TUESDAY SURGICAL EDUCATION

10:15 AM - 10:20 AM

RM134 Development of a High Fidelity Microvascular Surgery Simulation Platform for Resident Training

Virginia Tech Carilion School of Medicine, Roanoke

Presenter: **Matthew Joy, MD**

Matthew Joy, MD(1), Brian Fletcher, MD(2), Jaime De La Ree, PhD(3) and Anthony Capito, MD(1)

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Background

Microsurgery requires a high level of skill achieved only through guided practice and repetition to achieve proficiency. Learning curves are steep and studies have suggested that trainees must perform at least 50 procedures to achieve results comparable to the well-trained provider. These skills are a core part of plastic surgery training, thus it is essential that residents have sufficient opportunities during training to learn safe and effective microsurgical techniques. Due to current duty-hour restrictions and supervision requirements plastic surgery residents are becoming more reliant on opportunities for hands on training outside of the operating room to develop these skills. It is well established that simulation training significantly improves knowledge and technical skills in both operative and non-operative settings. Numerous models for microvascular simulation have been described utilizing both synthetic and tissue-based materials; however, virtually all of these models lack the combination of human tissue and pulsatile flow.

Methods

The authors, based on previous experience with a model for vascular surgery simulation training, designed and built a high-fidelity microvascular simulation platform using cryopreserved human vein grafts and a pulsatile flow generator. The platform utilizes relatively inexpensive and readily available materials including a finished plywood platform, plastic tubing, hose clamps, hose connectors and a 9-volt battery and pump system to create a simulated vascular circuit with adjustable pulsatile flow. The pulse generator was designed to recreate biphasic pulsatile flow with controls to adjust pulse rate and ratio of systole to diastole.

Results

The use of human cryopreserved vein and adjustable, biphasic, pulsatile flow allows for practice of techniques to control hemorrhage in the surgical field, to assess and address a leaking anastomosis, and to evaluate anastomotic patency during microsurgical simulation resulting in a highly realistic training experience.

Conclusion

The combination of human tissue and pulsatile flow results in a simulation that approaches the level of realism achieved with live-animal models. As a result, this simulation platform has the potential to allow plastic surgery residents to gain more proficiency and confidence in microsurgical techniques without the need for expensive animal labs or any additional risk to patients.

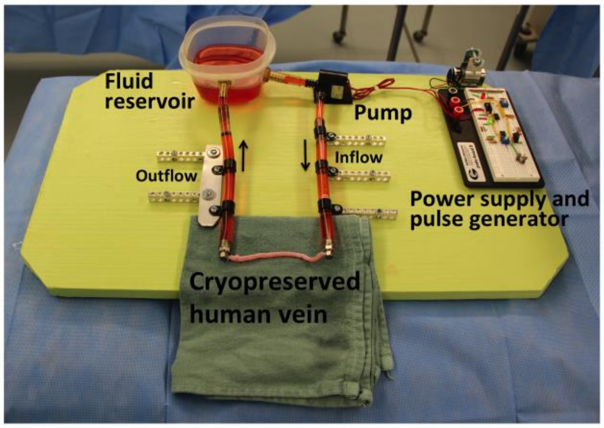

Figure 1. Fully assembled simulation platform with pulsatile flow circuit through cryopreserved human saphenous vein graft

10:20 AM - 10:25 AM

RM135 Analysis of Microsurgical Outcomes in Resident-Led Reconstruction: A Review of 163 Consecutive Cases

University of Texas Southwestern Medical Center, Dallas

Presenter: **Min-Jeong Cho, MD**

Min-Jeong Cho, MD and Andrew Y Zhang, MD

University of Texas Southwestern Medical Center, Dallas, TX

Background

With the advances in microsurgery, the published success rate of microsurgical reconstruction by experienced microsurgeon is greater than 95%. However, it is unknown whether the training residents can produce similar results. At our county hospital, while under direct supervision residents perform and lead all aspects of microsurgical reconstruction, from raising the flap to performing microanastomoses, with only as needed faculty assistance. In this study, we retrospectively reviewed the outcomes of 163 consecutive microsurgical cases to determine the efficacy and safety of resident-led reconstructions at the county hospital.

