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Characteristics and Intraoperative Treatments Associated with Head and Neck Free Tissue Transfer Complications and Failures

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Abstract

Objective—To investigate the association between perioperative patient characteristics and treatment modalities (eg, vasopressor use and volume of fluid administration) with complications and failure rates in patients undergoing head and neck free tissue transfer (FTT).

Study Design—A retrospective review of medical records.

Setting—Perioperative hospitalization for head and neck FTT at 1 tertiary care medical center between January 1, 2009, and October 31, 2011.

Subjects and Methods—Consecutive patients (N = 235) who underwent head and neck FTT. Demographic, patient characteristic, and intraoperative data were extracted from medical records. Complication and failure rates within the first 30 days were collected

Results—In a multivariate analysis controlling for age, sex, ethnicity, reason for receiving flap, and type and volume of fluid given, perioperative complication was significantly associated with surgical blood loss (*P* = .019; 95% confidence interval [CI], 1.01-1.16), while the rate of intraoperative fluid administration did not reach statistical significance (*P* = .06; 95% CI, 0.99-1.28). In a univariate analysis, FTT failure was significantly associated with reason for surgery (odds ratio, 5.40; *P* = .03; 95% CI, 1.69-17.3) and preoperative diagnosis of coronary artery disease (odds ratio, 3.60; *P* = .03; 95% CI, 1.16-11.2). Intraoperative vasopressor administration was not associated with either FTT complication or failure rate.

Conclusions—FTT complications were associated with surgical blood loss but not the use of vasoactive drugs. For patients undergoing FTT, judicious monitoring of blood loss may help stratify the risk of complication and failure.

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Keywords

head and neck free tissue transfer; anesthesia management; intraoperative vasopressors; intraoperative fluid management; intraoperative blood loss

Microvascular free tissue transfer (FTT) is one of the preferred reconstructive options for patients with head and neck defects.[1] While these procedures are often lengthy and complex, the overall reported success rate approaches 95%.[2-4] Postoperative complications can result in serious morbidity as well as increased hospital costs due to longer hospital stays and additional surgical or medical interventions.[5] For these reasons, there may be benefit in identifying modifiable factors that can improve perioperative outcomes in patients undergoing head and neck FTT.

The intraoperative management of these patients, with respect to hemodynamic control via vasopressor or fluid administration, is believed to affect free flap outcome.[2,3,6] Several animal models have shown that phenylephrine administered directly into the feeding artery of the free flap can decrease blood flow.[7-9] Additionally, a functional sympathectomy occurs during preparation of the anastomotic vessels, which can lead to hypersensitivity to alpha-adrenergic stimulation and result in vasospasm with potential flap compromise.[10,11] These findings have led to a dogmatic belief that vasopressors should be avoided intraoperatively during a microvascular free tissue dissection and reconstruction. However, recently published prospective and retrospective human studies suggest that the intraoperative use of vasopressors does not appear to negatively influence surgical success.[12-14]

In an attempt to avoid vasopressor use, patients will often receive generous amounts of intravenous fluid to compensate for periods of hypotension. The current literature suggests that more than 7 L of crystalloid given during initial FTT is associated with higher rates of graft failure and complications.[2,3] Another component of fluid balance is blood loss and transfusion. There is evidence suggesting that blood transfusions are associated with suboptimal outcomes during head and neck FTT.[2] Increased blood loss has also been correlated with negative outcomes following head and neck surgeries independent of transfusion.[15]

We performed this retrospective study of a head and neck FTT population to investigate intraoperative management strategies that may affect patient outcomes. The objective of this study was to investigate the association among preoperative characteristics, reason for surgery, intraoperative treatments, and FTT complication and failure rates.

Methods

All data were gathered from written and electronic medical records after approval from the institutional review board at the Medical University of South Carolina in November 2011. We identified a total of 235 consecutive patients from the operating room case log at the university who underwent a head and neck FTT between January 1, 2009, and October 31, 2011.

