



ASRM Concurrent Scientific Paper Presentations: Microsurgical Practice

January 17, 2016 – 7:15 AM to 8:15 AM

7:15 AM - 7:20 AM

Abdominoperineal Resection Reconstruction: Indications and Outcome of a Single Institution 7-year Experience

Stanford University, Stanford, CA, USA

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Abdominoperineal resection (APR) is the standard surgery of low lying rectal cancers, severe inflammatory bowel disease, and other perineal malignancies. Colorectal surgery most often closes the defect primarily; however, Plastic and Reconstructive Surgery (PRS) is commonly involved in reconstruction. Indications and choice for reconstruction are debatable. Identifying candidates for reconstruction and evaluating outcomes for reconstructive options is pertinent to determine which patients may benefit from PRS involvement.

A retrospective chart review was performed on all patients undergoing APR at our institution between 2007-2013. Data points included demographics, disease, operative position, and postoperative complications. Outcomes of interest included perineal healing and complications of donor and recipient sites.

178 APRs were performed, of which 51 involved PRS. Factors significant for PRS involvement included female gender (57% v. 36%, $p=0.0183$), prior history of smoking (27% v. 12%, $p=0.0141$), neoadjuvant chemoradiation (88% v. 61%, $p=0.0003$), and anal squamous cell carcinoma (SCC) (31% v. 2%, $p<0.0001$). The most frequent reconstruction was gluteal advancement flap ($n=26$) followed by pedicled gracilis flap ($n=16$) and pedicled vertical rectus abdominus muscle flap (VRAM) flap ($n=9$). Operative positioning was a predictor for type of reconstruction. All gluteal advancement flaps were performed with the patient in the prone position ($p<0.001$), while all VRAMs were performed supine/lithotomy ($p=0.05$). Gracilis reconstruction showed no significant positioning bias. Despite higher rates of neoadjuvant chemoradiation, complication rates between the reconstruction and primary closure were equivocal. When comparing modes of reconstruction, perineal incision specific complication rates were higher with gluteal flaps compared to primary closure (50% v. 26%, $p=0.0196$). Only VRAM reconstruction demonstrated a lower complication rate compared to primary closure (22% v. 60%, $p=0.0366$).

Successful reconstruction following APR is dependent upon careful consideration of individual patient variables. While the majority of APRs will not need PRS involvement, cases involving female gender, vaginectomy, neoadjuvant chemoradiation, or SCC may benefit from reconstruction. Despite higher rates of neoadjuvant chemoradiation, complication rates between reconstructed patients and primary closure were equivalent. VRAMs had the greatest reduction in complications. Gracilis flaps were successful and are available despite intraabdominal access. Gluteal advancements had the highest complication rates compared to other forms of reconstruction. Based on these findings, the supine position has excellent reconstructive options of either the VRAM if intraabdominal access is available or the gracilis if intraabdominal access is limited. However, the prone position presents a more difficult challenge with the gracilis flap being the preferred choice over gluteal advancement flaps.

7:20 AM - 7:25 AM

Contribution of Reconstructive and Microvascular Surgery to Hospital Based Care in the United States

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Introduction: As national healthcare policy efforts encourage the formation of multispecialty organizations that will be reimbursed for episodes of care rather than individual services provided, it will be important for each specialty to understand their contributions to hospital based care. We conducted this study to describe the contributions of plastic surgeons to hospital based care, focusing on reconstructive and microvascular procedures.

Methods: Using the 2004-2011 Nationwide Inpatient Sample, we conducted a cross-sectional study of all hospital discharges for adult patients who underwent a tissue graft or flap procedure. Discharges were grouped as breast or non-breast indication. Key outcomes included trends in the number of discharges per year, discharge characteristics, and healthcare utilization. Trends were tested for significance using the Cochran-Armitage test.

Results: The final sample included 429,833 discharges associated with a tissue graft or flap procedure with most having a non-breast indication (68.7%) for surgery. Among patients who underwent a non-breast procedure, the most common indications included complications of medical or surgical care including orthopedic joint and vascular graft issues, chronic wounds, or head and neck reconstruction. Between 2004 and 2011, there was a 23.3% increase in procedures overall, with growth noted among both breast (27.2%) and non-breast (21.7%) indications (see **Figure 1**). Concurrently, treated patients carried 23.5% greater medical comorbidity overall ($p<0.001$), with corresponding increases in complications ($p<0.001$) and length of hospital stay ($p<0.004$). During the study period, hospital charges related to flap procedures also rose 71% ($p<0.001$; breast=110%, non-breast=61%; see **Figure 2**).

Conclusions: The contribution plastic surgeons provide to hospital based care through microvascular and reconstructive procedures should not be underestimated. By offering care to patients across multiple specialties, plastic surgeons are important for both primary care to

patients and to ameliorate complications of care from other specialties. As their case volume has grown over the last several years across the United States, this role has resulted in plastic surgeons taking on sicker patients, with concurrent increases in cost, complications and length of hospital stay.

Keywords: Microvascular surgery; reconstructive surgery; free flaps; pedicled flaps; epidemiology

Figure 1.