Methods

We performed a retrospective review of patients who underwent microsurgical reconstruction at the county hospital from 2016 to 2018. Demographic, surgical procedure, flap data, resident levels, and complication data were collected.

Results

Of the 163 flaps performed, the most commonly performed reconstruction was breast (63.8%), followed by lower extremity (11.7%), upper extremity (6.7%), head and neck (6.1%), and genital (1.2%). The median procedure time was 540 minutes (240 – 990) and anastomoses time for each flap was 57 minutes (27 – 180). The venous anastomoses were performed by PGY3 (1.6%), PGY4 (37.1%), PGY5 (3.2%), and PGY6 (58%) while the arterial anastomoses were performed by PGY4 (18%), PGY5 (3.3%), and PGY6 (78.7%). The average number of anastomosis attempts was 1.3 with a range of 1 to 3. The total flap success rate was 96.3% with a takeback rate of 4.3%.

Conclusion

In conclusion, our analysis shows that resident-led reconstruction can achieve similar microsurgical success as the published rates. We believe resident-led microsurgical reconstruction can be safely performed with as needed faculty assistance in high-risk and complicated cases while allowing resident education and maturation of technical and decision-making skills.

10:25 AM - 10:30 AM

RM136 Impact of Difficulty Level on Resident Performance, Cognitive Capacity and Workload in Microsurgery Simulation Training

Anita T Mohan, Rochester

Presenter: **Anita T Mohan, MRCS MBBS**

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Background: Training at varied difficulty levels may increase the trainee's proficiency level in performing the tasks and minimize the risk of conducting errors. This pilot compares difficulty level on trainees' overall performance, cognitive capacity and workload in microsurgery simulation.

Methods: Sixteen surgical trainees were prospectively randomized into intervention and control groups. Each completed four sessions over 8-weeks. Session 1: all participants performed two standard rat femoral artery anastomoses (level 1). Sessions 2-3: Control group completed two level 1 microanastomoses; Intervention group performed four increasingly difficult microsurgical anastomoses at two different depths (levels 2 and 3), then repeated at a set angle (levels 4 and 5) with two tasks performed per session. Session 4: Both groups completed a final level 1 anastomosis. Outcome measures include Stanford Microsurgery and Resident Training (SMaRT) validated performance scores by two blinded reviewers; Rapid Cognitive Assessment Tool (RCAT) pre- and post-anastomosis to evaluate cognitive capacity, and at the end of each session NASA-Task Load Index (TLX) workload scores were recorded.

Results: The control group had consistent performance scores across sessions ($p>0.05$), however in the intervention group, increased difficulty (levels 2-5) was associated with lower performance scores compared to standard (level 1) femoral anastomosis ($p<0.01$, levels 2-4, $p=0.03$ level 5). Lower SMaRT performance scores were associated with increased mental and physical NASA-TLX workload ($p<0.001$). Although there was no statistical difference between control and intervention in the final session ($p=0.22$), SMaRT performance scores had an average improvement from Session 1 of 2.6 in control ($p=0.03$) and 3.6 in intervention ($p<0.001$) groups. Increased difficulty level was associated with higher mental and physical workload and Level 4/5 tasks demonstrated the highest workload compared to the first ($p=0.01$) and final session ($p=0.002$). RCAT performance scores during sessions 2-3 demonstrated a 23% deterioration in scores in the intervention group following the second anastomosis in difficult training sessions representing reduced cognitive capacity, but not statistically significant ($p>0.05$); In contrast, controls showed improved cognitive capacity when continuing to practice level 1 tasks during the sessions 2-3, ($p>0.05$).

Conclusion: Increased task difficulty is associated with greater workload, lower performance and cognitive capacity during training. However, trainees who practiced on progressively more difficult tasks had greater performance improvement, reduced mental and physical workload when resuming basic level tasks compared to those who practiced a single basic difficulty level. Further research is required in this field but may provide future directions in microsurgical training and trainee preparedness for the OR.

