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ORIGINAL RESEARCH

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Predicting length of stay in head and neck patients who undergo free flap reconstruction

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Abstract

Objective: Understanding factors that affect postoperative length of stay (LOS) may improve patient recovery, hasten postoperative discharge, and minimize institutional costs. This study sought to (a) describe LOS among head and neck patients undergoing free flap reconstruction and (b) identify factors that predict increased LOS.

Methods: A retrospective cohort was performed of 282 head and neck patients with free flap reconstruction for oncologic resection between 2011 and 2013 at a tertiary academic medical center. Patient demographics, tumor characteristics, and surgical and infectious complications were characterized. Multivariable regression identified predictors of increased LOS.

Results: A total of 282 patients were included. Mean age was 64.7 years (SD = 12.2) and 40% were female. Most tumors were located in the oral cavity (53.9% of patients), and most patients underwent radial forearm free flap (RFFF) reconstruction (RFFF—73.8%, anterolateral thigh flap—11.3%, and fibula free flap—14.9%). Intraoperative complications were rare. The most common postoperative complications included nonwound infection (pneumonia [PNA] or urinary tract infection [UTI]) (15.6%) and wound breakdown/fistula (15.2%). Mean and median LOS were 13 days (SD = 7.7) and 10 days (interquartile range = 7), respectively. Statistically significant predictors of increased LOS included flap take back (Beta coefficient [*C*] = +4.26, $P < .0001$), in-hospital PNA or UTI ($C = +2.52$, $P = .037$), wound breakdown or fistula ($C = +5.0$, $P < .0001$), surgical site infection ($C = +3.54$, $P = .017$), and prior radiation therapy ($C = +2.59$, $P = .004$).

Conclusion: Several perioperative factors are associated with increased LOS. These findings may help with perioperative planning, including the need for vigilant wound care, optimization of antibiotics prophylaxis, and institution-level protocols for postoperative care and disposition of free flap patients.

Michael M. Lindeborg, Rosh K. V. Sethi, and Sidharth V. Puram contributed equally to this study.

Level of Evidence: 2b; retrospective cohort.

KEYWORDS

anterolateral thigh flap, fibula free flap, free flap, head and neck cancer, head and neck reconstruction, length of stay, radial forearm free flap

1 | INTRODUCTION

Head and neck cancer patients undergoing free flap reconstruction have variable inpatient length of stay (LOS), ranging from days to weeks to months.[1-3] Variation in LOS has important clinical implications for patient recovery, placement in rehabilitation and acute care facilities, and the initiation of adjuvant multimodality therapy.[4,5] Additionally, LOS is associated with significant hospital costs.[6,7] Prior studies across various surgical specialties have identified several risk factors associated with increased LOS, including American Society of Anesthesiology (ASA) score, pre- and postoperative hemoglobin levels, age, comorbidities, and need for blood transfusion, and have successfully targeted these to decrease LOS, reduce cost, and improve quality of care.[8-11]

Several factors have been associated with variability in LOS specifically among head and neck cancer patients. These include age, recent weight loss, excess alcohol use, malnutrition, history of diabetes, ASA score, Kaplan Feinstein comorbidity index (KFI) score, low preoperative hemoglobin, mucosal surgery, crystalloid replacement volume, and anesthesia or procedure duration.[1,2,12-15] While past head and neck studies have explored clinical risk factors associated with increased LOS, there is a lack of studies that stratify by flap type and include a wider range of risk factors.

Overall, LOS is an important outcome metric monitored by insurers and quality organizations, and a marker of hospital quality associated with cost of care and patient outcomes. Therefore, this study aims to (a) describe LOS among head and neck patients undergoing free flap reconstruction and (b) identify factors that may predict increased LOS.

2 | MATERIALS AND METHODS

A retrospective review of all patients (N = 282) who underwent free flap reconstruction, including anterolateral thigh flap (ALT), fibula free flap (FFF), or radial forearm free flap (RFFF) reconstruction after oncologic resection at a major tertiary care center between 2011 and 2013 was performed. Data for this study were derived, in part, from a previous retrospective cohort study investigating risk factors associated with increased operative time.[16] Institutional Review Board approval was obtained.

