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The effect of training level on complications after free flap surgery of the head and neck

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ABSTRACT

Objectives: Analyze postoperative complications after free flap surgery based on PGY training level.
Methods: Data on free flap surgeries of the head and neck performed from 2005 to 2013 was collected from the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database. Cases identifying the status of resident participation in the surgery and the PGY level were included.
Results: There were 582 cases with primary surgeon data available. 63 cases were performed with a junior resident, 211 were performed with the assistance of a senior resident, 279 cases were performed with a fellow, and 29 cases were performed by an attending alone without resident involvement. The overall complication rate was 55.2%. There was no statistically significant difference in the rate of complications between groups (47.6%, 59.7%, 53.0%, 58.6%, $p = 0.277$). After controlling for all confounding variables using multivariate analysis there was no significant difference in morbidity, mortality, readmissions, and reoperation amongst the groups. Furthermore, when comparing resident versus fellow involvement using multivariate analysis there were no significant differences in morbidity (OR = 0.768[0.522–1.129]), mortality (OR = 1.489[0.341–6.499]), readmissions (OR = 1.018[0.458–2.262]), and reoperation (OR = 0.863[0.446–1.670]).
Conclusion: Resident and fellow participation in microvascular reconstructive cases does not appear to increase 30-day rates of medical, surgical, or overall complications.

1. Introduction

The training of surgical residents is a complex exercise in optimizing education without compromising the quality of surgical care. This process relies on attending physicians of academic institutions, who must make decisions regarding the appropriate degree of autonomy to grant residents in the OR. The subjective nature of this training in an evolving healthcare system necessitates continual investigation and discussion of resident impact on patient outcomes. The need for analysis has been magnified since the implementation of additional duty hour limitations in 2011 [1]. This effort by the Accreditation Council for Graduate Medical Education (ACGME) to mitigate resident fatigue and burnout has come with the obvious tradeoff of decreased training time, which is of particular concern in surgical disciplines [2]. It has been suggested that the lack of improvement in patient outcomes following the duty hour restrictions may be related to residents logging fewer hours in the operating room [3]. The possibility that these restrictions of work hours may be of greater consequence for surgical subspecialties must be considered.

Recent studies examining the effect of resident participation on surgical outcomes in a variety of surgical specialties have produced mixed results, some finding that resident participation negatively impacts outcomes [4–10], and others concluding that resident participation has no significant effect [11–17]. In light of this lack of generalizable conclusion, differences in outcomes may be best assessed on a procedure-specific basis to ensure patient safety. This is especially necessary for technically difficult procedures that are performed with less frequency, such as microvascular free flap tissue transfers. These surgeries are complex, technically difficult procedures with long operative times. Rates of postoperative complications are high at 30–40% [18], with the rate of flap failure reported to be almost 10% [19]. Analysis of this procedure specifically is important as it has been previously established that resident participation causes longer operative time [20], and prolonged operative time has been associated with flap failure [21]. The impact of otolaryngology resident and fellow participation on outcomes in free flap surgery has never been analyzed.

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The National Surgical Quality Improvement Program (NSQIP) is a prospective database developed by the American College of Surgeons (ACS) that tracks surgical outcomes in order to improve surgical quality. The database is ideal for our study because it uniquely records data on resident involvement and their post-graduate year (PGY) in addition to an array of preoperative and postoperative variables. The purpose of our study is to utilize the ACS-NSQIP to analyze the impact of resident and fellow involvement by PGY status on postoperative outcomes in free flap procedures.

2. Materials and methods

A retrospective analysis was performed on the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) patient data from 2005 to 2013. Current Procedural Terminology (CPT) codes (Table 1) were used to query the NSQIP database in December 2015 and select patients who had undergone free flap surgery of the head and neck. Only patients whose surgery was performed by an otolaryngologist or plastic surgeon were included in the study. Patients without a specific note of resident involvement in the surgery (Attending only vs. Attending and Resident) and post-graduate year (PGY) were excluded. Fellows (PGY > 5) were included in this study due to the fundamental nature of free flap reconstruction – these are complex cases, requiring an advanced level of skill for which training extends past primary otolaryngology residency. The remaining cases were stratified into four groups: junior residents (PGY 1–3), senior residents (PGY 4–5), fellows (PGY 6+), and attending only. The four groups were analyzed for demographics, preoperative characteristics, and postoperative outcomes. Multivariate analysis was used to account for demographics and significant comorbidities in order to identify the importance of training level as an independent risk factor associated with complications following free flap reconstruction of the head and neck.

