Comparison of Free Flap Outcomes at a University Hospital versus County Hospital Setting for Head and Neck Reconstruction

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Abstract

Introduction Patients at public county hospitals often have poorer access to healthcare with advanced disease on presentation. These factors, along with limited resources at county hospitals, may have an impact on outcomes for patients requiring complex head and neck reconstruction.

Objective To delineate differences in the frequency of complications in two different care settings, a public county hospital and a private university hospital.

Methods Retrospective review of otolaryngology patients at a university hospital compared with a publicly-funded county hospital. The main outcome measure was major complications including total flap loss or unplanned reoperation in 30 days. Secondary outcome measures included medical complications, partial flap loss, and unplanned hospital readmission in 30 days.

Results In the county hospital sample ($n = 58$) free flap failure or reoperation occurred in 20.7% of the patients, and minor complications, in 36.2% of the patients. In the university hospital sample ($n = 65$) flap failure or reoperation occurred in 9.2% of the patients, and minor complications, in 12.3% of the patients. Patients at the private hospital who had surgery in the oropharynx were least likely to have minor complications.

Conclusion Patients at the county hospital had a higher but not statistically significant difference in flap failure and reoperation than those at a university hospital, although the county hospital experienced more minor postoperative complications. This is likely multifactorial, and may be related to poorer access to primary care preoperatively, malnutrition, poorly controlled or undiagnosed medical comorbidities, and differences in hospital resources.

Keywords
- free tissue flaps
- head and neck cancer
- reconstructive surgery
- public hospitals
- postoperative complications

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Introduction

Free tissue transfers have drastically improved the options for head and neck reconstruction following ablative surgery. With new reconstructive techniques, larger defects are able to be effectively reconstructed to maximize functional and cosmetic outcomes. In fact, it is often the first line of treatment due to success rates that exceed 96%.[1,2] Differences in socioeconomic status and hospital resources, however, have been shown to affect the outcomes of cancer patients.[3–6] These findings are especially concerning due to significant differences in patient demographics and resources across hospitals. In particular, county hospitals often serve uninsured or underinsured patients with poorer access to care compared with private hospitals.[7]

Despite studies showing differences in outcomes based on socioeconomic status, there have been few studies examining the differences in treatment outcomes between public versus private hospitals with respect to head and neck cancer surgical outcomes. Currently, there is only one other study[8] examining the impact of these factors in treatment outcomes when looking at three hospitals with varying patient demographics. In his 2009 paper, Myers[8] showed that there was no significant difference in survival based on posttreatment Kaplan-Meier survival curves, with an insignificant difference in donor site, surgical, and medical complications.

The author's university is uniquely positioned to further elucidate the important question of whether there are differences in treatment outcomes between publicly-funded and private hospitals. It is affiliated with the largest public medical hospital in the county and much of the surrounding region.[9] In close proximity to this public county hospital (CH) is the private university hospital (UH), and the head and neck cancer patients are served by the same physicians at both hospitals. As of the most recent reporting, 11.2% of inpatient discharges at the public CH had private insurance, and 7.3% had Medicare,[9] in contrast to the UH, in which 41.7% of inpatient discharges had private insurance, and 46.7% had Medicare.[10] For the otolaryngology service, both hospitals are staffed by the same attending physicians, which allows for comparison of outcomes between the patient populations. Additionally, the otolaryngology residents rotate at both hospitals, with the entire fourth year of training spent at the university hospital, and the entire fifth year of training spent at the CH. The care team at the UH also includes an otolaryngology intern, a third-year resident, and a physician assistant. The team at the CH is made up of an otolaryngology intern, a second-year resident, and a fifth-year chief resident. At both institutions, patients undergoing free flap surgery are admitted to the intensive care unit (ICU) postoperatively, typically for one to two days, until criteria are met for transfer out of the unit to a step-down unit with telemetry. Using the experiences of these two hospitals, the present study aims to delineate differences in the frequency of complications in two different care settings, a public CH and a private UH, and examine possible causes of these differences, if they exist.

Methods

Patient Selection and Data Collection

After obtaining study approval from the institutional review board, medical records were retrospectively reviewed for all patients at the UH and CH who had free flaps performed by the otolaryngology service from 2009 to 2014. The same two microvascular surgeons performed the free flap surgeries at both hospitals. Procedures were only included if they were anterolateral thigh (ALT), radial forearm (RFFF), fibula, scapula, latissimus-free, iliac crest, or rectus free flap procedures. Surgical data including date of the surgery, indication for the free flap, type of free flap, TNM stage (if the indication was cancer resection), American Society of Anesthesiologists (ASA) grade, preoperative diagnosis, length of hospital stay, lesion site, and preoperative albumin of the patient were recorded.