LOS data were collected for each patient, and was defined as the time between the day of surgery and the day of hospital discharge. Patient demographics, cancer staging, and clinical data such as previous cancer treatment, tumor site, and comorbidities were collected. Inpatient events were characterized including flap take back (defined as flap failure or compromise requiring surgical intervention), postoperative transfusion, wound breakdown or fistula not related to infection, surgical site infection (SSI; both recipient and donor sites), and postoperative cardiac (myocardial infarction, arrhythmia, congestive heart failure), pulmonary (pulmonary embolism, respiratory distress or failure) and infectious complications (urinary tract infection [UTI], pneumonia [PNA]). Antibiotic prophylaxis protocol at

TABLE 1 Patient demographics

Variable	Number (%)
Age, mean (SD)	64.7 (12.2)
Female gender	112 (39.7)
ASA 3 or 4	169 (59.9)
Stage I-III	137 (54.8)
Stage IV	113 (45.2)
Flap type	
ALT	32 (11.3)
FFF	42 (14.9)
RFFF	208 (73.8)
Tumor site	
Cutaneous/temporal	29 (10.3)
Hypopharynx	15 (5.3)
Larynx	37 (13.1)
Oral cavity	152 (53.9)
Oropharynx	24 (8.5)
Sinus/maxilla	25 (8.9)
ORN (yes)	20 (7.1)
Preoperative XRT	126 (44.7)
Packed Red Blood Cell transfusion	138 (48.9)
Flap take back (yes)	37 (13.1)
In-hospital cardiac issue	21 (7.5)
In-hospital pulmonary issue	22 (7.8)
In-hospital nonwound infection (PNA or UTI)	44 (15.6)
In-hospital wound breakdown or fistula	43 (15.2)
In-hospital surgical site infection	25 (8.9)
LOS (d), mean (SD)	13.0 (7.7)
LOS (d), median (IQR)	10.0 (7.0)

Note: Surgical site infection includes both donor and recipient sites. Table adapted from Lindeborg et al.[16]

Abbreviations: ALT, anterolateral thigh; ASA, American Society of Anesthesiology Physical Classification; FFF, fibular free flap; IQR, interquartile range; LOS, length of stay; ORN, osteoradionecrosis; PNA, pneumonia; RFFF, Radial forearm free flap; UTI, urinary tract infection; XRT, radiation.

study site was to stop antibiotic prophylaxis 24 hours after first perioperative prophylactic dose.

Patient characteristics and inpatient events were characterized descriptively and stratified by flap type. Univariable comparisons were performed using Student's *t* test, chi-square test, and the Kruskal-Wallis test where appropriate. A linear multivariable regression analysis was performed to identify predictors of increased LOS. All data manipulation and statistical analysis were performed using STATA v13 (STATA Corp, North Carolina).

3 | RESULTS

3.1 | Patient characteristics

A total of 282 patients underwent RFFF (N = 208, 73.8%), FFF (N = 42, 14.9%), or ALT (N = 32, 11.3%) reconstruction after oncologic resection and were included in the study (Table 1).

Mean patient age was 64.7 years (SD = 12.2 years), 40% of patients were female, and 59.9% of patients had an American Society of Anesthesiologists (ASA) Physical Status Classification System status of 3 or 4. A high proportion of patients had advanced stage cancer, with 45.2% stage IV and 54.8% stage I to III. The most common tumor site was the oral cavity (53.9%). Forty-four percent of patients had received prior radiation therapy. Postoperatively, 48.9% of patients received packed red blood cell transfusion. The most common postoperative complications were nonwound infection (PNA or UTI) (15.6%) and wound breakdown or fistula (15.2%).

3.2 | Pre- and perioperative factors by flap type

Patient demographics, tumor characteristics, and pre- and perioperative factors were stratified by flap type (Table 2). Preoperative factors, including patient age, gender, and ASA status, did not vary. There were significant differences, however, in tumor site and stage. Patients who

TABLE 2 Pre- and perioperative factors by flap type[a]

Variable	ALT (32)	FFF (42)	RFFF (208)	*P* value
Age (y)	65.8 (10.6)	63.3 (11.8)	64.9 (12.5)	.487
Female, no. (%)	14 (43.8)	14 (33.3)	84 (40.4)	.615
ASA 3 or 4, no. (%)	23 (71.9)	18 (42.9)	128 (61.5)	.074
Tumor site				<.0001
Cutaneous/temporal	3 (9.4)	1 (2.4)	25 (12.0)	
Hypopharynx	1 (3.1)	0 (0)	14 (6.7)	
Larynx	1 (3.1)	0 (0)	36 (17.3)	
Oral cavity	7 (21.9)	41 (97.6)	104 (50)	
Oropharynx	7 (21.9)	0 (0)	17 (8.2)	
Sinus/maxilla	13 (40.6)	0 (0)	12 (5.8)	
Stage				<.0001
I-III	8 (25.8)	1 (3.2)	128 (68.1)	
IV	23 (74.2)	30 (96.8)	60 (31.9)	
ORN (yes)	0 (0)	7 (16.7)	13 (6.3)	.068
Preoperative XRT	17 (53.1)	12 (28.6)	97 (46.6)	.059
Packed Red Blood Cell transfusion	21 (65.6)	19 (45.2)	98 (47.1)	.131
Flap take back (yes)	4 (12.5)	5 (11.9)	27 (13.0)	.981
In-hospital cardiac issue	0 (0)	6 (14.3)	15 (7.2)	.072
In-hospital pulmonary issue	5 (15.6)	5 (11.9)	12 (5.8)	.067
In-hospital nonwound infection (PNA or UTI)	6 (18.8)	7 (16.7)	31 (14.9)	.797
In-hospital wound breakdown or fistula	7 (21.9)	4 (9.5)	32 (15.4)	.377
In-hospital surgical site infection	4 (12.5)	4 (9.5)	17 (8.2)	.614
Mean LOS (d) (SD)	14.8 (9.4)	13.9 (6.7)	12.6 (7.6)	.125
Median LOS (d) (IQR)	12 (9)	11 (7)	10 (6)	.094

