session 1, however final session scores were 58.8 and 48.4 respectively ($P>0.05$). The average decrease in overall perceived workload score in control and intervention groups was 4.1 and 15.6 respectively.

Conclusion: Little is published on mental and physical demands of microsurgery training and the factors that influence them. This study is among the first to review these elements within the context of microsurgical education and simulation training. If an advanced microsurgical simulation is able to more closely simulate challenges of the OR environment (which could be inferred from a lower post-intervention workload and improved cognitive capacity), it would be a valuable education resource Our preliminary results serve as a foundation for ongoing larger prospective studies to evaluate the demands of microsurgical training and practice.

2:24 PM - 2:29 PM
RM 93. **A Novel Robotic Platform Designed for Reconstructive (Super)Microsurgery: Breaking Boundaries**
MUMC+, Maastricht
Presenter: Raimondo Cau, PhD
Tom van Mulken, M.D.(1), Shan Shan Qiu, MD(1), Rutger M. Schols, M.D, Ph.D.(1), Clint Boymans, MD(1), Ferry Schoenmakers, MSc(2), Raimondo Cau, PhD(2) and Rene Van Der Hulst, MD, PhD(1)
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Background

In microsurgery, accuracy is crucial for the quality of the procedure. This accuracy is mainly limited by the surgeon's physical skills. Mastering the techniques of microsurgery requires years of dedicated practice and experience. In general, microsurgery is regarded as one of the most complex disciplines across the surgical domain.

Robotic technology can be of assistance, by enabling higher precision and by reducing issues related to human fatigue, accessibility, and ergonomic posture. The development of robotic technology brings microsurgery into a new era where medical procedures can be performed that go beyond what is currently possible by the human hand.

Currently existing robotic platforms are not particularly designed or dedicated for microsurgical applications and as such do not fulfill the technical requirements necessary for microsurgery.

Methods

Therefore, a new type of microsurgical robot has been developed specifically for reconstructive (super)microsurgery by a long–term collaborative effort of microsurgeons and engineers. This has led to a small-size and versatile solution that is compatible with current operating techniques, micro-instruments and other OR equipment. Essentially, the system is designed for high precision in (super)microsurgical procedures, user-friendly and safe assistance, and cost-efficient use.

Results

First preclinical and clinical results show that the device is feasible for its intended use. A series of preclinical trials involving micro-anastomoses on artificial tissue and animal models has been completed successfully. Secondly, a randomized clinical pilot study is being performed to assess the performance of the device during supermicrosurgical procedures.

Conclusion

Robot-assisted microsurgery using the novel device is found to be a feasible alternative to the conventional manual approach and may be able to advance the field of microsurgery. First results of the device are promising but need to be validated further in more extensive clinical trials. Currently, the potential benefits of device are being validated for multiple microsurgical areas of interest.

2:29 PM - 2:34 PM

RM 94. **Systematic Review and Guidelines for Perioperative Management of Pediatric Free Tissue Transfer Patients**

Albany Medical Center, Albany

Presenter: Paschalia M Mountziaris, MD, PhD

Paschalia M Mountziaris, MD, PhD, Craig T Fournier, MD, Siba Haykal, MD, PhD, Courtney A Carpenter, MD, Kristen M Rezak, MD and Ashit Patel, MBChB

Albany Medical Center, Albany, NY

Background: Microsurgical free tissue transfer has gained popularity for various reconstructive applications in children, with successes reported despite the technical challenge of small caliber vessels. Although several recent publications describe strategies for perioperative care of adult free tissue transfer patients, no guidelines exist for children. The goal of this study was to identify the best available evidence on perioperative management of pediatric patients undergoing free tissue transfer, and to develop evidence-based recommendations to optimize outcomes.

Methods: A systematic review of the literature was conducted in Pubmed, Embase, Scopus, and Cochrane Library databases from inception until June 2017. Two reviewers screened the search results to identify strategies to guide perioperative care of pediatric free tissue transfer patients. Due to the scant, low-level evidence found upon preliminary search of the pediatric microsurgical literature, both pediatric anesthesia guidelines for healthy children undergoing major surgeries as well as specific studies of pediatric free tissue transfer patients were included.

Results: 170 articles were selected, their full text was reviewed, and 47 articles met criteria. Reasons for exclusion included vague / absent descriptions of perioperative care parameters, case reports, and studies of syndromic or chronically ill children. Management approaches specific to the pediatric population were identified, classified according to level of evidence (LOE), and used to formulate recommendations in six categories: patient temperature, anesthesia, fluid administration/blood transfusion, anticoagulation, and vasodilator use (see Table).

Conclusion: High quality (LOE 1) data was found for all but patient temperature (LOE 3) and vasodilator use (LOE 4) in the pediatric anesthesia literature, while the microsurgical literature provided LOE 3 data for anesthesia and analgesia, and LOE 4 data for all other categories. Key recommendations include administration of sevoflurane to induce general anesthesia, with supplemental regional blocks placed under ultrasound guidance (LOE 1). Regional sympathetic blockade improves outcomes in upper extremity microsurgery, and should be continued for postoperative pain control (LOE 3). A multimodal analgesia strategy should be implemented including NSAIDs (LOE 1). Preoperative fasting should be limited to 2-6 hours (LOE 1). Isotonic crystalloid should be used perioperatively (LOE 2), and transfusions restricted until hemoglobin <7 g/dl (LOE 1). Venous thromboembolism prophylaxis administration should be based on risk assessment, with chemical prophylaxis reserved for high risk patients, ideally with low molecular weight heparin (LOE 1). These guidelines serve as an important first step toward standardization of perioperative care in pediatric free tissue transfer to improve outcomes and minimize complications.

SUMMARY OF EVIDENCE-BASED RECOMMENDATIONS

Factor	LOE	Recommendation
Temperature	**3***	**Monitor temperature frequently intra-operatively.**
	4	**Consider warming the operating room for temperature ≥ 27°C.**
	4	For children ≤2 years old, maintain core body temperature at 38°C
	5	Maintain core body temperature >36°C at all times
Anesthesia	**1***	**Consider sevoflurane for general anesthesia (GA)**
	1*	**Use ultrasound guidance to place regional blocks and epidurals.**
	3*	Only supplement GA if an experienced anesthesiologist is available.
	3	**Implement sympathetic blockade during upper extremity microsurgery**
	4	Use epidural anesthesia for lower extremity procedures
	5*	Avoid IV induction of general anesthesia.
Fluids & Blood Transfusions	**1***	**Preoperative fasting durations should adhere to the 2-4-6 rule.**
	1*, 4	**Restrict transfusions until hemoglobin <7g/dl or patient symptomatic.**
	2*	Administer isotonic crystalloid to maintain perioperative normovolemia but avoid fluid overload. Limit glucose supplementation.
	2*	Limit perioperative colloid use.
	4	Maintain fluid supplementation for 5-7 days postoperatively.
Analgesia	**1***	**Utilize a multimodal strategy including NSAIDs ± acetaminophen.**
	3	**Consider regional blockade for postoperative pain control**
Anti-coagulation	**1*, 4**	**Administer venous thromboembolism prophylaxis (VTE ppx) based on risk assessment; reserve chemical prophylaxis for high risk**
	1*, 4	**Consider low molecular weight heparin instead of dextran for VTE ppx**
Vasodilators	**4**	**Consider topical verapamil or lidocaine to treat vasospasm**

* Indicates evidence based on pediatric patients undergoing major surgery, not specifically free tissue transfer.