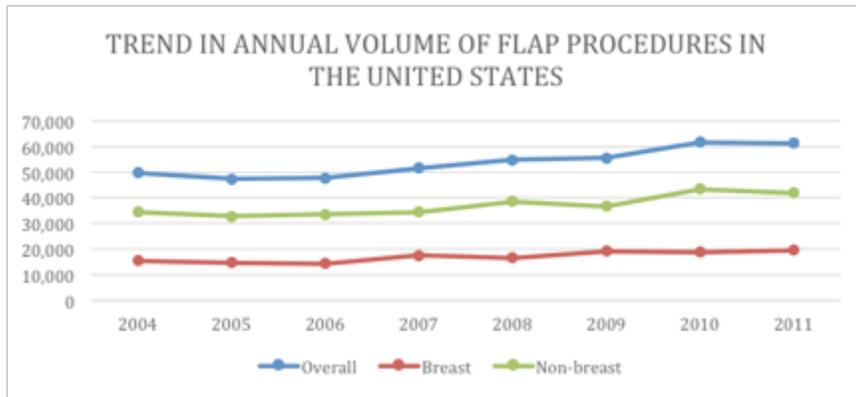
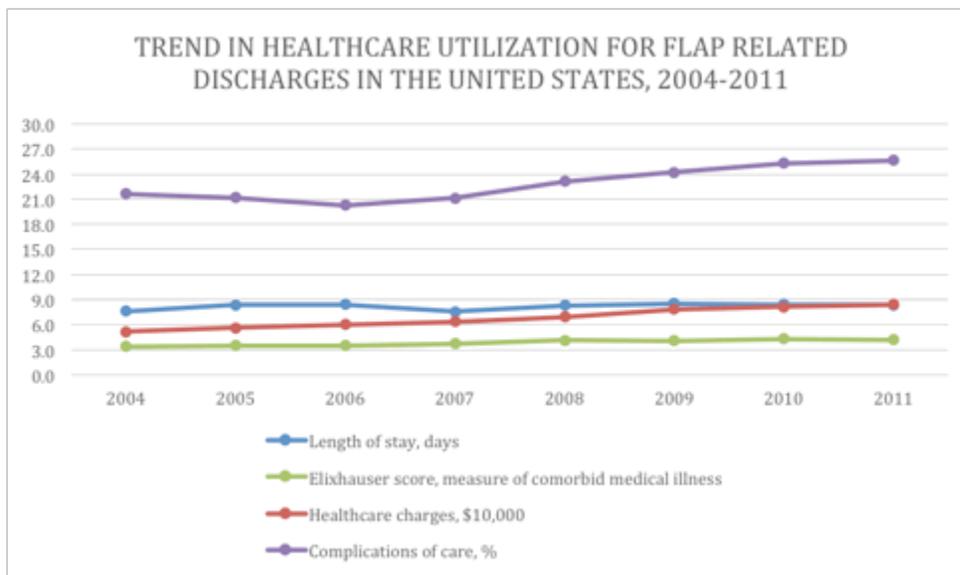


Figure 2.



7:30 AM - 7:33 AM

Discussion

7:33 AM - 7:38 AM

Microsurgery Competency During Plastic Surgery Residency: An Objective Skills Assessment of an Integrated Residency Training Program

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¹University of South Florida, ²Queen Mary University of London

Background:

Since the introduction of contemporary microsurgery, microsurgical education has been an integral aspect of plastic surgery training. Like most traditional surgical education, microsurgical skills are mostly taught on an apprenticeship model. This study aims at evaluating microsurgery skill acquisition within an integrated plastic surgery residency using electromagnetic hand-motion analysis and The Global Rating Scale.

Methods:

Cross-sectional study of a U.S. integrated plastic surgery residency program. Participants included all residents PGY1-6(n=18) and microsurgical attendings (n=4). Participants performed microsurgical arterial anastomoses on cryopreserved rat aortas. Hand-motion analysis of two consecutive anastomoses was recorded using DextrosMD™ hand-motion tracker. Total time to complete the task (mins), number of hand movements and path length (mm) were recorded as outcome measures. Subsequently, 3 raters blindly reviewed a video recording of the same anastomosis for each participant and by applying the Global Rating Scale, a score between 0-100 was given for each participant. Data was analyzed using SPSS (version21) with p-value of 0.05 signifying statistical significance.

Results:

The average number of microsurgical clinical cases performed by training level was 0,1,18,3,18,44,107 for PGY1-6 and attending physicians respectively. The data demonstrated construct validity as hand-motion analysis outcome measures statistically varied according to the level of skill (ANOVA, $p < 0.0001$ for time, number of hand movements and path length). The attending physicians invariably demonstrated higher level of skills (shorter time, less number of hand movements and path length) than the resident cohort until the PGY6 year of training. However, the participant's scores on the global rating scale demonstrated statistically significant variations among participants that are not consistent with the skill level and years of experience.