Note: Surgical site infection includes about donor and recipient sites.
Abbreviations: ALT, anterolateral thigh; ASA, American Society of Anesthesiology Physical Classification; FFF, fibular free flap; IQR, interquartile range; LOS, length of stay; ORN, osteoradionecrosis; PNA, pneumonia; RFFF, radial forearm free flap; UTI, urinary tract infection; XRT, radiation.
[a]There were no statistically significant differences in patient demographics and preoperative characteristics across flap type except for tumor site and tumor stage. Student's *t* test and the Kruskal-Wallis test were used for quantitative data, while chi-square test was used to analyze proportional data.

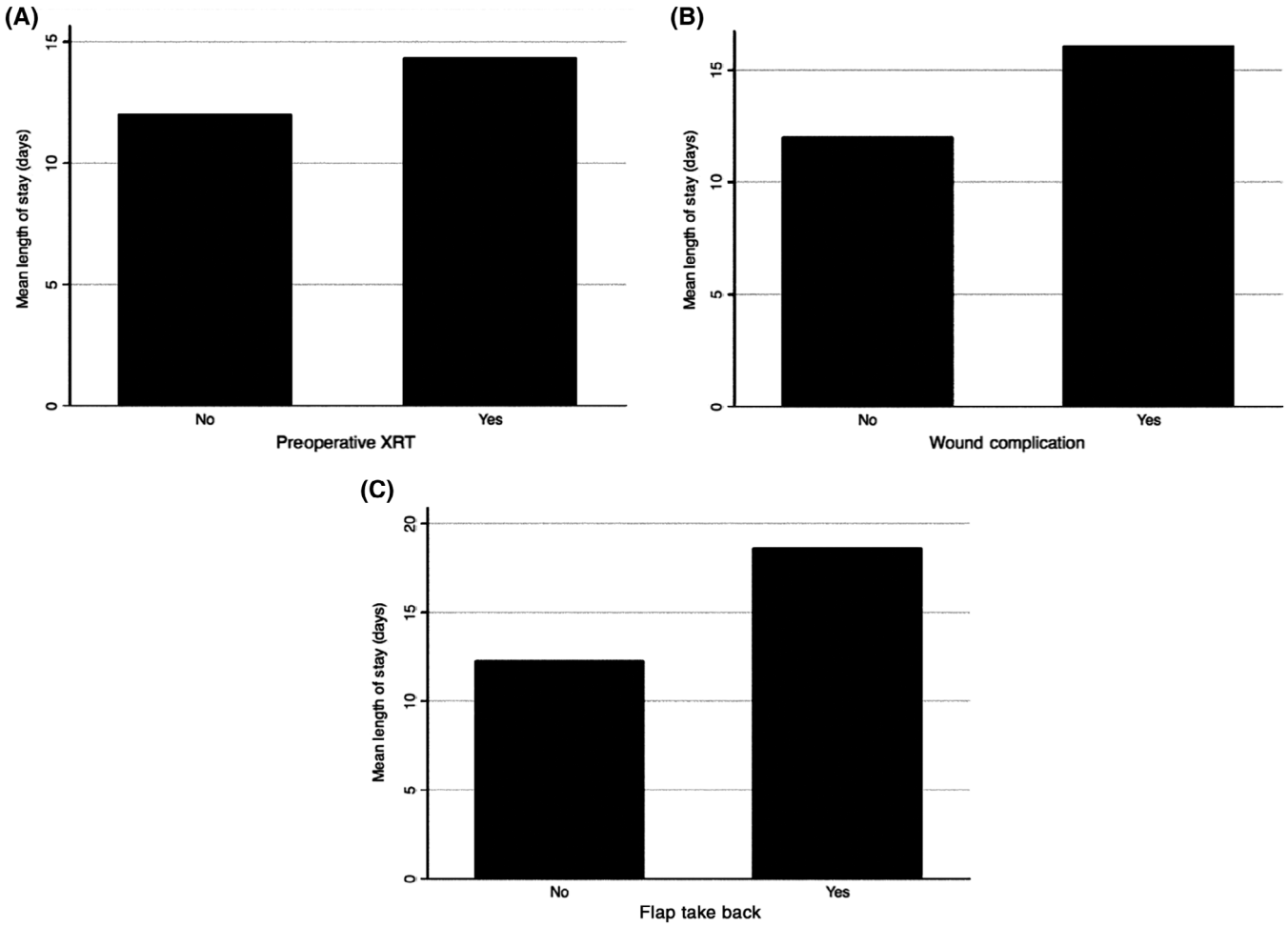

FIGURE 1 Univariable analysis of factors associated with increased length of stay. A, Preoperative radiation (XRT); B, Wound complication; C, Flap take back

underwent FFFs more commonly had stage IV tumors located in the oral cavity. History of prior radiation therapy was more common among patients who underwent RFFF as compared to those who had ALT or FFF patients. Though not significantly different, the data for in-hospital cardiac and pulmonary issues were variable across flap type.

3.3 | Length of stay

The mean LOS was 13 days (SD = 7.7, range 4-65). Duration of stay was similar when stratified by flap type (14.8 ± 9.4 days for ALT, 13.9 ± 6.7 days for FFF, and 12.6 ± 7.6 for RFFF). Median LOS was 10 days (interquartile range = 7), and was also not significantly different across flap types (Table 2). In bivariable analysis, preoperative radiation (XRT) was associated with a significant increase in LOS of approximately 2.5 days (Figure 1A). Wound complication (breakdown or fistula) was also associated with a significant increase LOS of approximately 4 days (Figure 1B). Finally, patients who returned to the operating room for flap take back had a significantly longer LOS as compared to those who did not (Figure 1C).

3.4 | Multivariable analysis of pre- and perioperative factors associated with greater LOS