Preoperative characteristics include diabetes mellitus, current smoker, dyspnea, current alcohol use, pneumonia, ventilator use (<48 h prior to surgery), weight loss (>10% in the 6 months prior to surgery), chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), previous myocardial infarction, previous percutaneous coronary intervention (PCI), previous cardiac surgery, angina, history of treatment for peripheral vascular disease (PVD), hypertension (requiring medication), acute renal failure, hemiplegia, transient ischemic attack, cerebrovascular accident (CVA) with or without neurological deficit, central nervous system (CNS) tumor, disseminated cancer, steroid use (<30 days prior to surgery), bleeding disorders, dialysis (<2 weeks prior to surgery), chemotherapy (<30 days prior to surgery), radiotherapy (<90 days prior to surgery), systemic sepsis, previous operations, emergency operation, wound infection, open wound, functional status (independent/dependent), ASA (American Society of Anesthesiologists) class, and work relative value units (RVU) (Table 2).

Postoperative variables included surgical complications, medical complications, overall complications, overall mortality, reoperation rates, readmission rates, unplanned readmission rates, total operating time, and length of stay (Table 3). Surgical complications consisted of superficial, deep, and organ/space surgical site infections (SSI), wound disruption, and bleeding requiring blood transfusion within 72 h of the postsurgical period. Medical complications included pneumonia, pulmonary embolism (PE), ventilator use for >48 h, unplanned reintubation, urinary tract infection (UTI), deep vein thrombosis

Table 1
Current procedural terminology code.

Free flap reconstruction	CPT code
Free muscle or myocutaneous flap with microvascular anastomosis	15756
Free skin flap with microvascular anastomosis	15757
Free fascial flap with microvascular anastomosis	15758
Free jejunum transfer with microvascular anastomosis	43496
Free omental flap with microvascular anastomosis	49006
Free omental flap with microvascular anastomosis	49906
Free osteocutaneous flap with microvascular anastomosis; other than iliac crest, metatarsal, or great toe	20969
Bone graft with microvascular anastomosis; fibula	20955
Bone graft with microvascular anastomosis; iliac crest	20956
Bone graft with microvascular anastomosis; metatarsal	20957
Bone graft other than fibula, iliac crest, or metatarsal	20962
Free osteocutaneous flap with microvascular (iliac crest)	20970
Free osteocutaneous flap with microvascular (metatarsal)	20972
Free osteocutaneous flap with microvascular (great toe)	20973
Partial esophagectomy, cervical, with free intestinal graft	43116
Graft for facial nerve paralysis; free muscle graft by microvascular anastomosis	15842

Table 2
Patient demographics and characteristics in free flap surgery patients by PGY level.