Conclusion:

This data suggests that the plastic surgery residency training program equips its residents with adequate microsurgery skills. The objective assessment of hand-motion is a valid tool for the evaluation of microsurgical skill. It is more accurate and reflective of the level of skill when

compared to the Global Rating Scale. The global rating scale enables the assessment of specific microsurgical skills but it is a subjective assessment and may produce significant inter-rater variations. Identifying the predictive validity of hand-motion analysis will be a useful tool to establish clinical safe training and practice thresholds, and the application of both assessment tools simultaneously can yield better evaluation.

Table 1: Time to Complete Anastomosis

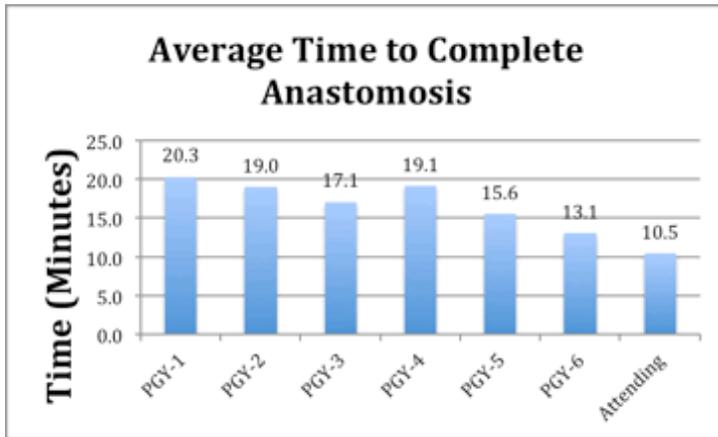


Table 2: Total Path Length

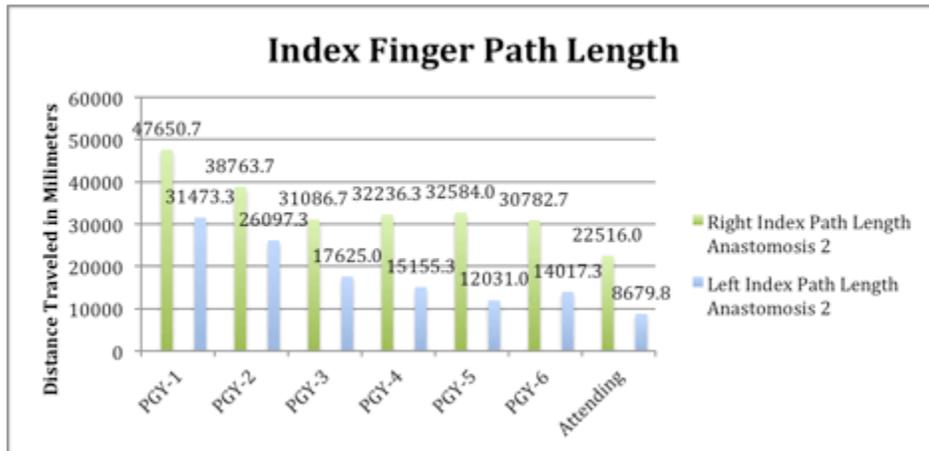


Table 3: Number of Hand Movements

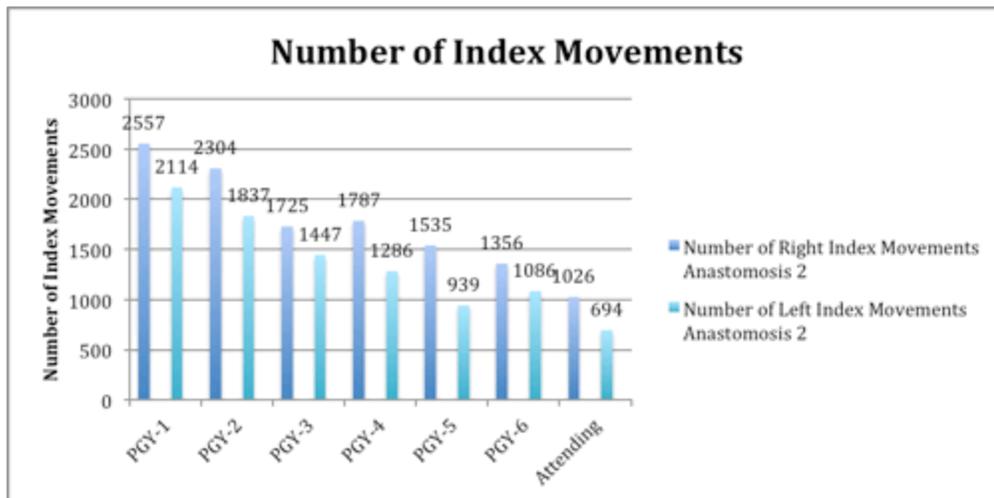
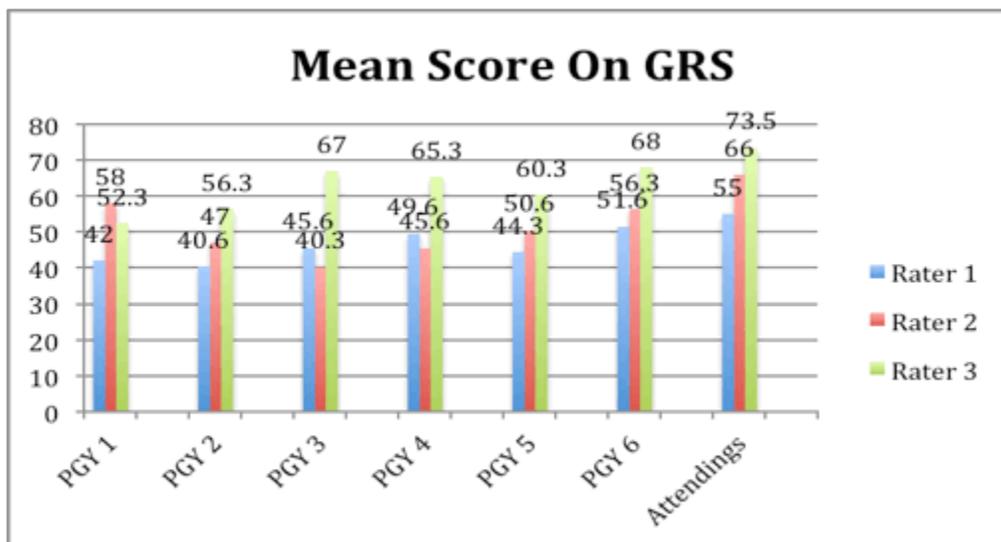