A multivariable regression model was performed to identify factors associated with greater LOS (Table 3). Significant predictors of increased LOS included flap take back (beta coefficient [*C*] = +4.26, $P < .0001$), in-hospital PNA or UTI ($C = +2.52$, $P = .037$), wound breakdown or fistula ($C = +5.0$, $P < .0001$), SSI ($C = +3.54$, $P = .017$), and history of prior radiation therapy ($C = +2.59$, $P = .004$) (Table 3). Of note, there was no significant difference in LOS between patients who had either PNA, a UTI, or both PNA and a UTI.

4 | DISCUSSION

In this study, we investigated the factors that may affect LOS for head and neck cancer free flap reconstructive surgeries in 282 patients at a tertiary medical center. Flap take back, postoperative PNA or UTI, wound breakdown or fistula, SSIs, and history of prior radiation therapy were associated with increased LOS. Notably, flap type was not associated.

TABLE 3 Multivariable linear regression of pre- and perioperative factors associated with greater length of stay

Variable	Beta coefficient	95% Confidence interval	*P* value
Preoperative and demographic factors			
Female gender (vs male)	−1.11	−2.87 to −0.66	.217
Age (per 1 additional year)	+ 0.05	−0.02 to 0.13	.162
Stage IV (vs stage I-III)	+ 0.02	−1.91 to 1.96	.982
History of ORN	+ 1.45	−6.36 to 9.27	.715
Preoperative XRT	+ 2.59	0.84-4.35	.004
ASA 3 or 4 (vs 1-2)	+ 1.09	−0.65 to 2.82	.219
Flap type			
ALT	REF		
FFF	+ 2.31	−1.15 to 5.78	.189
RFFF	−0.01	−2.73 to 2.72	.999
Perioperative complications (yes vs no)			
Transfusion	+0.89	−0.86 to 2.63	.317
Flap take back	+4.26	1.68-6.84	.004
Cardiac complication	+2.60	−0.69 to 5.88	.120
Pulmonary complication	+1.80	−1.47 to 5.08	.280
Nonwound infection (PNA or UTI)	+2.52	0.15-4.89	.037
Wound breakdown or fistula	+4.98	2.60-7.35	<.0001
Surgical site infection	+3.54	0.63-6.45	.017

Note: Surgical site infection includes both donor and recipient sites.
Abbreviations: ALT, anterolateral thigh; ASA, American Society of Anesthesiology Physical Classification; FFF, fibular free flap; LOS, length of stay; ORN, osteoradionecrosis; PNA, pneumonia; RFFF, radial forearm free flap; UTI, urinary tract infection; XRT, radiation.