10:35 AM - 10:40 AM

RM137 Indocyanine Green Microangiography in the Cadaveric Model: A Technique for Microsurgical Simulation

Georgetown University Hospital, Washington

Presenter: **Chrisovalantis X. Lakhiani, MD**

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Background

Realistic microsurgical simulation models can help surgical residents practice technically demanding skills in safe environments. Prior studies have used indocyanine green (ICG) microangiography to mimic physiologic tissue perfusion, in the setting of an artificially perfused cadaveric system, for simulation of microvascular procedures.[1,2] However, ICG microangiography has not been attempted for the in-situ assessment of raised flaps in the cadaveric model. Here we attempt to show the feasibility and reliability of ICG microangiography as a method of flap assessment in the cadaveric model.

Methods

Three fresh frozen cadavers were obtained from our institution's willed body program. After flap dissection was performed, the afferent vessel was cannulated with an 18 or 22-gauage IV catheter. A one-liter solution of lactated ringer's solution on a pressure bag, or via manual compression, was hung and connected to the IV tubing. The ICG was administered as a secondary infusion into the flap and allowed to drain via the efferent vessel into a collecting basin. The *SPY Elite* imaging system was used to capture and record the fluoroscopic image.

Results

Two mid-level plastic surgery residents participated in raising cadaveric flaps. Flaps raised included 5 anterolateral thigh, 5 superficial circumflex iliac artery perforator, and 5 radial forearm flaps. Perfusion was then assessed using indocyanine green angiography. Of 15 flaps, 13 were raised successfully and 2 were not owing to technical misadventure, which was identified by ICG leakage through transected of avulsed vessels. This provided opportunity for teaching and refinement in technique.

Conclusion

ICG microangiography is a feasible and reliable method of assessing flap perfusion in the cadaveric model. Consequently, it can be a valuable tool for practicing microsurgical techniques outside of the operating room.

References

1. Carey JN, Rommer E, Sheckter C, Minneti M, Talving P, Wong AK et al. Simulation of plastic surgery and microvascular procedures using perfused fresh human cadavers. J Plast Reconst Aesthet Surg. 2014;67(2):e42-8.

2. Carey JN, Minneti M, Leland HA, Demetriades D, Talving P. Perfused fresh cadavers: method for application to surgical simulation. Am J Surg. 2015;210(1):179-87.