Demographic information including sex, age at the time of surgery, ethnicity, smoking history, and alcohol history was recorded. Additionally, records of past medical history, including diabetes, coronary artery disease, and past cancer treatment were noted. Operative information included estimated blood loss and units of intraoperative transfusions.

The primary outcome measures were postoperative major and minor complications. Major complications were defined as total flap loss or unplanned reoperation for reasons other than total flap loss within 30 days. Minor complications included partial flap loss not requiring reoperation, infections, fistula formation, medical complications, and unplanned hospital readmission within 30 days of the original procedure.

Statistical Analysis

A power analysis indicated a need for at least 30 control patients to achieve statistical significance. In view of this, all free flaps performed at the CH were included and compared with a control group of at least that size at the UH. The Chi-squared with Yates continuity correction, the Fisher exact test, and the Wilcoxon nonparametric test were used for the bivariate statistical analysis. The Yates continuity correction was required to prevent overestimation of statistical significance from small data. Logistical multivariate regression was used to better understand the major factors affecting whether a patient had a complication. In addition to age and length of hospital stay, only variables that had less than 5% missing values and met a p-value cutoff of 0.25 on the univariate analysis were included for the multivariate analysis.[11,12] Of note, flap types with only one or two cases were excluded from the final multivariate regression analysis. All statistical analyses were conducted using the R (R Core Team, Vienna, Austria) and Stata (StataCorp., College Station, Texas, US) software. Statistical significance was established when $p < 0.05$ for all analyses.

Results

The total study population consisted of 123 patients who received head and neck free flap procedures from 2009 to

Table 1 Key demographics of the patients included from the university hospital and county hospital

	County Hospitaln = 58	University Hospitaln = 65	*p*-value
Gender	n (%)	n (%)	
Male	38 (65.5)	46 (70.8)	
Female	20 (34.5)	19 (29.2)	0.67
Age (years) at surgery			
Median	54	65	
Range	12–73	32–85	< 0.001
Race			
Caucasian, n (%)	18 (31.0)	46 (70.8)	
Hispanic, n (%)	21 (36.2)	8 (12.3)	
Black, n (%)	6 (10.3)	4 (6.2)	
Asian, n (%)	9 (15.5)	5 (7.7)	
Other, n (%)	4 (6.9)	2 (3.1)	< 0.001
Smoking			
Non-smoker	24 (41.4)	34 (52.3)	
Former smoker	13 (22.4)	17 (26.2)	
Current smoker	21 (36.2)	14 (21.5)	0.20
Alcohol			
None	32 (55.2)	45 (69.2)	
Social	12 (20.7)	16 (24.6)	
Heavy	14 (24.1)	4 (6.2)	0.019
Diabetes			
Non-diabetic	54 (93.1)	55 (84.6)	
Diabetic	4 (6.9)	10 (15.4)	0.23

2014. In total, 58 patients who received a free flap at the CH were matched with a randomly selected control group of 65 cases of the more than 250 done at the UH from 2009 to 2014.

Patient Demographics and Baseline Characteristics

The majority of the sample was male (66% versus 70%), and there were no differences in sex distribution ($p = 0.67$; see ►**Table 1** for sample characteristics). The median age at the CH was significantly younger (54) compared with the UH (65) ($p < 0.001$). The plurality of patients at the UH identified themselves as Caucasian (46%). In contrast, the plurality of patients at the CH identified themselves as Hispanic. ($p < 0.001$) There was a significant difference in cases with a history of alcohol use ($p = 0.019$). The cases at the CH tended to have a history of heavy alcohol use (24%) relative to the UH (6%). There was no statistically significant difference in the case of smoking ($p = 0.20$).

Tumor Characteristics and Past Medical History

The tumor characteristics are described in ►**Table 2**. In both cases, the most common site of the lesion was located in the oral cavity. However, there was a significant difference in the distribution of lesion locations between CH and UH ($p = 0.016$). Of the 123 cases analyzed in the present study, 108 were related to cancer resection. The most common stage for these cancers was T4N0M0. That said, the CH population displayed a greater distribution of more advanced nodal staging compared with the population at the UH ($p = 0.0012$). There was also a statistically significant difference in prior radiation treatment between the 2 facilities, with 41.5% of patients at the UH receiving previous radiation treatment, against 12.1% of patients at the CH ($p < 0.001$). There was, however, no significant difference in prior chemotherapy treatment ($p = 0.47$).