	PGY 1–3 (Junior) N = 63	PGY 4–5 (Senior) N = 211	PGY 6+ (Fellow) N = 279	Attending only N = 29	p
Age cohorts (%)					
≤ 40 years	3.2	8.5	7.5	10.3	0.505
41–60 years	36.5	37.4	39.1	34.5	0.945
61–80 years	57.1	48.8	41.6	55.2	0.075
> 80 years	3.2	5.2	11.8	0.0	**0.006**
Sex (%)					
Male	81.0	69.5	65.6	82.8	**0.040**
Female	19.0	30.5	34.4	17.2	
Race (%)					
White	82.4	87.8	84.4	82.1	0.661
Black	11.8	4.4	8.4	17.9	**0.047**
Other	5.9	7.8	7.1	0.0	0.492
Unknown	19.0	14.7	19.4	3.4	0.117
Admission status					
Inpatient	88.9	97.6	98.6	96.6	**0.001**
Outpatient	11.1	2.4	1.4	3.4	
Obese (BMI > 30, %)	28.6	19.0	21.9	13.8	0.300
Comorbidities (%)					
Diabetes	9.5	10.4	11.5	3.4	0.597
Current smoker	25.4	23.2	25.4	34.5	0.620
Dyspnea	9.5	7.1	8.6	20.7	0.115
Alcohol	9.5	10.4	11.5	6.9	0.868
Pneumonia	0	0.5	0	0	0.623
Weight loss	11.1	13.3	12.2	3.4	0.497
COPD	7.9	7.1	6.8	10.3	0.909
CHF	0	0.5	0.7	0.0	0.872
MI	0	0.5	0.7	0.0	0.872
Previous PCI	3.2	10.0	5.4	0.0	0.049
Previous cardiac surgery	4.8	6.6	4.7	3.4	0.752
PVD	0.0	0.9	1.1	3.4	0.506
Hypertension	47.6	46.4	46.6	34.5	0.643
Hemiplegia	0	0.5	1.1	0.0	0.707
TIA	4.8	3.8	2.2	3.4	0.622
CVA	1.6	1.4	1.4	3.4	0.865
CVA w/no deficit	1.6	1.4	1.4	6.9	0.183
CNS tumor	0.0	0.5	1.4	0.0	0.523
Disseminated cancer	3.2	9.5	7.9	10.3	0.421
Wound infection	9.5	6.6	10.8	3.4	0.302
Steroid use	4.8	2.4	5.7	3.4	0.335
Bleeding disorders	6.3	2.4	3.6	0.0	0.320
Dialysis	0	0	0.7	0	0.536
Chemotherapy	3.2	4.3	8.6	0.0	0.066
Radiotherapy	1.6	1.9	1.4	6.9	0.234
Previous operations	3.2	6.2	5.0	10.3	0.519
Emergency operation	0.0	0.0	0.7	0.0	0.536
Open wound	33.3	20.0	18.7	16.1	0.697
Recent Transfusion	0.0	0.9	1.1	0.0	0.809
Functional status					
Independent	96.8	99.1	96.8	100	0.287
Totally or partially dependent	3.2	0.9	3.2	0.0	
ASA class (%)					
1 and 2	28.6	23.7	15.5	20.7	**0.042**
3 and 4	71.4	76.3	84.5	79.3	
Work relative value units	29.72 ± 11.84	30.51 ± 11.2	26.80 ± 10.46	26.03 ± 13.53	**0.001**

Bold Text = Statistically Significant.

Table 3
Operative characteristics and postoperative complications in free flap surgery patients by PGY level.

	PGY 1–3 (Junior) $N = 63$	PGY 4–5 (Senior) $N = 211$	PGY 6+ (Fellow) $N = 279$	Attending only $N = 29$	p
Surgical complications overall (%)	44.4	54.5	49.5	58.6	0.384
Superficial SSI	7.9	7.1	9.3	3.4	0.640
Deep SSI	1.6	4.3	2.2	13.8	**0.008**
Organ/space SSI	0.0	0.9	0.7	0.0	0.837
Wound disruption	6.3	4.7	4.3	0.0	0.586
Blood transfusion within 72 h	34.9	46.9	40.9	48.3	0.279
Flap failure	3.2	6.2	5.7	0.0	0.459
Medical complications overall (%)	11.1	16.6	16.1	20.7	0.647
Pneumonia	4.8	7.6	5.0	10.3	0.484
Unplanned reintubation	1.6	2.8	3.6	3.4	0.860
Urinary tract infection	0.0	0.5	2.2	0.0	0.243
Deep vein thrombosis	0.0	1.9	1.1	0.0	0.570
Renal insufficiency	0.0	0.0	0.4	0.0	0.780
Pulmonary embolism	1.6	1.4	0.4	0.0	0.522
Ventilator >48 h	3.2	5.2	5.0	6.9	0.877
CVA with neurological deficit	0.0	0.0	0.0	3.4	<**0.001**
Cardiac arrest requiring CPR	1.6	1.9	0.4	0.0	0.351
Myocardial infarction	0.0	2.4	1.1	0.0	0.390
Sepsis	1.6	5.2	3.6	6.9	0.488
Septic shock	0.0	0.0	0.7	0.0	0.536
Overall complications	47.6	59.7	53.0	48.6	0.277
Mortality	0.0	1.9	2.2	0.0	0.581
Total OP time, mean, minutes	636.86 ± 189.55	574.48 ± 161.74	571.33 ± 156.83	513.66 ± 203.50	**0.005**
Total anesthesia time, mean, minutes	729.98 ± 191.20	667.83 ± 165.02	662.05 ± 162.74	591.61 ± 210.79	**0.003**
Length of stay, mean, days	12.91 ± 10.0	11.79 ± 11.13	11.59 ± 9.28	8.30 ± 3.70	0.226
Return to OR	7.3	15.4	18.0	0.0	0.190
Unplanned readmission	4.8	4.7	5.4	0.0	0.645

Bold Text = Statistically Significant.