Figure 1. Single Perforator Anterolateral Thigh Flap

Figure 2. Superficial Circumflex Iliac Artery Perforator (SCIP) Flap

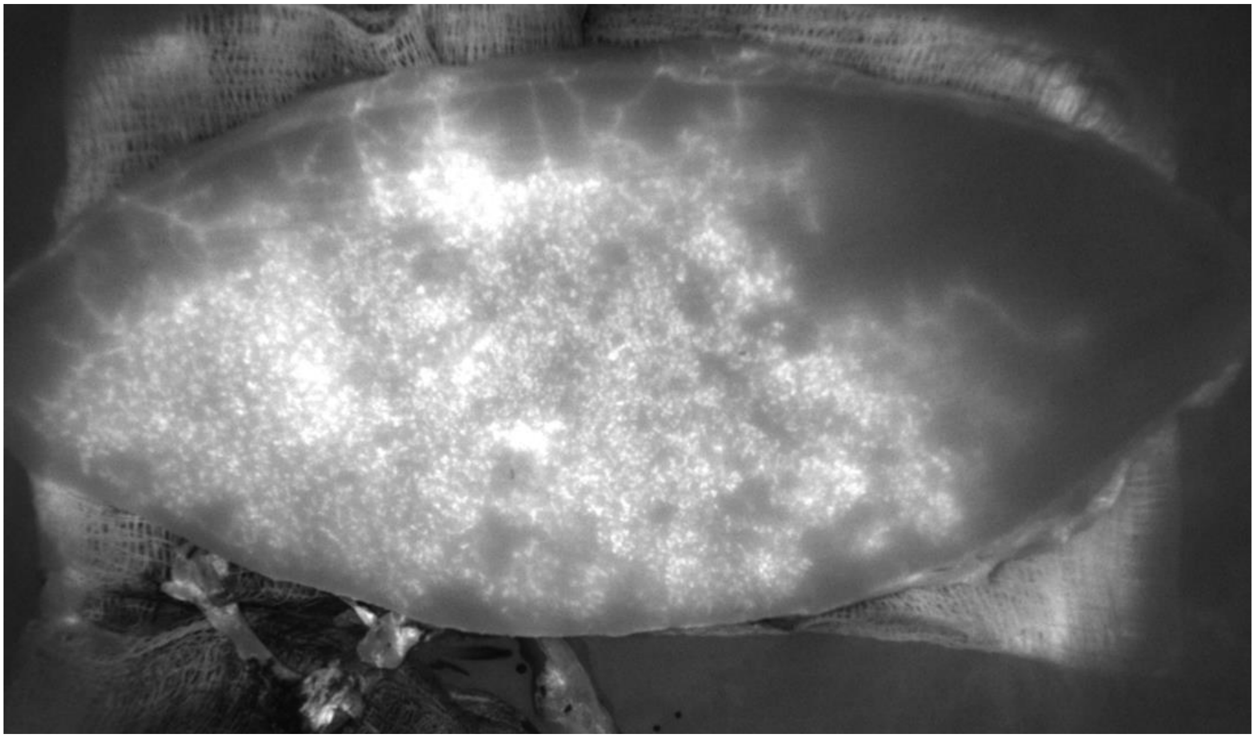
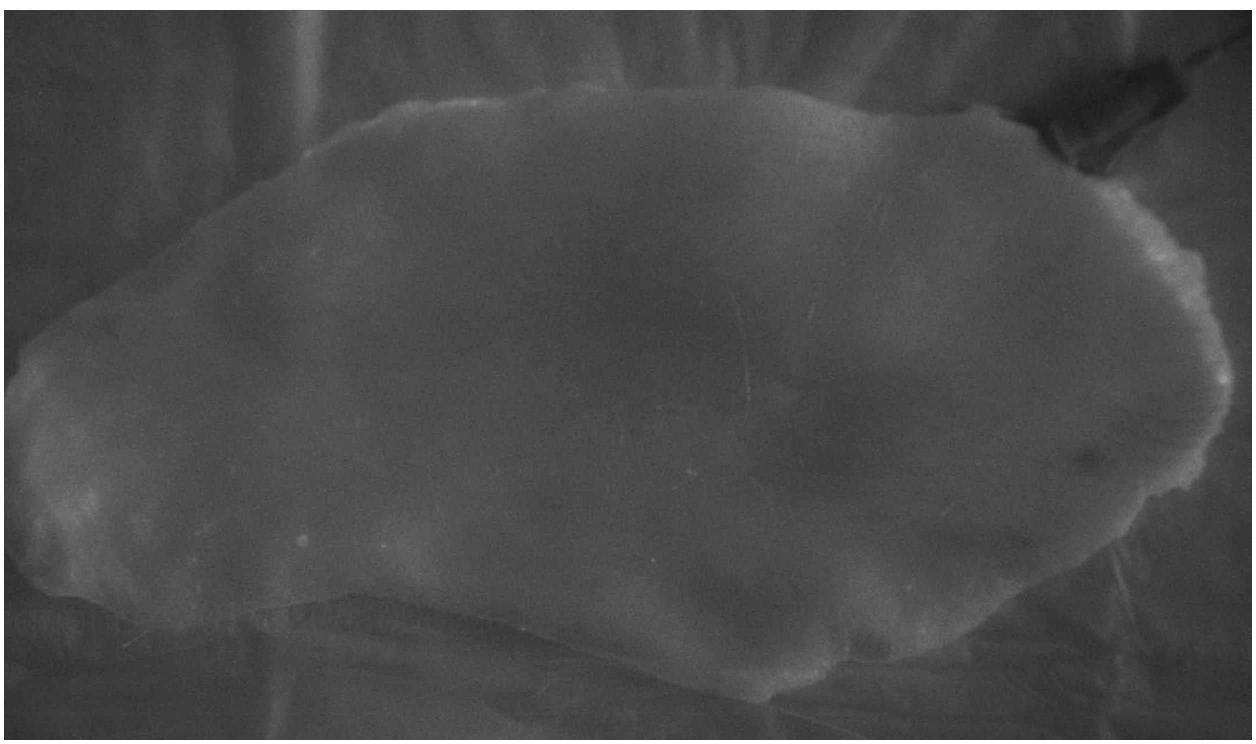