Through retrospective chart review, we gathered patientspecific data, including age, sex, ethnicity, American Society of Anesthesiology classification, height, weight, preoperative patient comorbidities, preoperative use of an ACE inhibitor or angiotensin receptor blocker, preoperative and postoperative hemoglobin (g/dL), reason for surgery, and prior radiation exposure. Body mass index was calculated from preoperative recorded weight and height. Reason for FTT was recorded as cancer, osteoradionecrosis, or "other," which encompassed issues such as chronic fistula, nonhealing wounds, and trauma. Twelve specific preoperative comorbidities were extracted from the preoperative anesthesia record to be consistent with previously published studies: cardiomyopathy/congestive heart failure, coronary artery disease, moderate to severe valvular disease, chronic obstructive lung disease, renal disease, current tobacco use, prior tobacco use, liver disease, cardiac arrhythmias, peripheral vascular disease, diabetes, and asthma. Duration of graft ischemia time was obtained, when available, from dictated surgical intraoperative notes. Data regarding duration of anesthesia and surgery were obtained from the intraoperative anesthetic record (PICIS, Wakefield, Massachusetts).

Data regarding intraoperative vasopressor and fluid use were collected from the intraoperative anesthesia record. Sympathomimetic agents used intraoperatively included phenylephrine, ephedrine, dobutamine, and epinephrine. Total administered dose of these drugs, including duration of infusion rate when applicable, was recorded. Vasopressor use only within the first 2 hours of anesthesia time was noted separately, as microvascular surgery was not typically occurring at this time. Data regarding type and amount of fluid administration were also collected from the intraoperative anesthesia record. Fluids were divided into crystalloid and colloid; colloids were further subdivided into albumin, high or low molecular weight hydroxyethyl starch, packed red blood cells, fresh frozen plasma, and platelets. Total amount of fluid given intraoperatively was obtained from the anesthetic record and used to calculate an average fluid administration rate during anesthesia (in mL/kg/h). Data regarding blood loss, urine output, and net fluid balance were also extracted from the anesthetic record. Total fluid loss included blood loss, urine output, and "other" loss where recorded. Total urine output and net fluid balance during the intraoperative period were then calculated (in mL/kg/h).

Complication within 30 days of the initial FTT was defined as either a return to the operating room for surgical intervention or a serious complication that did not require operative intervention (eg, fistula formation, infection, bleeding) but did require some other intervention (eg, readmission to the hospital). Flap failure within 30 days was defined as a graft that was unsalvageable and required surgical removal. Data regarding complication and failure were obtained from electronic medical records, including dictated operative notes, hospital discharge summaries, and postoperative clinic notes.

Statistical Methods

Associations among occurrences of perioperative complications with variables in the data set were examined through generalized linear mixed models, with an assumption of a binomial distribution and a logit link to account for repeated procedures on patients. Due to the small number of postoperative failures, a negligible patient effect was assumed, and chisquare and Fisher's exact tests were used where appropriate to examine associations between flap failure and all dichotomous variables. Only univariate models for failure were considered, owing to the overall number of failures. Continuous variables were checked for normality through the Shapiro-Wilk test. Student's *t* test was used to examine associations between postoperative failure and all normally distributed continuous variables. The Mann-Whitney *U* test was used to test for associations between failure and all nonnormally distributed continuous variables. Since not all subjects received albumin, hetastarch, platelets, fresh frozen plasmas, red blood cells, or blood products, subgroup analyses were performed on those subjects that received the different fluids to determine if the volume of any specific fluid was associated with either postoperative complications or failure. All analyses were conducted in SAS 9.3 (SAS Institute, Cary, North Carolina).