Past medical history is described in ►**Table 2**. 15.4% of patients at the UH had diabetes compared with 6.9% of patients at the CH ($p = 0.23$). A greater proportion of patients at the UH (43.1%) also had prior surgeries compared with the patients at the CH (25.9%) ($p = 0.07$). Both of these proportions were not statistically significant.

Surgical Characteristics

The surgical characteristics are highlighted in ►**Table 3**, and there was a wide range of indications for surgery. The proportion of the different types of indications between the two hospitals was not significant ($p = 0.55$). The most common type of flap for both hospitals was the radial

Table 2 Key characteristics of tumors and any treatment prior to surgical resection for which free flap reconstruction was required from both the university hospital and county hospital

	County hospital n = 58	**University hospital n = 65**	***p*-value**
Lesion site	n (%)	n (%)	
Oral	35 (60.3)	35 (53.8)	
Buccal	5	1	
Retromolar trigone	4	1	
Floor of mouth	4	3	
Mandible	9	13	
Alveolar ridge	2	1	
Tongue	11	12	
Oropharynx	5 (8.6)	8 (12.3)	
Posterior wall	0	2	
Base of tongue	1	0	
Tonsil	4	6	
Soft palate	0	2	
Overlapping sites	0	4 (6.2)	
Larynx	0	4 (6.2)	
Skin	6 (10.3)	7 (10.8)	
Sinus/Maxilla	11 (19.0)	3 (4.6)	
Parotid	0	3 (4.6)	
Nasopharynx	1 (1.7)	1 (1.5)	0.016
T stage			
1	3 (6.1)	7 (11.9)	
2	7 (14.3)	16 (27.1)	
3	15 (30.6)	12 (20.3)	
4/4a/4b	24 (49.0)	24 (40.7)	0.22
N stage			
X	1 (2.0)	10 (16.9)	
0	22 (44.9)	35 (59.3)	
1	11 (22.4)	4 (6.8)	
2/2a/2b/2c	15 (30.6)	8 (13.6)	
3	0	2 (3.4)	0.0012
M stage			
X,0	49	59	
Prior radiotherapy			
Yes	7	27	
No	51	38	< 0.001
Prior chemotherapy			
Yes	7	12	
No	51	53	0.47
	County hospitaln = 58	**University hospital**n = 65	***p*-value**
Diabetes mellitus			
Yes	4 (6.9)	10 (15.4)	
No	54 (93.1)	55 (84.6)	0.232
Prior surgery			
Yes	15 (25.9)	28 (43.1)	
No	43 (74.1)	37 (56.9)	0.0704

Table 3 Characteristics of the indication for surgical resection as well as the type of free flap used for reconstruction from the university hospital and county hospital

	County hospitaln = 58	University hospitaln = 65	*p*-value
Indication for surgery			
Cancer resection	49 (84.5)	59 (90.8)	0.55
Benign resection	3 (5.2)	2 (3.1)	
Reconstruction	5 (8.6)	2 (3.1)	
Osteoradionecrosis	1 (1.7)	2 (3.1)	
Type of flap			
Anterolateral thigh	23 (35.4)	16 (27.6)	0.54
Fibula	11 (16.9)	15 (25.9)	
Radial forearm	30 (46.2)	24 (41.4)	
Latissimus	1 (1.5)	1 (1.7)	
Scapula	0	1 (1.7)	
Rectus	0	1 (1.7)	

forearm flap. The distribution of the types of flaps was not significantly different between the two hospitals ($p = 0.54$).

Surgical Outcomes

Surgical outcomes are described in ►**Table 4**. During the surgery, 2 out of the 58 patients at the CH had intraoperative complications. One patient experienced a cerebrospinal fluid (CSF) leak and the other patient's vagus nerve was injured. At the UH, none of the patients experienced any intraoperative complications ($p = 0.22$). Following surgery, a statistically significant percentage of patients at the CH (36.2%) experienced minor postoperative complications compared with the patients at the UH (12.3%) ($p = 0.003$). Major complications were noted in 20.7% of CH patients, with 10.3% of patients experiencing total flap failure, and 10.3% requiring unplanned reoperation for reasons other than total flap failure. As for the UH, 9.2% of patients had major complications, with 6.2% experiencing total flap failure and 3.1% requiring reoperation. This, however, was not statistically significant for combined major complications ($p = 0.08$), or for each type of major complication (flap failure: $p = 0.51$; reoperation: $p = 0.15$). The mean length of stay for the patients at the CH was 16 days, compared with 10 days at the UH.