Figure 3. Failed SCIP Flap Harvest



10:40 AM - 10:45 AM

RM138 Multidisciplinary Microsurgical Simulation Course Utilizing the "Blue-Blood" Chicken Thigh Model Significantly Enhances Resident Education, Confidence, and Attitudes

The University of Wisconsin-Madison, Madison
Presenter: **Nikita O. Shulzhenko, BA**
Nikita O. Shulzhenko, BA, Sarah M. Lyon, MD, Weifeng Zeng, MD, Aaron M. Dingle, PhD and Samuel O. Poore, MD, PhD
University of Wisconsin - Madison, Division of Plastic and Reconstructive Surgery, Madison, WI

Background: Current microsurgical education models are either cost-ineffective, unrealistic, or carry ethical implications, and are all practiced within bastions of single specialties. We aimed to test the use of our solution to these limitations—the "Blue-Blood" Chicken Thigh Model, a simple method of perfused living-tissue simulation—on resident education within a novel day-long multidisciplinary microsurgical experience.

Methods: A 10-hour microsurgical course was developed integrating didactic lectures and case presentations from three surgical subspecialties, followed by one-on-one practical sessions utilizing hydrogel microvessels and the "Blue-Blood" Chicken Thigh Model. Informed consent, pre- and post-course surveys were obtained from attendees. Inferential statistics were performed using the Wilcoxon signed-rank test.

Results: Ten sets of surveys were collected (100% response rate). Respondents varied between Post-Graduate Year 3 (PGY-3) and PGY-7 and represented Plastic and Reconstructive Surgery (N=6), Urology (N=3), and Otolaryngology (N=1). An average of four end-to-end, 1.5 end-to-side, and 0.3 coupler-assisted anastomoses were performed per attendee. Following the course (Table 1), participants felt significantly more comfortable operating a microscope (Z=-2.805, P=0.005) and handling microsurgical instruments (Z=-2.191, P=0.028), and felt significantly more confident handling tissues (Z=-2.395, P=0.017), manipulating needles (Z=-2.499, P=0.012), microdissecting (Z=-2.805, P=0.005), performing end-to-end (P=0.002) and end-to-side anastomoses (Z=-2.803, P=0.005), using an anastomotic coupler (Z=-2.521, P=0.012), and declaring anastomoses suitable (Z=-2.312, P=0.021). All but one participant (Table 2) believed that "blue-blood" vessels were "very much" or "incredibly" more realistic compared to hydrogel microvessels (Median Likert Score (MLS) ± Median Absolute Deviation (MAD): 3.48±0.50). Fifty percent of participants believed that the use of live animals in the course would have "not at all" improved their learning (MLS±MAD: 0.96±0.58). All but one participant significantly improved their awareness of the value of microsurgery in other specialties "very much," with two believing it to have been improved "incredibly" (MLS±MAD: 3.53±0.21).

Conclusion: The "Blue-Blood" Chicken Thigh Model is a highly realistic microsurgical simulator which offers a suitable *in-vivo* experience without traditionally associated disadvantages. Its use within a microsurgical training course significantly improves resident comfort and confidence in core operative domains. Given the shared foundational knowledge requisite in microsurgery, interdisciplinary training experiences nurturing otherwise unlikely one-on-one learning opportunities and interspecialty collaboration.