Table 4: Mean Scores on Global Rating Scale



7:38 AM - 7:43 AM

Novel simulation for microvascular anastomosis to the internal mammary vessels

University of Manitoba, Winnipeg, Canada

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Purpose

To create a surgical simulator for microsurgical anastomosis to the internal mammary artery during breast reconstruction. The simulation addresses key points of fidelity including motion from the heart and lungs, depth of the operative field, obstruction from the flap and retractors, and vessel size and thickness.

Design

This is a descriptive study detailing the design and implementation of a novel microsurgery simulator.

Materials and Methods

Computer aided design, 3D printing, and silicone molding were used to create the simulator. Independently controlled, variable speed heart and lung motion were simulated with a micro computer controlling multiple servo motors which displace a silicone membrane. A silicone breast pocket and flap were used to replicate the depth and obstruction of the surgical field. Fresh porcine internal mammary vessels were used to complete the simulation.

Results

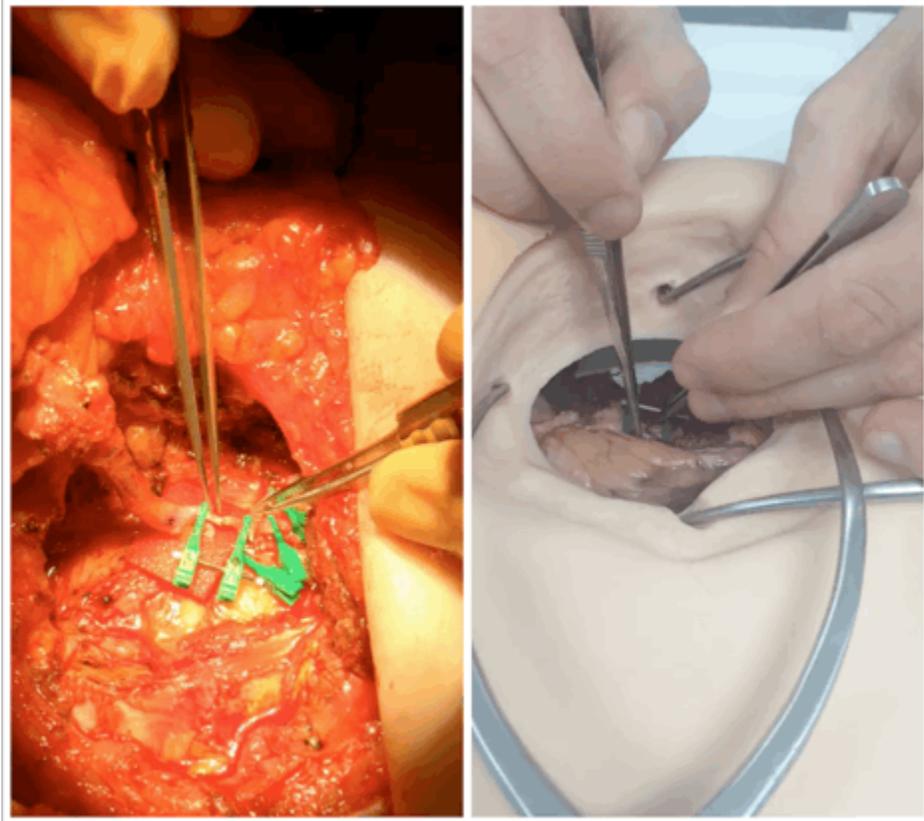
A novel microsurgery simulator was created which replicates motion, depth and obstruction during microsurgical anastomosis to the internal mammary artery. (Figure 1) This simulator has supplanted the rat model previously used in the University of Manitoba microsurgery lab. The cost to manufacture each simulator is under \$300, with minimal disposable cost for the porcine vessels. This compares favorably to live rat based simulations which can cost several thousand dollars to implement.

