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ORIGINAL PAPER

Impact of microsurgery skill acquisition on free flap ischaemia time and free flap outcomes

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Abstract

Background Microsurgical training is challenging in our current healthcare environment. There has been a paradigm shift in surgical training due to the reduced hands-on training opportunities. This is particularly true for highly specialised advanced skills such as microsurgery. Understandably, there is a reluctance to encourage trainees to perform micro-anastomosis due to the high stakes nature of free flap surgery. We aimed to compare flap ischaemia times and return to theatre between attending plastic surgeons and plastic surgery residents. Our secondary aim was to correlate flap outcomes to the grade of a surgeon performing the microsurgical anastomosis.

Methods Data was collected on all free flap surgeries in a single institution over a 12-month period. Patient demographics, flap ischaemic times, return to theatre, flap outcomes and overall complications were recorded. Statistical analysis was performed using Stata 12.0. *T* test two group means comparison was used to compare ischemia times. Non-parametric statistics were used to evaluate flap outcome measures. A p value < 0.05 was considered statistically significant.

Results Fifty-four free flaps were performed in a single institution over a 12-month period. Attending group ($n = 34$) average flap ischaemia time was 70 min compared to 65 min for the resident group ($n = 20$), $p = 0.4$. There were no differences in return to theatre ($p = 0.2$), flap loss ($p = 0.6$), or overall complications (0.4).

Conclusions This study demonstrates that resident performance of microsurgery does not adversely affect clinical outcomes in free flap surgery. The hands-on operative teaching of microsurgery should be encouraged amongst residents in plastic surgery. Level of evidence: Level IV, risk/prognosic study

Keywords Microsurgery · Surgical training · Ischaemia time · Flap outcomes

Introduction

Microsurgical training is challenging in our current healthcare environment. There has been a paradigm shift in surgical training characterized by a radical augmentation of patient expectations, appropriate emphasis on patient safety and a call for competency-based training [1–4]. This has occurred during a challenging period of change characterized by a global reduction in working hours for doctors in training [5]. These collective challenges have culminated in a decrease in the hands-on surgical training exposure. This holds particularly true for highly specialised advanced skills such as microsurgery [6].

To combat these challenges, many surgical training programmes have incorporated mandatory training courses and high fidelity simulation into their curriculum [7]. Simulation-based training can assist with overcoming the steep learning curve associated with microsurgery [8, 9]. However, realistic haptic feedback, "real-life" operative conditions under the microscope, along with good judgement in a clinical setting requires trainee participation in microsurgery anastomosis prior to becoming fully proficient in microsurgery. It has been shown that the operative experience of the surgeon is a major determining factor in the success or failure of microsurgical anastomosis [10].

Understandably, there is a reluctance to encourage trainees to perform microsurgical anastomosis due to the high stakes nature of free flap surgery. Prior studies exploring the effect of resident involvement on patient outcomes among different

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surgical specialties have produced conflicting results. While there are multiple studies across various specialties that demonstrate that resident involvement resulted in poorer surgical outcomes [11–16], other studies showed no detrimental effect in outcomes with resident participation [17, 18]. Jordan et al. specifically demonstrated that resident involvement in plastic has been shown to be safe in a large study involving over 10,000 patients [18]. However, there is a paucity of studies examining the subspecialty of microsurgery. One study pointedly illustrates that resident involvement at a general level in microsurgery cases was safe and not associated with poor flap outcomes [19].

Microsurgical anastomosis is often the most critical step of a free tissue transfer case with poor technique potentially resulting in devastating outcomes such as the need for a return to theatre for flap salvage or ultimately flap failure. It is also a time-critical step of the operation with prolonged ischaemia times resulting in poorer outcomes [20]. Given the complexity of microsurgery, its dependence of operator competence and the high stakes nature, we examined the direct impact of resident involvement in microsurgical anastomosis on a patient and flap-related outcomes.

The aim of this study was the compare flap ischaemia times, return to theatre rates and free flap outcomes between attending senior microsurgeons and plastic surgery residents.

Materials and methods

Data source

Our Plastic and Reconstructive Surgery tertiary referral unit provides free tissue transfer for the breast, head and neck and lower limb reconstruction. All cases of free tissue transfer performed in the department are recorded prospectively in a database. Ethical approval was granted by the Galway University Hospitals Research Ethics Committee.

Patient selection

All cases of free flap reconstruction between April 2018 and April 2019 were included for analysis. Data collected included patient demographics and co-morbidities, history of radiotherapy and chemotherapy, grade of surgeon performing microvascular anastomosis, flap ischaemia time, return to theatre, flap success, other surgical complications including arterial/venous thrombosis and haematoma. Cases in which the resident performed the front wall of the arterial anastomosis were recorded as training cases. It was at the discretion of the attending surgeon whether or not the trainee would perform the arterial anastomosis; in most instances, a plan for the division of training roles was determined prior to commencing the case although this was reviewed as the case progressed. All residents who participated in this study had at least 3 years of formalized training in plastic surgery, had completed a microsurgery training course and significant experience in managing microsurgical trauma. Venous anastomoses were performed using a coupler device and were performed by the operating attending surgeon. The attending surgeon stayed scrubbed for the duration of all cases and supervised the trainee performing the anastomosis. For the purposes of this study, cases where the attending performed the anastomosis were compared to resident cases to determine if ischaemia time, return to theatre and flap loss were negatively affected.

Statistical analysis

Statistical analysis was performed using Stata 12.0. Chi-square and t tests were used to perform univariate analysis on categorical and continuous variables, respectively. A p value < 0.05 was considered statistically significant.