Table 1. Pre- and Post-Course Survey Result Comparisons by Wilcoxon Signed-Rank Test (*N* = 10).
Likert Descriptors: 0-1 "Not At All", 1-2 "A Little", 2-3 "Somewhat", 3-4 "Very Much", 4-5 "Incredibly"

Response Domain	**Pre-Course**		**Post-Course**		**MLS Change**	***Z* Statistic**	***P* Value**
	MLS	**MAD**	**MLS**	**MAD**			
Anxiety Performing Supervised Microsurgery	2.44	0.31	1.53	0.54	-0.92	-1.326	0.185
*Microscope Operation Comfort	2.46	0.54	3.34	0.26	0.88	-2.805	0.005
*Instrument Handling Comfort	2.79	0.46	3.13	0.34	0.34	-2.191	0.028
*Needle Manipulation Confidence	2.50	0.49	3.36	0.35	0.87	-2.499	0.012
*Vessel Microdissection Confidence	1.53	0.92	2.81	0.32	1.28	-2.805	0.005
*Safe Tissue Handling Confidence	2.26	0.85	3.34	0.16	1.08	-2.395	0.017
*End-to-End Anastomosis Confidence	1.95	0.75	3.25	0.44	1.31	†	0.002
*End-to-Side Anastomosis Confidence	1.49	0.69	2.21	0.36	0.72	-2.803	0.005
*Anastomotic Coupler Use Comfort	1.58	1.08	2.78	0.78	1.20	-2.521	0.012
*Declaring Suitable Anastomosis Confidence	2.34	0.69	3.35	0.21	1.01	-2.312	0.021
*Value of Microsurgery within Specialty	4.42	0.07	4.49	0.21	0.07	†	0.008
Value of Simulation for Operative Training	3.85	0.41	4.07	0.49	0.22	-0.700	0.484
Likelihood of Positive Influence of Microsurgery on Future Career Decisions	3.58	0.81	3.53	0.51	-0.05	†	0.727

MLS, Median Likert Score; MAD, Median Absolute Deviation; *, <.05; †, Statistical analysis performed with non-parametric Sign test given non-symmetry of difference distribution for Wilcoxon Signed-Rank test

Table 2. Participant responses to reflection questions following the training course.
Likert descriptors: 0-1 "Not at All", 1-2 "A Little", 2-3 "Somewhat", 3-4 "Very Much", 4-5 "Incredibly"

Reflection Question		**MLS**	**MAD**
Q1:	**"Blue-blood" vessels**, despite being blue, were ______ **more realistic** as compared to the fake vessels.	3.48	0.50
Q2:	The **use of live animals** (e.g. rat, pig, etc.) in this course would have **improved my learning:**	0.96	0.58
Q3:	This course has **improved my awareness** of the **value of microsurgery in other specialties:**	3.53	0.21
Q4:	The **knowledge** I have learned in this course will **improve what I am able to gain from future operative experiences:**	3.70	0.26
Q5:	The **skills** I have learned and/or practiced in this course will **improve what I am able to gain from future operative experiences:**	3.92	0.43

MLS, Median Likert Score; MAD Median Absolute Deviation.

10:45 AM - 10:50 AM

RM139 Musculoskeletal Pain and Ergonomics Among Plastic Surgery Residents: Results of a National Survey and Analysis of Contributing Factors

Johns Hopkins University, Baltimore

Presenter: **Georgios Kokosis, MD**

Georgios Kokosis, MD(1), A. Lee Dellon, M.D., Ph.D.(2), Scott T. Hollenbeck, M.D.(3), Bernard T. Lee, MD, MBA, MPH, FACS(4) and Devin Coon, MD, MSE(5)

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Background

Musculoskeletal symptoms and injuries among surgeons are under-estimated, but are increasingly recognized to constitute a major problem with reported prevalence of symptoms and of true injuries approaching 80% and 27% respectively. This is thought to be the result of accumulation of damage to the body throughout cumulative years of practice. However, it has not been established when symptoms start and what factors contribute to the development and progression of symptoms.