(DVT), renal insufficiency (increase in creatinine >2 mg/dL above preoperative value), acute renal failure, CVA with neurological deficit, nerve injury, cardiac arrest requiring CPR, myocardial infarction, sepsis, and septic shock. (Table 3).

Statistical analyses were conducted using SPSS Version 22 (IBM, Armok, NY). Pearson's chi-square, Fisher's exact tests, independent 2-tailed *t*-test, and cross-tabulation were utilized to assess statistical relationships between variables. Probability values (p-value) < 0.05 were considered significant and Hoshmer–Lemshow analysis was used as a goodness-of-fit test for regression analysis. Since NSQIP omits personal identifiers, Institutional Review Board approval has been granted for all administrative database studies, per Rutgers New Jersey Medical School (Newark, New Jersey) Institutional Review Board policy.

3. Results

The initial 2005–2013 dataset contained 1417 free flap reconstruction cases of the head and neck. After appropriate data manipulation it was determined that 582 of these cases had data on the presence or absence of residents assisting on the case as well as data on the level of resident training (Table 2). The final cohort was comprised of 63 cases performed with a junior resident (PGY1–3), 211 cases with a senior resident (PGY4–5), 279 cases with a fellow (PGY6+), and only 29 cases performed by an attending alone with no resident assistance (Table 2). Thus, 84.2% of all head and neck free flap cases in this study were performed with the assistance of a senior resident or fellow.

3.1. Preoperative demographics and comorbidities

In this cohort of free flap patients, the majority of patients were between the ages of 61–80 and this was true for all levels of resident training and there was no significant difference between group for this age category ($p = 0.075$) (Table 2). The second most common age group was 41–60 and this too was true across all PGY levels with no significant differences (Table 2). Cases in which the patient was greater than the age of 80 were performed with fellow involvement at a significantly higher rate than other PGY levels, with 11.1% of fellow cases falling in this category as compared to 3.2% for juniors, 5.2% for seniors, and 11.8% for attending's alone (Table 2). Male sex was the most common gender across cases at each training level however there was a significantly irregular distribution ($p = 0.040$) of these cases across the levels with junior and attending alone cases comprised of 81.0% and 82.8% of males, respectively and senior and fellow cases comprised of 69.5% and 65.6% of males, respectively (Table 2). White was the most common race across all training levels and this did not vary significantly between groups. Blacks were the second most common race in cases performed with junior (11.8%) or fellow (8.4%) assistance, and cases performed by an attending alone (17.9%) but was the third most common race in senior cases (4.4%) with other races the second most common racial group for this training level. This difference in the distribution of black race across training levels was significant ($p = 0.047$) (Table 2). The vast majority of free flap patients had their procedures performed as inpatients, and this was true for all training levels however these rates were distributed in a significantly irregular fashion ($p = 0.001$) with 88.9% of junior cases performed on inpatients and >95% of cases for seniors, juniors, and fellows performed on inpatients.

Exploration of multiple co-morbid conditions indicated that a positive current smoking status, recent weight loss, hypertension, wound infection/open wound, and current alcohol use were the most common conditions in this cohort, however bivariate chi-square testing revealed that neither these, nor any other of the less common conditions were distributed irregularly in patients across training levels (Table 2).

A study of ASA class revealed that the majority of patients in each training level cohort were categorized as either a class 3 or class 4 risk however this distribution diverged from the expected ($p = 0.042$) with 71.4% of junior cases having these classifications, 76.3% of seniors, 84.5% of fellows, and 79.3% of attendings operating alone.

The average work relative value units (RVU's) of the cases in each training cohort also differed significantly from each other ($p = 0.001$), with fellows as the only training category displaying a mean RVU of >30 with attendings alone having the lowest mean RVU value (26.03) (Table 2).

3.2. Operative variables and postoperative complications

Analysis of mean total operative time and mean anesthesia time revealed a significant, negatively linear trend in both variables with the greatest average durations for both variables in the junior cohort and decreasing regularly through the senior and fellow cohorts, and reaching their nadir in the attending alone cases (Table 3).