Results

Of the 235 patients, 13 received more than one FTT, resulting in a total of 248 surgeries. Of the 13 who required multiple FTT, 6 had 2 grafts placed during the same procedure, and 7 had 2 FTTs on different days. There were 9 types of donor tissue sites identified from dictated operative reports, which included latissimus dorsi, radial and ulnar forearm, fibular osteocutaneous, scapular, lateral thigh (the majority being anterior lateral thigh), temporoparietal fascial, pectoralis major, and rectus abdominis. Uncommon free flap tissue donor sites (eg, ulnar, pectoralis major, temporoparietal) were independently verified in the medical record as FTT, as opposed to pedicled flap. Of the 235 patients, 169 (71.9%) were men, and 189 (80.4%) were Caucasian. The mean age at time of surgery was 59 years, and 188 patients (78%) were classified as American Society of Anesthesiology class 3. The majority (75.8%) were either current or former tobacco users. Nearly half (47.1%) received prior radiation therapy to the head and neck region; 17 patients (7.2%) had preoperative chemotherapy; and 2 (0.08%) received both chemotherapy and radiation therapy. The primary reason for undergoing FTT was cancer (90.5%). The 3 most likely sources for donor sites were scapular (26.2%), radial (21.4%), and thigh (20.2%). Characteristics of the 235 subjects are reported in Tables 1 and 2.

Flap complications developed in 69 (27.8%) of the 248 FTTs. Of the 69 patients having complications, the majority (88.4%) required a return to the operating room within 30 days of initial FTT. Of the 8 who did not require a return trip to the operating room, readmission or prolonged hospital stay was required for flap infection (n = 4) and for partial flap dehiscence and/or failure (n = 4). FTT failure occurred in 6.5% (n = 16) of the 248 patients undergoing FTTs. Overall in-hospital mortality rate within the first 30 days was 0.85% (n = 2).

In the univariate analysis, flap complication was significantly associated with rate of intraoperative fluid administration, blood loss, transfusion of blood products, total fluid received, and net fluid balance (Table 3). Mean amount of intraoperative fluid given to patients who developed a complication was 8.33 mL/kg/h, compared to 7.02 mL/kg/h for patients without complications (*P* = .01; 95% confidence interval [CI], 1.04-1.31). Mean intraoperative blood loss was 791.8 mL for those who developed a complication, compared to 624.5 mL for those who did not (*P* = .006; 95% CI, 1.02-1.14). Finally, net fluid balance was positive 5.62 mL/kg/h for those who developed complications versus 4.71 mL/kg/h for those who did not (*P* = .03; 95% CI, 1.01-1.33; Table 4).

However, in a multivariate analysis controlling for age, sex, ethnicity, reason for receiving flap other than cancer, rate at which fluid was given, and type of fluid given, only intraoperative blood loss remained significantly associated with complications (*P* = .019; 95% CI, 1.01-1.16). Approximately 50.8% of patients received intraoperative transfusion with packed red blood cells. Of the 123 patients who received packed red blood cells, 4 also received fresh frozen plasma, with 1 patient receiving both fresh frozen plasma and platelets (Table 5).

Flap complication and failure were not significantly associated with sex, age, body mass index, length of surgery, length of anesthesia, free flap ischemia time, preoperative use of ACE inhibitor or angiotensin receptor blocker, prior radiation, preoperative or postoperative hemoglobin, change in hemoglobin, preoperative American Society of Anesthesiology classification, or vasopressor use. Approximately 70 patients (28.9%) received 1 of the above-mentioned vasopressors. Sixty-five patients received phenylephrine, ephedrine, or both (Table 5).

FTT failure was significantly associated with the reason for surgery and the preoperative diagnosis of coronary artery disease. Subjects undergoing FTT for a reason other than cancer had 5.40 greater odds of failure than subjects needing FTT as a result of cancer (*P* = .03; 95% CI, 1.69-17.3). Subjects with preoperative coronary artery disease had 3.60 times the odds of having flap failure when compared to subjects who did not have coronary artery disease (*P* = 0.03; 95% CI, 1.16-11.2).

Discussion

The complication and failure rates (27.8% and 6.5%, respectively) in the head and neck free flap population studied were consistent with previously reported rates of 25% to 33%[2,16-18] and 4% to 8%, respectively.[2-4,19-21] This retrospective study found that perioperative complication was significantly associated with intraoperative blood loss, while rate of intraoperative fluids received did not reach statistical significance, when controlling for confounding variables. Surgical failure was significantly associated with surgical indication other than cancer and preoperative diagnosis of coronary artery disease. Intraoperative vasopressor administration was not associated with either complication or failure rate.