Head and neck cancer free flap patients are often at increased risk for postoperative infection due to multiple wound areas, clean-contaminated operation sites, underlying comorbidities, and prolonged operation time.[17] SSIs and wound complications (breakdown or fistula) were associated with substantially increased LOS. The literature reports that SSIs can occur in up to 22% to 39% of head and neck cases, even with the use of antibiotic prophylaxis.[13] Other head and neck studies not only corroborate that SSI is an independent risk factor for LOS, but also show that SSI increases the risk for 30-day readmission.[14,18-20] Past studies have explored the use of postoperative antibiotic prophylaxis; however, no randomized controlled study has demonstrated a significant reduction in SSIs with postoperative prophylaxis.[17] Of note, programs implementing infection-control protocols such as the Center for Medicare and Medicaid's National Surgical Care Improvement Project have demonstrated a lower than expected rate of SSIs.[17,21] Type and duration of perioperative antibiotic prophylaxis, degree of wound surveillance postoperatively, and rehabilitative support are interventions that have the potential to successfully diminish infection rate.[22-24]

Postoperative nonwound infections, such as PNA and UTI, represent common yet avoidable postoperative complications that prolong discharge in head and neck cancer patients. Past studies have found that hospital acquired pneumonia occurs in as many as 4.7% to 9.7% of head and neck patients postoperatively, but few have examined its impact on LOS.[25-27] Penel et al showed that postoperative pneumonia was correlated with an increased LOS; however, prolonged antibiotic use after free flap construction may not decrease pneumonia risk.[13] Khariwala et al demonstrated that a prolonged course of antibiotics was actually associated with a higher risk of pneumonia in free flap patients.[28] Additionally, other respiratory complications such as prolonged ventilator dependence are associated with increased LOS.[20] To date, there has been limited data surrounding antibiotic type and duration to minimize nonwound infections in complicated free flap surgical patients.[17] Head and neck surgical teams should explore both pharmacological measures, such as optimizing perioperative antibiotics, and nonpharmacological measures, such as early ambulation, local antiseptic care, and greater care with intubation and urinary catheter placement.[29]

History of radiation therapy was associated with increased LOS. It is notable that the majority of head and neck free flap studies demonstrate a positive association between preoperative radiation therapy and postoperative infectious complications or flap survival.[30-35] Robust infection prevention protocols may prove especially beneficial for patients with a history of radiation therapy.

Past studies have found that increased operative time may be associated with increased LOS in free flap patients.[20] In our cohort, operative time was not significantly associated with increased LOS. With improvements in free flap surgical techniques and down trending operative times, operative time may not be a strong predictor of postoperative complications.[16] Operative time may also be a proxy

for surgical complexity and increase the risk for complications and LOS.

Nonmodifiable preoperative patient-specific factors (eg, history of chemotherapy and/or radiation) are associated with increased LOS, and should be taken into account when planning for patient disposition. The factors can also be used to identify patients who may be at higher risk for perioperative complications. Institution-specific practices may also play a role, and merit further exploration. For example, we previously found that LOS and hospital mortality are comparable to nonacademic centers, even though academic center patients are often more complicated, and have higher rates of chemotherapy and radiation.[36] Careful attention to history of radiation and other clinical factors associated with complications and increased LOS may optimize the quality of patient care and minimize related health care expenditures.

This study is limited by its retrospective design, potential for absence of other confounding variables not ascertainable in the patient's medical record. Other variables worth investigating in future studies include postoperative delirium, substance use or withdrawal, need for postacute care, and need for tracheostomy or feeding tube at discharge. The sample size of this study is relatively small, includes more males than females, and samples patients from only a single institution. To control for institution-specific factors that could influence LOS, future studies with a broader, more diverse study population can help to confirm these findings.

Ultimately, this study demonstrates that multiple factors may be associated with significantly increased LOS, many of which may be modifiable. Though high-volume free flap programs often have established perioperative protocols, efforts to optimize care pathways and minimize LOS continue to be essential. Further studies that prospectively investigate the impact of programs targeting these factors would be valuable in better understanding their merit and potential for intervention.

5 | CONCLUSION

This study identifies several pre- and perioperative factors during head and neck free flap reconstructive surgery that are associated with increased LOS. Initiatives to address these factors could decrease LOS, leading to hospital savings and improved patient outcomes. These initiatives may include optimizing perioperative antibiotic use, as well as the institution of specific protocols to minimize risk for SSI and medical complications such as PNA and UTI.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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