The overall complication rates across the training levels differed insignificantly ($p = 0.227$), ranging from 47.6% in the junior cohort to 59.7% in the senior cohort. Overall rates of mortality, surgical complications, medical complications, reoperation, and unplanned readmission, as well as average length of hospital stay, did not differ significantly between training levels (Table 3). Examination of specific medical and surgical complications revealed that deep surgical site infection and stroke were not randomly distributed across the training cohorts with elevated rates in the attending alone (deep SSI = 13.8%, $p = 0.008$; Stroke = 3.4%, $p \leq 0.001$) group (Table 3).

3.3. Multivariate analysis

Binary logistic multivariate analysis was performed to account for significant confounders identified in the bivariate analysis. After accounting for age, sex, race, inpatient status, ASA class, work RVUs, and anesthesia duration, overall complication rate, surgical complication rate, and medical complication rate remained non-significant across the training groups (Table 4a–c).

4. Discussion

Attending physicians of academic institutions are ultimately responsible for ensuring that they are followed by a new generation of competent doctors. In the training of young surgeons, the goal is to optimize resident education and hands-on experience without compromising the quality of surgical care. This task is made particularly difficult by the current healthcare climate, where public and administrative attention to cost, quality, and efficiency continues to grow. In addition, residents are logging fewer hours in the OR following the implementation of duty hour restrictions, but the long-term consequences of this have not yet been appreciated [22]. Therefore, these analyses of resident involvement and patient outcomes are integral in assessing if current teaching paradigms are evolving appropriately.

In order to specifically assess resident education in the field of otolaryngology, the impact of resident experience must be evaluated on specialty-wide and procedure-specific scales. One prior study by Vieira et al. queried NSQIP for all surgical otolaryngology cases and evaluated outcomes between those with and without a resident involved [23]. Analysis by propensity matching and logistic regression found that resident participation is not associated with increased morbidity or mortality, and concluded that residents are being appropriately involved in cases selected for their experience level. Similar findings have been published regarding endoscopic sinus surgery [24] and thyroidectomy [25], but procedure-specific data is otherwise lacking.

This study serves to supplement this existing literature by evaluating the impact of residents on outcomes in one of the most complex procedures performed by residents. Free flap tissue transfers require advanced technical skill and a long operative course. Therefore, patients are at an inherently high risk of postoperative complications [26]. This procedure is well suited for identifying possible pitfalls of intraoperative resident training and assessing the validity of the claims made by Vieira et al. Our findings are in agreement, demonstrating that resident involvement does not independently increase the risk for any postoperative medical or surgical complication following free flap repair significantly when accounting for potential cofounders.

These results are best understood in the context of the limitations of the NSQIP database when purposed for this analysis. For each case, NSQIP records the PGY for the highest level of resident involved, and does not identify procedures involving multiple residents. Therefore, it is difficult to draw conclusions about outcomes specific to the senior resident and fellow groups, as these procedures may have frequently involved more junior residents as well. For example, it would not be uncommon to have a senior resident assist in the microvascular anastomosis while a junior resident closes the donor site. But again, there is no way to ascertain the role of each resident or account for different degrees of involvement. Despite these limitations, the stratification of groups does allow us to appropriately conclude that resident involvement does not put the patient at an increased risk of additional morbidity or mortality, and this is true even when the highest trained resident in the room is a PGY3. Further, it can be assumed that for all combinations of residents and fellows, attendings are appropriately assigning trainee roles and dictating the level of involvement of their assistants in a way that does not compromise patient outcomes.

This study also serves to add to existing literature by adding fellow participation for an additional level of experience, which has not been included in prior analyses. Complex reconstruction of head and neck defects with free flaps often times requires two-team approaches with multiple residents and/or attendings, and several institutions across the country benefit from fellow level assistance. Therefore, our analysis attempted to include fellow participation as designed by any PGY level 6 and above. Unfortunately, we are unable to identify and exclude residents in research tracks or other routes who are PGY6 but are not in fellowship positions, and there is likely some overlap between the senior and fellow cohorts. However, the lack of significant associations in both groups further substantiates the claim that outcomes are the same for all combinations of PGY levels operating with attending oversight.