Finally, blood loss at the CH was greater (1198.1 mL versus 871.5 mL). The mean number of transfusions at the CH for the procedure was 3.1 packed red blood cells (PRBCs) compared with 2.9 PRBCs at the UH.

Multivariate regression was used to determine the significant variables contributing to complications in ►**Tables 5** and **6**. Length of hospital stay and the presence of previous surgeries positively contributed to the presence of major complications in a statistically significant way. Patients at UH were less likely to have minor complications (odds ratio [OR]: 0.21; $p = 0.01$). Additionally, patients who had surgery on the oropharynx were less likely to have minor complications (OR: 0.22; $p = 0.01$), but patients who were social alcohol users were more likely to have complications (OR: 5.97; $p = 0.003$).

Discussion

Free flap reconstruction for head and neck cancers has revolutionized the treatment options for patients, and is now commonly a first-line method of treating and reconstructing head and neck cancer. Numerous studies have demonstrated the effectiveness and relatively low complication rate of free flaps. Many studies have looked at the various predictors of flap outcome; however, few have examined how care received at publicly-funded hospitals compares to privately-funded hospitals with regards to free flap surgery complications.

Past medical history and medical comorbidities have been investigated as possible predictors of complications related to free flap surgery, including prior irradiation, female gender, lengthy operating time, diabetes mellitus, peripheral vascular disease, and renal failure.[13–17] The published data, however, is inconsistent regarding the predictability of these variables. In a retrospective cohort study of 2,846 patients, Ishimaru et al.[13] found that diabetes, peripheral vascular disease, renal failure, preoperative radiotherapy, and longer anesthesia duration were predictors of free flap failure. In their study of 881 patients, Zhou et al.[14] also demonstrated an association of prior irradiation as a risk factor for flap failure; however, they did not find an association between age, diabetes, or prior neck surgery with flap failure. Rosenberg et al.[15] found that female gender and operating time were predictors of surgical complications. le Nobel et al.[17] found that only higher tumor stage and pharyngoesophageal reconstruction were associated with increased complications, with no association observed with preoperative radiation, chemotherapy, smoking, alcohol, age, diabetes, peripheral vascular disease, myocardial infarction, cerebrovascular disease, flap type, or indication for reconstruction.

Table 4 Comparison of surgical outcomes between the county hospital and university hospital, including major and minor complications

	County hospitaln = 58	University hospitaln = 65	*p*-value
Intraoperative complications			
Yes	2 (3.4)	0	
No	56 (96.6)	65 (100.0)	0.22
Major postoperative complications			
Yes	12 (20.7)	6 (9.2)	
No	46 (79.3)	59 (90.8)	0.08
Total flap failure			
Yes	6 (10.3)	4 (6.2)	
No	52 (89.7)	61 (93.8)	0.51
Unplanned reoperation			
Yes	6 (10.3)	2 (3.1)	
No	52 (89.7)	63 (96.9)	0.15
Minor postoperative complications			
Yes	21 (36.2)	8 (12.3)	
No	37 (63.8)	57 (87.7)	0.003
Estimated blood loss			
Mean	1198.1	871.5	
Range	50–3850	200–3300	0.03
Transfusions			
Mean	3.1	2.9	
Range	0–12	0–10	0.88
Mean length of hospital stay	16	10	< 0.001

Table 5 Predictors of major complications with odds ratios and 95% confidence intervals

	Odds ratio	95% confidence interval		*p*-value
Hospital type				
Private hospital	0.77	0.17	3.44	0.73
Public hospital	1-REF			
Gender				
Male	2.54	0.61	10.51	0.20
Female	1-REF			
Age at the time of surgery	0.98	0.94	1.03	0.49
Type of flap				
Fibular flap	1.31	0.24	7.08	0.75
Radial forearm	0.46	0.11	1.95	0.30
Anteriorlateral thigh	1-REF			
Length of hospital stay	1.16	1.05	1.27	0.004
Race				
White	0.54	0.13	2.17	0.39
Non-white	1-REF			
Past surgery				
Yes	7.11	1.59	31.74	0.01
No	1-REF			