Conclusions

A novel microsurgical simulation has been created and implemented in the University of Manitoba microsurgery lab. The low cost and increased fidelity of this simulation offer a viable alternative to rat-based simulations. Preliminary evaluation by both students and instructors has been favorable, and distribution to several microsurgery centers and formal validation is planned.

Figure 1

Intraoperative photo of vessel anastomosis during DIEP flap reconstruction shown on left, compared with the microsurgical simulator on the right.



7:43 AM - 7:48 AM

Fibula free tissue reconstruction of Mandible. Can simplifying the planning process lead to better outcome?

Tel Aviv Medical Center, Tel Aviv, Israel

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The free fibula osteocutaneous flap is currently the “go to” flap for reconstruction of mandibular defects. Flap harvest is followed by osteotomies shaping the fibula to reconstruct the mandible shape. Balsa wood physical characteristics are unique. Low-density but high in strength balsa wood may be easily carved beside the operating table corresponding to the actual defect. We present a new intra-operative 3D planning system for mandibular reconstruction based on Balsa wood beam.

Following excision by the ablative surgeon, a single balsa beam is carved as the excised mandible segments using a surgical blade. The segments are then temporarily assembled together simulating the new mandible at the site of the defect. Osteotomies are then performed on a side table guided by the Balsa segments length and angles.

Between 2010-2015, 30 patients underwent mandibular reconstruction using the Balsa beam technique for osteotomy design. Average age 54.17 (5-75), length of mandibular defect 9.62 cm (4-19) and number of fibula segments 1.89 (1-4). Pre-operative computer aided 3D planning and printing was performed in 16 of the patients. 3D printing of the mandible with straight lines extrapolations from the noninvolved side were used for a separate plate preparation, and compared to the blast wood carved mandible done intra-operatively.

29 of 30 flaps survived and all osteotomy sites gained solid bone union. Minor complications were: fistula formation (2), fixation failure (1). All patients regained good function of the mandible, without structural deformity or joint pain. Postoperative imaging demonstrated excellent precision and accuracy of flap positioning. Comparison with cases performed before balsa wood technique demonstrated increased complexity of flap design along with reduced operative time in the Balsa technique group.

Different methods are known for osteotomy design. The most popular being 2D planning modalities such as the cut paper ruler, as well as surgical trial-and-error. Those methods do not yield an adequate structural guide for performing osteotomies. Advanced preoperative virtual surgical planning with pre-designed fibula osteotomy molds are a promising technique, however, they are expensive, requires special equipment, technical ability and staff and time consuming preoperatively and have little to no flexibility intra-operatively in case the ablative surgeon does not adhere to the ablative plan.

The Balsa Beam intra-operative planning tool allows for precise contouring of microvascular fibula free flaps. This intuitive and inexpensive approach simplifies the daunting task of complex 3D planning. Therefor may reduce pre and intra-operating time and enable better fit and function.

7:48 AM - 7:51 AM

Discussion

7:51 AM - 7:56 AM

Use of Mice in Supermicrosurgical Training

Cleveland Clinic, Cleveland, OH, USA

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Introduction:

The scope of supermicrosurgical procedures has increased tremendously in the recent years and now includes lymphatico-venous anastomosis, transfer of vascularized lymphatics, and perforator-to-perforator flap transfer. Supermicrosurgery, while involving a great deal of skill, with appropriate training can be mastered. Currently, the most commonly used animal model for microsurgical training is rat. The aim of this study was to 1) evaluate the feasibility of using mice in advanced supermicrosurgical training as an alternative to rats 2) test if commonly used rat microsurgical models can be applied in mice, and 3) compare the cost of using mice versus rats in microsurgical training.

Methods:

Fifteen C57BL/6 and fifteen CD1 male mice weighing 25-35g were anesthetized with isoflurane 1.5-2.5% vol / buprenorphine 0.05mg/kg and used for supermicrosurgical training. Basic supermicrosurgical techniques included end-to-end and end-to-side anastomosis using femoral vessels, carotid arteries, common jugular and posterior jugular veins (Figure 1). Advanced techniques included orthotopic groin flap transfer (femoral vessels) and groin flap transfer to the neck area (carotid artery and posterior jugular vein) (Figure 2). For all anastomoses a simple interrupted suturing technique using 12-0 nylon on 50 μ m needle was used. The rat/mouse cost ratio was calculated using the historical data from our institution using Sprague-Dawley rats.

Results:

All animals successfully tolerated anesthesia and training sessions lasting up to 8 hours. The average diameter of femoral artery, femoral vein, carotid artery, common jugular vein, and posterior jugular vein was 0.37 ± 0.04 , 0.51 ± 0.07 , 0.59 ± 0.05 , 0.68 ± 0.08 , 0.61 ± 0.07 mm, respectively. After a steep learning curve, an immediate patency rate of 100% for arterial anastomosis and 80% for venous anastomosis was achieved. Qualitatively, vessels were fragile, translucent and very thin. The average rat/mouse cost ratio for animal purchase was: 3.40, for housing: 4.57, and for supplies needed for one training session: 1.43.