The only differences identified between groups that are of possible clinical significance are the total operating time and duration of anesthesia. As expected, free flap cases involving only junior residents last longer, as there is likely more time spent teaching during these procedures and junior residents less likely to be able to work at a different surgical site autonomously. The increased times could also be attributed to a more complicated patient set-up and positioning that junior residents may not be familiar with. Prolonged operative times may raise concerns as this has repeatedly been shown to be associated with

Table 4

a. Multivariable regression of overall complication risk in free flap reconstruction by PGY level.

	Complication rate	*p*	Odds ratio
PGY 1–3 (Junior) $n = 63$	47.6	0.269	0.542
PGY 4–5 (Senior) $n = 211$	59.7	0.903	0.994
PGY 6+ (Fellow) $n = 279$	53.0	0.237	0.577
Attending only $n = 29$	51.3	ref	Ref

b. Multivariable regression of surgical complication risk in free flap reconstruction by PGY level

	Complication rate	*p*	Odds ratio
PGY 1–3 (Junior) $n = 63$	44.4	0.184	0.475
PGY 4–5 (Senior) $n = 211$	54.4	0.585	0.774
PGY 6+ (Fellow) $n = 279$	49.5	0.077	0.434
Attending only $n = 29$	59.6	ref	ref

c. Multivariable regression of medical complication risk in free flap reconstruction by PGY level

	Complication rate	*p*	Odds ratio
PGY 1–3 (Junior) $n = 63$	11.1	0.062	0.172
PGY 4–5 (Senior) $n = 211$	16.6	0.464	0.661
PGY 6+ (Fellow) $n = 279$	16.1	0.618	0.753
Attending only $n = 29$	20.7	ref	ref

Regressions included Age, Sex, Race, Inpatient Status, ASA Class, Work RVUs, and Anesthesia Duration.

Regression not included for Deep SSI or Stroke due to low number of complications combined with low numbers of attending only cases. These analyses yield poor quality models.

increased postoperative complications [27,28]. The most notable of these associations in head and neck surgery is wound infection, which complicates 26% of cases lasting longer than 6 h [29]. In our analysis, the length of the operation gets shorter when residents with greater experience are involved, but the differences did not correspond to any significant increases in complication rates. In fact, the only significant difference related to infection or wound disruption was an increased rate of deep surgical site infection, notably associated with a lack of any resident or fellow involvement. It can be hypothesized that this is a consequence of operating without assistance in a procedure involving multiple surgical sites. However, this finding certainly represents an area for additional investigation.

Of course, considerable literature on this topic exists outside of the field of otolaryngology. Studies surrounding specific procedures, specialties, and degrees of surgical complexity have all drawn a variety of conclusions with no generalizable pattern [30–32]. However, our results allow for the conclusion that the training of otolaryngology residents and fellows in free flap repairs is appropriate and poses no risk to the patient in their 30-day postoperative course.

The NSQIP database is best suited for this analysis as it uniquely records PGY level of involved residents on a national scale. This study is therefore subject to the limitations that come with the use of a large clinical database designed for universal applicability. While NSQIP records a substantial number of patient characteristics and operative factors, information specific to flap management including the use of antibiotics, anticoagulation, and monitoring, as well as surgeon operative volumes, hospital type, geographic region, and cancer staging was not recorded and could not be analyzed. Further, outcome variables are only recorded for the first 30 postoperative days, so differences in long-term consequences cannot be assessed. Although NSQIP is a national database with wide-reaching penetration, participation is still voluntary. Therefore, our findings may not be applicable to all audiences in all clinical settings. Our data is temporally limited to cases reported from 2005 to 2013. During this time, the database increased its scope of information of individual patients, thus creating a heterogeneous dataset particularly as it applies to patient readmission data. Finally, free flaps are rarely done by an attending alone, therefore, those that are performed by an attending alone could lead to a selection bias, where the free flap that is required is not as complex and/or the patient is much healthier, therefore, leading to fewer postoperative complications.

5. Conclusion

Microvascular reconstructive surgery is most often performed at academic training institutions. Resident and fellow participation in these complex cases does not appear to increase 30-day morbidity, mortality, readmission, or reoperation. Prolonged total operative time is an acceptable consequence of intraoperative instruction as there are no associated complications. These findings suggest that in these cases, attending physicians exercise appropriate judgment in defining the operative roles of their residents, and the current model of intraoperative learning is acceptably safe. Continued investigation is warranted to ensure that resident education and experience is being optimized while maintaining quality of care.

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None.

Conflicts of interest

None.

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