Results

Patient demographics

Fifty-four free flaps were recorded over a 12-month period. Thirty-four arterial anastomoses were identified in the attending group, and 20 were identified in the resident group. Patient demographics were similar in both groups and are detailed in Table 1.

Flap outcomes

Flap-related outcomes are detailed in Table 2. On comparison of flap ischaemia time, the attending surgeon's mean ischemia time was 70 min, median time 65 min (range 30–176 min) compared to the mean time 65 min, median time 65 min (range 44–99 min) in the resident group, $p = 0.4$. There were 5 patients who returned to the theatre in the attending group compared to 1 in the resident group, $p = 0.2$. There was 1 complete flap loss in the attending group and none in the resident group, $p = 0.4$.

Overall complications

On further analysis of flap-related complications (Table 3), there were no differences found between the two groups, $p = 0.2$. Two patients had venous thrombosis on surgical exploration in the attending group, and none were identified in the resident group, $p = 0.2$. One patient in the resident group returned to theatre due to flap ischemia and was found to have arterial thrombosis on exploration, and there were no complications of arterial thrombosis in the attending group, $p = 0.4$.

Table 1 Patient demographics

	Consultant (n=34)	Trainee (n=20)	p value
Free flap (by site)			
–Breast	26	19	NS
–Head and neck	6	1	
–Lower limb	2	0	
Free flap (by type)			
–DIEP	26	17	NS
–SIEA	1	1	
—ALT	4	1	
–RF	2	1	
–Gracilis	1	0	
Age (years)			
Range	33–67	33–70	NS
Mean	49	51	
Gender			
Male	5	1	NS
Female	29	19	
Smoker			
Yes	3	1	NS
No	21	12	
Ex-smoker	10	7	
Radiotherapy			
Yes	2	4	NS
No	32	16	
Chemotherapy			
Yes	6	4	NS
No	28	16	
ASA grade			
I	12	6	NS
II	21	13	
III	1	1	

Two patients underwent evacuation of haematoma in the attending group compared to one in the resident group, $p = 0.2$.

Discussion

The findings of our study conclude that trainee involvement in microsurgical anastomosis did not adversely affect flap ischaemia times, flap specific complications or ultimately flap loss rates.

This is in keeping with the literature published to date which shows resident involvement has no detrimental on free flap outcomes. Hirshe et al. [19] comparative cohort study of 391 flaps showed no difference in flap outcomes between attending and resident surgeons. Similarly, Lin et al. [20] analysis of 93 flaps performed in conjunction with the chief resident showed a satisfactory flap success rate. Neither study however directly compared microsurgical anastomosis between attending and resident surgeons.

Table 2 Flap outcomes

	Attending (n=34)	Resident (n=20)	p value
Flap ischaemia time			
Mean	70	65	0.4
Range	30–176	42–99	
Return to theatre	5	1	0.2
Flap loss	1	0	0.4

Table 3 Specific complications

	Attending (n=34)	Resident (n=20)	p value
Venous thrombosis	2	0	0.2
Arterial thrombosis	0	1	0.4
Haematoma	2	1	0.2

The largest series published by a group in Texas [21] on the effect of resident involvement in free flap surgery detailed a comprehensive analysis of over 1400 cases and showed no adverse effects on any outcome measures or flap failure. Again, resident involvement was only assessed generally, and it was not detailed whether the resident performed the flap dissection or microsurgical anastomoses.

While the results of our study show no difference in adverse outcomes, a reasonable point to make would be that resident case selection was based on the perceived difficulty level of the microsurgical anastomosis, with the attending performing the more challenging cases. This is apparent when the breakdown of free flaps by site and type were analysed, with the attending performing the majority of the head and neck as well as the lower limb cases, where the donor vessel integrity and availability can be challenging. This also explains why the mean time was slightly longer in the attending group as the flap ischemia time in the head and neck free flaps will typically be longer due to the time it takes to inset the free flap prior to a microsurgical anastomosis.

Clearly flap success is dependent on a variety of factors beyond simply the microvascular anastomosis. The planning and decision-making for a free flap are complex and a variety of factors including flap harvest, recipient vessel choice and pedicle placement along with flap inset determine a successful outcome which in our series were all performed by the experienced microsurgical attending. We feel that the patients in our series achieved good overall flap success rates irrespective of who was placing the microvascular sutures in the anastomosis due to the overall expertise of an experienced attending microsurgeon. These reassuring results should challenge the well-accepted notion that microsurgical success is lower in more inexperienced hands.

The learning curve in microsurgery has a unique complexity compared with other surgical skill acquisition; therefore, we conclude that it is appropriate that free flap cases directly involve residents so that they can progress along this steep learning curve throughout their training under the direct guidance of their experienced attending microsurgeon [22]. Performance of microsurgical anastomosis by residents

should be encouraged as standard practice within plastic surgery training curricula.

Conclusions

This study demonstrates that resident performance of microsurgery does not adversely affect clinical outcomes in free flap surgery. The hands-on operative teaching of microsurgery should be encouraged amongst residents in plastic surgery.

Compliance with ethical standards

Conflict of interest Christina E. Buckley, Paula F. Wrafter, Fiachra Sheil, Niall M. McInerney and Alan J. Hussey declare that they have conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional ethics committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The Galway Clinical Research Ethics Committee approved this study (approval # C.A. 2163).

Informed consent Informed consent was obtained from all participants included in this study.

Patient consent Patients signed informed consent regarding publishing their data

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