Conclusions:

Mice can be successfully used as a cost-effective alternative to rats in supermicrosurgical training. Common rat microsurgical models can be successfully applied in mice. The diameter of main peripheral blood vessels is in appropriate range for supermicrosurgery: 0.2 to 0.8 mm. Vessels are fragile, translucent and very thin - similar to human lymphatics, which make them suitable for simulation of lymphaticovenous anastomosis. Future applicability of this model could be for supermicrosurgical training of clinicians as well as researchers conducting VCA studies on small rodents.

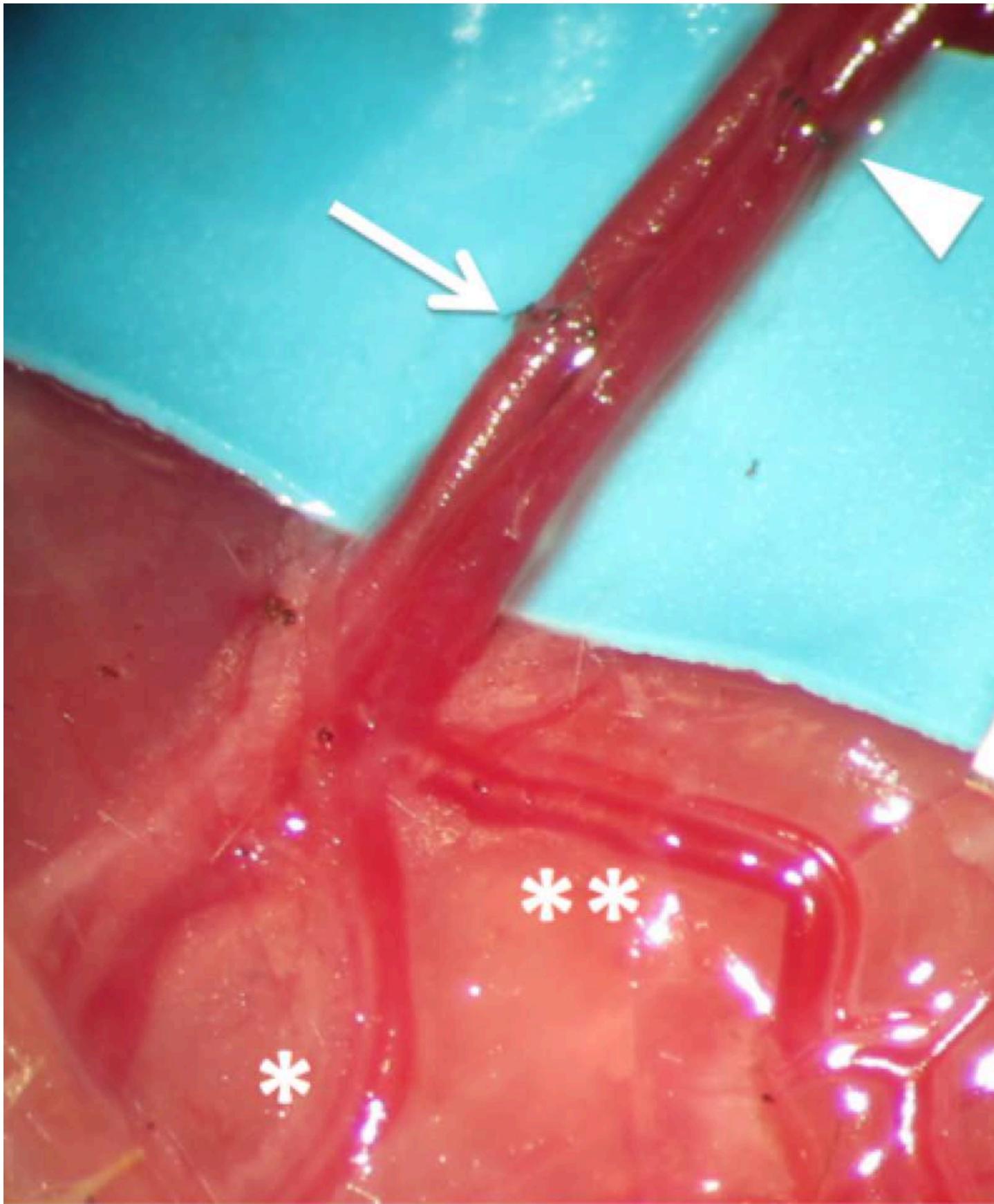


Figure 1. Arrow – femoral artery anastomosis (~0.4mm); Arrowhead – femoral artery anastomosis (~0.5mm); * – Superficial epigastric vessels (~0.2mm); ** – T