Blood Loss and Transfusions

Increasing intraoperative blood loss has been correlated with perioperative complications in head and neck FTT according to univariate analysis.[6] Hypovolemia, commonly caused by intraoperative blood loss, negatively affects the microcirculation and may worsen survivability of graft tissue.[22] Blood flow to the grafted tissue 6 to 12 hours after surgery is typically reduced to nearly 50% of the preoperative blood flow values owing to vascular damage and flow reduction associated with microanastomoses, which may lead to ischemic complications.[23] Chaukar et al determined that intraoperative blood loss exceeding 1000 mL led to significant wound complications following head and neck surgeries.[15] Our data showed univariate and multivariate associations between intraoperative blood loss and incidence of perioperative complications. Most of the patients suffering significant blood loss during the procedure were initially resuscitated with crystalloid, and, depending on their preoperative hemoglobin, some received packed red blood cells. Due to variability in practice (eg, individual transfusion cutoffs) and not controlling for preoperative anemia, this retrospective study lacks appropriate power to evaluate the more complex relationships associated with relative anemia, net fluid balance, hemoglobin, and flap outcomes.

Extensive research has attempted to delineate best practices regarding the management of perioperative anemia, with unclear conclusions. Studies have demonstrated that preoperative hemoglobin <11 g/dL independently predicted a higher surgical complication rate and longer hospital length of stay.[21,24,25] Anemia may predispose patients to oxygen deficits as well as more frequent transfusions.[24] Conversely, increased blood viscosity and elevated hematocrit may lead to venous flow reduction at the anastomotic site, which can lead to thrombosis or decreased blood flow during or after surgery.[23] The risk of clot formation is further complicated owing to the effects of inflammation and perioperative immobilization.[22,26] To improve postoperative outcomes, a transfusion criterion for patients undergoing FTT has been recommended to be a hematocrit <25%.[27] Our current study found no association between FTT complication or failure and starting, ending, or change in hemoglobin. Based on the results of this study, it appears that blood transfusion itself is merely one of several variables contributing to perioperative complications.

Fluid Administration

Optimal intraoperative fluid management is still widely debatable and often dependent on multiple patient and surgical factors.[2,3,22,24,25] Intraoperative maintenance fluid requirements depend on anesthesia and surgical time. Type, rate, and quantity of fluids administered vary significantly in the literature.[2,3,22,24,25] Estimated blood loss and insensible losses are difficult to estimate, but the net fluid balance (ie, fluids administered minus fluids lost) may be more clinically relevant than simple fluid intake.[28]

In this study, 123 patients (51%) received total intravenous fluid volume of greater than 7 L, with a mean total volume of 7495 mL. Patients suffering perioperative complications received on average 525 mL more crystalloid than patients without complications. In addition, Clark et al discovered that >130 mL/kg of crystalloid replacement over a 24-hour period increased the rate of medical—but not surgical—complications in the patient population.[24] The mean total intraoperative fluid replacement was approximately 107 mL/kg. Patients who developed complications received 118 mL/kg of fluid on average, and patients who did not develop complications received a mean of 102 mL/kg, intimating the significance of fluid management during surgery.

There have been several reasons postulated for the association between intraoperative fluid administration and complications during FTT, including impaired lymphatic drainage of the graft as well as increased mechanical stress on the tissue due to edema.[2,7,29]

Overall these findings may help guide anesthesia providers in the perioperative management of patients, and they may affect FTT success. Future directions of research in this patient population need to include a prospective evaluation of goal-directed fluid (and blood component) administration and vasoactive drugs to determine whether a standardized method of physiologic management leads to improved outcomes for patients undergoing FTT of the head and neck.