Methods

A 19-question survey approved by our institution`s IRB and ACAPS was sent to all plastic surgery residents. The presence of various musculoskeletal symptoms was calculated and predictors of these symptoms were evaluated. Respondents were asked how often they have pain after operating and categorized into frequent/symptomatic (“every case”/“often”) versus asymptomatic (“not often”/“never”). Assessment of dichotomous variable predictors was performed using logistic regression with ordered logistic regression for multilevel ordered variables (e.g., PGY level).

Results

We received 104 total responses. 94% of residents had experienced musculoskeletal pain in the operating room. The neck was the most commonly affected area (54%) followed by the back (32%) and extremities (12%). Interestingly, 52% of responders developed these symptoms during the first two years of their residency. Furthermore, increasing PGY level ($p = 0.3$) and independent versus integrated status ($p = 0.6$) had no correlation with pain, suggesting that symptoms began early in training.

Pain symptoms were frequent for 47%, while 5% reported experiencing symptoms during every case. The use of a headlight correlated with frequent pain (OR=2.5, $p=0.027$). The use of microscope and loupes did not correlate with frequent pain. Eighty-nine percent of responders were aware of having bad surgical posture, but only 22% had received some form of ergonomics training at their institution. 64% of responders believe that the operating room culture does not allow them to report the onset of symptoms and ask for adjustments. This was more common among residents reporting frequent pain (OR 3.12, p=0.009).

Conclusion

Plastic surgeons are at high risk for occupational symptoms and injuries. Surprisingly, symptoms start early during residency and are not simply related to complex cases such as microsurgery. Eighty-nine percent of residents believe they have poor surgical posture and almost half report frequent pain after operating, yet the majority do not receive formal ergonomics training. As residents are aware of the problem and looking for solutions, this suggests an opportunity for educational intervention to improve the health and career longevity of the next generation of surgeons.

10:50 AM - 10:55 AM

RM140 Nursing Monitoring of Microsurgical Free Flaps: Identifying and Addressing Knowledge Gaps

University of Nevada, Las Vegas School of Medicine, Las Vegas
Presenter: **Ashish Francis, MD**
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Background

Microsurgical free flaps require careful monitoring to detect early signs of compromise. At many hospitals, nurses provide the majority of postoperative monitoring on free flap patients and are charged with alerting physicians to a failing free flap. The aim of this study is to identify knowledge gaps in free flap monitoring in both experienced and novice nurses and to provide free flap education to address those gaps.

Methods

A pilot survey was administered to identify knowledge deficiencies in nurses monitoring free tissue transfers. A PowerPoint-based nursing in-service on free flap monitoring and patient care was then designed to address these deficiencies. An 18-question multiple choice quiz was administered before and after the in-service. Pre- and post-test scores were compared based on experience and nursing unit. At six months, the participating nurses completed a survey rating their confidence with free flap patient care as a result of the in-service.

Results

A total of 72 nurses completed the in-service training course and quiz. The average quiz score increased from 62% to 89% after the in-service ($p<0.05$). Nurses working in our free flap monitoring unit scored an average of 73% on the pretest, while nurses outside this unit scored 55% ($p<0.05$). The follow up survey showed that prior to the course 38% of respondents reported no confidence or little confidence with free flaps, decreasing to 6% after the course ($p<0.05$).

Conclusion

There were significant gaps in nursing knowledge identified in this study with improvement seen after completion of our in-service course. Our survey shows an increase in nursing confidence after the in-service, but it remains to be seen if the changes in nursing confidence and knowledge positively impact patient care and flap outcomes. Future studies will be undertaken to examine patient outcomes by looking at free flap complication and salvage rates to assess the impact of this training model in the clinical setting. In addition, this model for nursing education can be utilized when establishing microsurgical programs in community hosp