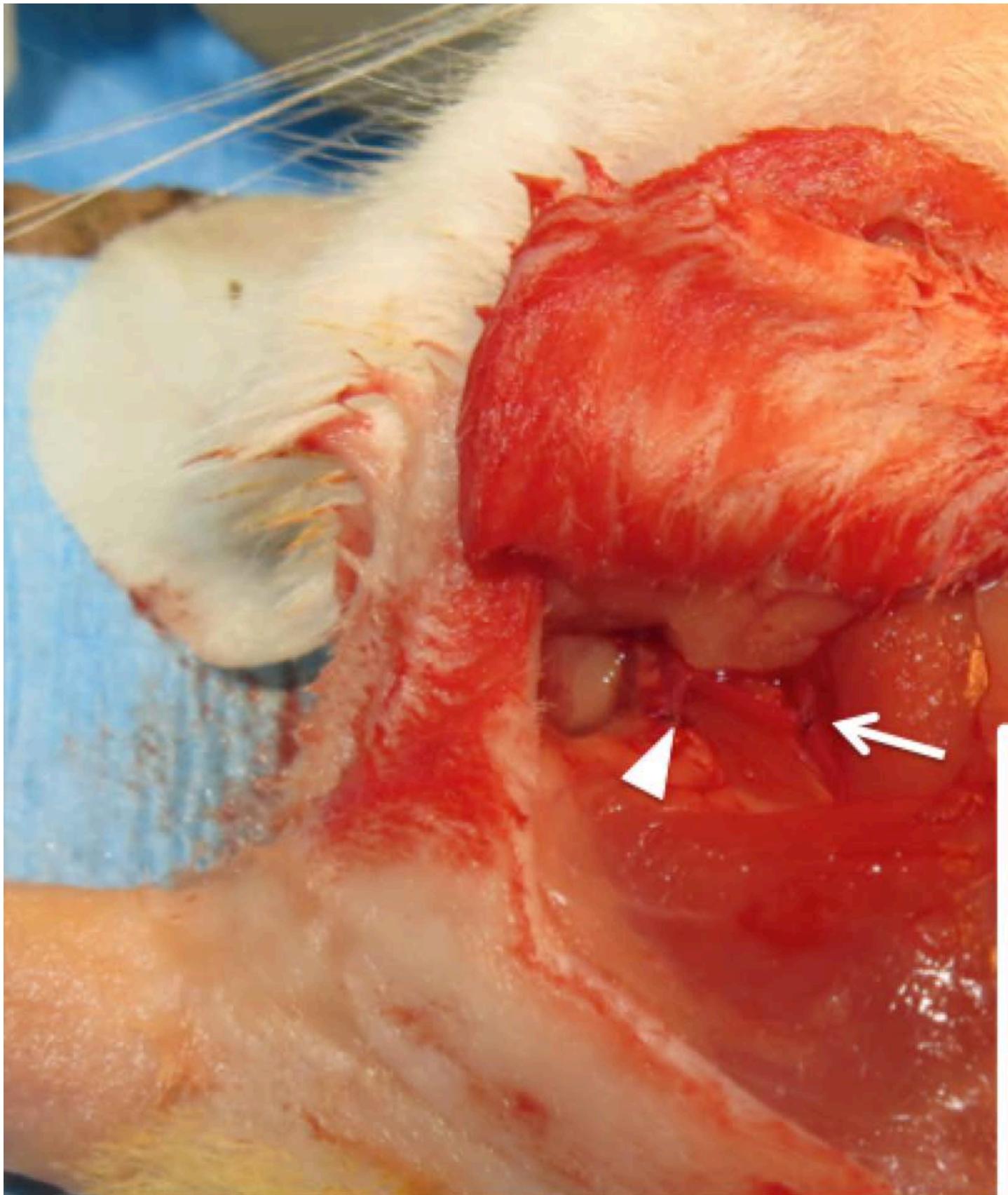


Figure 2. Groin flap transferred to the neck; Arrow – end-to-side anastomosis between the flap and carotid arteries; Arrowhead – end-to-end anastomosis between the flap and another artery.

7:56 AM - 8:01 AM

The Predictive Validity of Hand Motion Analysis & Global Rating Scores as Skills Assessment Tools in Microvascular Anastomosis Patency in Live Simulation

Microvascular Anastomosis Simulation Hub, Blizzard Institute, London, United Kingdom

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Background: Current methods to objectively evaluate microvascular anastomosis technical skill include the use of structured global rating scales (GRS) and hand motion analysis (HMA). We explored any correlation between these two methods in *ex-vivo* assessment with *in vivo* patency rates.

Methods: Eleven trainees and three expert microsurgeons were recruited. Randomised and blinded assessments were made of video recordings of a standardized microvascular anastomosis on a cryopreserved rat aorta. Hand motion analysis using the DextrosMD system, and the Structured Assessment of Microsurgery Skills (SAMS) were used to measure skill. Anastomosis patency was measured at 60 minutes post procedure in a live animal model.