Vasoactive Drugs

Multiple human studies have shown that intraoperative use of vasopressors does not appear to affect outcomes in FTT.[2,3,13,30] Our results support these recent studies, as there was no association between intraoperative use of vasoactive substances and complication or failure after FTT. Seventy patients (28.9%) received some type of vasoactive medication intraoperatively, with the majority of these patients (92.8%) receiving phenylephrine, ephedrine, or both. Fifty-one percent of patients who received ephedrine and 55% who received phenylephrine did so within the first 2 hours of anesthesia time, during which the surgeons are typically performing the primary resection (or resections) and neck dissection and there is typically no dissection, ischemia, or tissue transfer occurring. The half-lives of the 3 vasoactive drugs used are all fairly brief, and little circulating drug would be expected to be present during FTT.

Comorbidities and Reasons for FTT

Many studies have evaluated patient characteristic data (ie, medical comorbidities) to see if there is any correlation with surgical complication, failure, and overall (medical) perioperative complication rates.[2,4,5,16-20,22,31-33] Howard et al found coronary artery disease to be an independent predictor of medical and surgical complications in patients receiving an FTT who were 70 years and older.[34] Interestingly, our results show coronary artery disease to be independently associated with flap failure regardless of age ($P = .03$; 95% CI, 1.16-11.2).

Limitations

Because of the retrospective design, data analysis is limited by the availability and quality of the medical records. Due the paucity of quality data in this field, care remains varied by institution and even practitioner. There was no universal standardization of fluid use (type, rate, goal, timing), vasopressor use, or exact blood product transfusion guidelines for the cases studied, and varied criteria were undoubtedly used for administration of each. The research performed was aimed to determine if perioperative characteristics and treatments were associated with complication or failure after FTT, but our design and results cannot attribute or differentiate causality of complication or failure (eg, surgical technique vs medical comorbidity).

Conclusions

Some findings in this study may be useful when considering the perioperative planning and intraoperative management of this patient population. First, intraoperative blood loss was significantly associated with complication in a multivariate analysis. Second, both coronary artery disease and reason for FTT were significantly associated with an increased rate of failure in a univariate analysis. Finally, vasopressor administration did not significantly affect perioperative complication or failure rates, but the overall administration rate was low, thus making it difficult to compare the results to other reported studies.

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Table 1

Distribution of Patient Demographics and Characteristics.

Variable: Category	No. (%) or Mean ± SD
Sex	
Male	169 (71.9)
Female	66 (28.1)
Age	
Male	59.02 ± 11.76
Female	59.13 ± 14.29
Body mass index	
Male	25.50 ± 5.52
Female	24.51 ± 6.04
Ethnicity	
Caucasian	189 (80.4)
African American	43 (18.3)
Other	3 (1.28)
ACE-I/ARB use: Yes	52 (21.5)
Prior radiation: Yes	114 (47.1)
ASA classification	
2	45 (18.7)
3	188 (78.0)
4	8 (3.32)
Flap type[a]	
Latissimus dorsi	37 (14.9)
Fibular osteocutaneous	34 (13.7)
Lateral thigh	50 (20.2)
Pectoralis major	1 (0.40)
Radial forearm	53 (21.4)
Rectus abdominis	3 (1.21)
Scapular	68 (28.1)
Temporoparietal	1 (0.40)
Ulnar forearm	1 (0.40)
Reason for flap	
Cancer	219 (90.5)
Osteoradionecrosis	12 (4.96)
Other	11 (4.55)

Abbreviations: ACE-I/ARB, ace inhibitor/angiotensin receptor blocker; ASA, American Society of Anesthesiologists.

[a]Based on 248 observations but 235 unique subjects, owing to some subjects receiving >1 flap at time of surgery.

Table 2

Patient Comorbidities.