Table 6 Significant predictors of minor complications

	Odds ratio	95% confidence interval		*p*-value
Hospital type				
Private hospital	0.21	0.06	0.66	0.01
Public hospital	1-REF			
Age	1.01	0.98	1.05	0.47
Length of hospital stay	1.05	1.00	1.10	0.07
Lesion site				
Oropharynx	0.22	0.07	0.66	0.01
Other	1-REF			
Alcohol use				
Social	5.97	1.82	19.60	0.003
Heavy	1.61	0.38	6.87	0.52

Finally, Mücke et al.[16] demonstrated in their study that the only independent predictor of flap failure was previously failed attempts at microvascular reconstruction. As demonstrated, the published data regarding predictors of flap outcomes is inconsistent, with no single variable clearly associated with them.

Despite the many published studies analyzing predictors of flap outcome, there is a paucity of data regarding the impact of treatment at a private hospital compared with a publicly-funded hospital. Myers[8] studied the outcomes of patients undergoing free flap surgeries at private, public, and Veterans Administration hospitals. He found that the only statistically significant differences between the cohorts was age, intraoperative fluid administration, intensive care unit (ICU) days, and total hospital days. With regards to outcomes, there was no statistically significant difference in total flap loss or posttreatment Kaplan-Meier survival curves.

Data from our study does not demonstrate an association between previous radiation, gender, or operating time on flap outcome, but does show a correlation with past surgery and alcohol use leading to an increased likelihood of complications. Additionally, the data demonstrates an increased length of hospital stay at the CH, which is likely multifactorial and may be correlated to more complicated postoperative courses due to higher rates of complications, but also may be attributed to difficulty in finding appropriate placement for patients prior to discharge given the lower percentage of patients with insurance compared with the UH. In addition, there were significant differences in demographics between the public and private hospitals, with publicly-funded hospital patients being more likely to have a history of heavy alcohol use, have diabetes, and have advanced nodal disease. Although ASA class was collected as part of this initial data collection, a large number of cases from the CH did not document ASA class in the surgical record; therefore, inclusion of the ASA class in the final analysis could not be performed.

Our data suggests that patients undergoing surgery at the CH were more likely to experience minor complications when compared with the UH. This may be related to several factors, including the higher percentage of social and heavy alcohol users in the county population, as well as higher nodal staging at presentation. The more advanced presentation of patients at the CH may be due to decreased access to primary care, leading to late detection of the cancers and delays in referral and treatment. Additionally, although there were no statistically significant differences in premorbid conditions between the CH and UH, our data does not demonstrate how well or poorly managed are the chronic conditions of the patients, nor is it able to capture undiagnosed conditions related to poor access to a primary care physician, which may further contribute to the increased rate of complications at the CH compared with the UH. Free flap surgery is more commonly performed at the UH compared with the CH: $\sim$ 75 per year at the UH, compared with 30 per year at the CH; however, because the same attending physicians perform the surgeries at both hospitals, and the structure of the residency program allows senior residents to gain experience at the UH the entire fourth year and subsequently bring that knowledge to the CH for their fifth year, the level of experience of the otolaryngology team is similar between the hospitals, and likely does not have a significant impact on outcomes.

Although our study demonstrated a statistically higher incidence of minor complications at the county facility compared with the private facility, the rate of complications was relatively low, and the majority of cases at both hospitals were uncomplicated. The rate of total flap loss at both institutions (10.3% at the CH and 6.2% at the UH) was in line with other published reports of overall success of microvascular free flaps in the head and neck region. This reinforces the safety and utility of free flap surgery for reconstruction of head and neck cancers.

Conclusion

Patients who had free flap reconstruction at a publicly-funded hospital had a higher but not statistically significant

difference in total flap failure and reoperation for reasons other than total flap failure than those at a university hospital. This is likely multi-factorial, and may be related to poorer access to primary care preoperatively, leading to delay in diagnosis and treatment, malnutrition, poorly-controlled or undiagnosed medical comorbidities, and differences in hospital resources. Further research is necessary to delineate identifiable risk factors for flap failures and complications so that these may be addressed preoperatively to improve patient care and safety.

Prior Meeting Presentation
Abstract entitled "Comparison of Free Flap Outcomes at a University Hospital versus County Hospital Setting" previously presented at the AHNS Annual Meeting, July 16–20, 2016

Conflict of interests
The authors have no conflict of interests to declare.

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