Results: A total of 173 anastomosis were performed. Patency rates ranged between 17 – 90% in the trainee group, and was 95% for the expert group. There was a statistically significant correlation between the GRS score [SAMS] and HMA parameters (time to completion, & number of hand movements) *ex-vivo* and the patency rate *in vivo* (Spearman coefficient 0.74 - $P < 0.001$; 0.69 – $P = 0.0001$; 0.47 – $P = 0.014$ respectively).

Conclusions: There is a strong correlation between the *ex-vivo* results of hand motion analysis using an electromagnetic tracking device, and the SAMS global rating scale, with anastomosis patency rate in a live animal model. A robust *ex-vivo* simulation based assessment system in microsurgery training is feasible. This model could be used to identify appropriate thresholds to reduce, replace and refine the use of live animal models in microsurgery training as well as define competency/proficiency levels for trainees and specialists and support safe clinical practice.

8:01 AM - 8:06 AM

Towards Transition Thresholds - Predictive Validity of Non-Living Model Microsurgery Simulation Training –How Far can we push the 3-Rs?

Microvascular Anastomosis Simulation Hub, Blizzard Institute, London, United Kingdom

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Background: According to the guiding principles of the three Rs (replace, reduce and refine) for more ethical use of animals in biomedical sciences, this study evaluated the predictive validity of a non-living microsurgery training course (synthetic and cadaveric chicken thigh models),

compared to a living tissue microsurgery training course (anaesthetized rat femoral vessels model).

Methods: 26 trainees were recruited. 11 trainees underwent 40 hours of live animal model microsurgery training, and 15 trainees underwent 40 hours of non-living microsurgery training. Both cohorts were then evaluated on an anaesthetized rat training model. The patency of microvascular anastomoses was evaluated at 0 and 60 minutes using the Acland flow test. Comparison between the two cohorts' patency rates was determined using the Chi squared test (IBM SPSS Statistics Version 21)

Results: A total of 165 anastomoses were performed in the live model cohort and 285 anastomosis in the non-living model. Patency rates in the live animal model cohort ranged between 17 – 90%. For the non-living model trainees' patency rates ranged from 20 – 80%. There was no statistically significant difference between the two cohorts' immediate anastomosis patency rates (0 minutes post procedure) ($p=0.09$). However, a statistically significant difference was observed between the two cohorts when their delayed anastomosis patency rates were compared (60 minutes post procedure) ($p=0.05$).

Conclusions: A non-living simulation microsurgery course offers a safe, effective, ethical and economic approach to early skill acquisition in microsurgery. A competency-based transition to live animal models is recommended (move on only after demonstrating competence on non-living model). Living models in microsurgery basic training are necessary to produce physiologically patent anastomoses. We are identifying transition thresholds for live animal model training.

8:06 AM - 8:11 AM

Connector Assisted End-to-End Neurorrhaphy for the Treatment of Painful Neuroma

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Introduction: There are number of reported treatments for painful neuroma. Most commonly, following the neuroma excision they include implantation of the proximal nerve stump into muscle or bone. About sixty year ago, attempts were made with the end-to-end neurorrhaphy as an alternative solution for neuroma treatment but failed to prove the efficacy. In the past decade, end-side neurorrhaphy is also suggested as a valid alternative, yet when two paralel sensory nerves are injured, its applicability is suboptimal. Connector assisted neurorrhaphy was evaluated in twenty two patients allowing us to re-visit the effectiveness of the end-to-end neurorrhaphy.

Methods: Twenty two consecutive patients included 10 forehead, 9 dorsum of the foot and 3 hand nerve injuries. Trauma was the cause of nerve injury in 8 forehead patients and one foot patient, while the rest had post-operative nerve injuries. Forhead patients had supraorbital/supratrochelar nerve neuroma, foot patents had superficial and/or deep peroneal nerve neuroma, while hand cases had sensory branches of radial, ulnar and/or medial nerve involved. The conservative managements provided no pain relief. Patients had pain for 1.7 years (7m-3.6 y) in average. Patients with forehead headaches refused trigeminal ablative procedures, while patients with dorsum of foot or hand neuroma desired no proximal nerve excision in order

to maximally preserve the sensation. Therefore, following aforementioned neuroma excisions, connector assisted end-end neurorrhaphy was performed, to address forehead, foot and hand pain, respectively.

Results: Minimal patient's follow up was 1 year (range 1-4 years). Pre-operative pain level was 6-8 without direct stimulation of the neuroma, while with the pressure over the painful site was 10. Post-operative long term outcome resting pain was 0-1, while when the direct pressure was applied over the neurorrhaphy site, and 1 at 1 year ($p < 0.001$). All forehead patients had resolution of forehead/trigeminal neuralgia related headaches, while ambulation and hand dexterity were improved in foot/hand patients respectively. All patients reported improvement in quality of life.

Summary: This highly selected group of patients with chronic postoperative/traumatic neuroma in difficult anatomical areas can be successfully treated. Connector assisted end-to-end neurorrhaphy might contribute to the success compared to unsuccessful attempts in mid 40-s as it directs the nerve axons towards each other within contained environment, preventing sprouting into the subcutaneous tissues and thus reform a neuroma.

8:11 AM - 8:15 AM

Discussion