Variable: Category	No. (%)
No. of comorbidities	
0	39 (16.6)
1	113 (48.1)
2	48 (20.4)
3	24 (10.2)
4	10 (4.26)
5	1 (0.43)
Type of comorbidity	
Cardiomyopathy/congestive heart failure	5 (2.13)
Coronary artery disease	30 (12.8)
Moderate/severe valve disease	2 (0.85)
Chronic obstructive pulmonary disease	37 (15.7)
Renal disease	10 (4.26)
Current tobacco use	58 (24.7)
Prior tobacco use	120 (51.1)
Liver disease	4 (1.70)
Arrhythmia	11 (4.68)
Peripheral vascular disease	7 (2.98)
Diabetes	35 (14.9)
Asthma	7 (2.98)

Table 3

Odds Ratios and 95% Confidence Intervals for Univariate and Multivariable Logistic Regression Models of Flap Complication.[a]

Variable	Univariate			Multivariable		
	OR	**95% CI**	***P***	**OR**	**95% CI**	***P***
Age	1.01	0.99-1.03	.430	1.02	0.99-1.05	.180
Sex, male	0.59	0.18-1.09	.091	0.60	0.30-1.20	.148
Ethnicity, Caucasian	0.55	0.28-1.10	.090	0.45	0.20-0.99	**.049**
Reason for flap, cancer	0.57	0.26-1.38	.211	2.41	0.83-7.00	.106
Fluid received, mL/kg/h	1.17	1.04-1.31	**.011**	1.13	0.99-1.28	.065
Blood loss	1.08	1.02-1.14	**.006**	1.08	1.01-1.16	**.019**
Any blood product, y/n	1.83	1.01-3.30	**.045**	1.11	0.50-2.44	.797
Total fluid received	1.02	1.00-1.05	**.050**	NA		
Net fluid, mL/kg/h	1.16	1.01-1.33	**.032**	NA		

Abbreviations: CI, confidence interval; OR, odds ratio; y/n, yes or no.

[a]Values in bold indicate statistical significance ($P < .05$).

Table 4

Distribution of Continuous Perioperative Variables Determined for the 248 Unique Procedures.

	All			Complication					
				Yes			No		
Variable	No.	Mean	SD	No.	Mean	SD	No.	Mean	SD
Length of …									
Ischemia, min	146	213.1	81.8	33	207.7	77.2	113	214.7	83.4
Surgery, h	234	12.53	3.26	65	12.36	3.71	169	12.59	3.08
Anesthesia, h	248	14.55	3.57	65	14.28	3.81	177	14.64	3.48
Total …									
Fluid, mL	248	7495	2719	65	8018	2946	177	7303	2613
Crystalloid, mL	248	6060	2089	65	6444	2261	177	5919	2010
Fluid rate									
In mL/kg	248	106.8	47.1	65	118.3	54.5	177	102.6	43.5
In mL/kg/h	248	7.37	2.77	65	8.33	3.17	177	7.02	2.52
Urine									
Output, mL	248	1788	946	65	1878	1147	177	1755	862
Rate, mL/kg/hr	248	1.77	1.02	65	1.93	1.14	177	1.72	0.97
Loss									
Blood, mL	248	669.5	477.9	65	791.8	626.6	177	624.5	403
Total fluid, mL	248	2461	1202	65	2675	1584	177	2382	1021
Net fluid balance									
In mL	248	5027	2218	65	5343	2169	177	4910	2231
In mL/kg/h	248	4.95	2.32	65	5.62	2.58	177	4.71	2.17
Hemoglobin, g/dL									
Starting	248	12.59	2.01	65	12.3	1.93	177	12.69	2.04
Ending	248	10.45	1.36	65	10.37	1.43	177	10.49	1.34
Change	248	–2.13	1.89	65	–1.94	1.93	177	–2.21	1.88

Table 5

Intraoperative Fluid and Vasopressor Use.

Variable: Category	No. (%)
Vasopressor use	
Phenylephrine	41 (17.0)
Ephedrine	43 (17.9)
Vasopressor type	
Any agent	70 (28.9)
No agent	172 (71.1)
Phenylephrine/ephedrine	65 (26.9)
Other	5 (2.07)
Fluid amount	
Total intravenous fluid > 7 L	123 (51.0)
Total crystalloid > 7 L	71 (29.3)
Type of fluid administered	
Albumin	113 (47.9)
Hydroxyethyl starch	151 (62.4)
Any colloid	219 (90.5)
Platelets	1 (0.41)
Fresh frozen plasma	4 (1.65)
Red blood cells	123 (50.8)
Any blood product	123 (50.8)