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Effect of Perioperative Antithrombotics on Postoperative Transfusion and Hematoma in Head and Neck Free Flaps

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Abstract

Objective. To explore if antiplatelet or anticoagulant therapy increases the risk of transfusion requirement or postoperative hematoma formation in patients undergoing microvascular reconstruction for head and neck defects.

Study Design. Retrospective cohort study.

Setting. Departments of Otolaryngology–Head and Neck Surgery at the University of Alabama at Birmingham, the University of Colorado, and the University of California Irvine.

Methods. A multi-institutional, retrospective review on microvascular reconstruction of the head and neck between August 2013 to July 2021. Perioperative antithrombotic data were collected to examine predictors of postoperative transfusion and hematoma.

Results. A total of 843 free flaps were performed. Preoperative hemoglobin, hematocrit, operative time, and flap type were positive predictors of postoperative transfusion in both bivariate ($P < .0001$) and multivariate analyses ($P < .0001$). However, neither anticoagulation nor antiplatelet therapy were predictive of postoperative transfusion rates and hematoma formation.

Conclusion. Antithrombotic regimens do not increase the risk of postoperative transfusion or hematoma in head and neck microvascular reconstruction. Based on this limited data, perioperative antithrombotic regimens can be considered in patients who may otherwise be at risk for these postoperative complications.

Microvascular free tissue transfer is the primary reconstructive surgery for large, complex defects within the head and neck. There are many considerations in the perioperative care of patients undergoing free flap reconstruction. Most flap-related postoperative surgical complications are the result of thrombosis at the pedicle anastomosis.[1-3] Vessel thrombosis is a dreaded complication, as it can lead to flap failure even if addressed in a timely manner. As a result, perioperative use of antithrombotics is common, but there is significant heterogeneity in the literature regarding different perioperative regimens and reported outcomes. Antithrombotic therapy includes both anticoagulant and antiplatelet agents, effectively targeting the coagulation cascade in addition to platelet aggregation. Commonly used anticoagulants include heparin (unfractionated and low molecular weight subcutaneous heparin [SQH]) and enoxaparin. Aspirin is most commonly used for antiplatelet therapy, either 81 or 325 mg.

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Most antithrombotic practices are based on anecdotal evidence, surgeon training tendencies, and prior use.[4-6] The effects of antithrombotics on free flap outcomes remain controversial, particularly regarding the effect on hematoma formation. Hematomas are the second most common cause of emergent re-exploration of microvascular free flaps.[7,8] Hematoma rates after free flap reconstruction range widely and have been reported to be between 1% and 30%.[3,8-11] There are mixed conclusions in the literature regarding the risk of hematoma formation with various antithrombotic regimens. Additionally, the relationship between antithrombotic therapy and packed red blood cell (pRBC) transfusion rates has not previously been explored in this patient population. Given the longer operative time with microvascular free flap reconstruction and the common presence of underlying medical comorbidities in this patient population, pRBC transfusion rates are of particular interest. Most reports on antithrombotic therapy and free flap complications are based on single-institution experiences. In this study, we present a multi-institutional, retrospective study to explore whether perioperative antithrombotic therapy increases the transfusion requirement or risk of postoperative hematoma formation in patients undergoing head and neck free flap reconstruction.

Methods

Patient Selection

Patients who underwent a microvascular free tissue transfer to the head and neck between August 2013 and July 2021 at the University of Alabama at Birmingham (UAB), University of Colorado (UC), and University of California Irvine (UCI) were identified for this multi-institutional, retrospective review following institutional review board approval at each participating institution. All consecutive patients were included (n = 834).

Data Collection

Electronic medical records were analyzed to gather demographics, perioperative use of anticoagulation or antiplatelet agents, intraoperative heparin bolus, postoperative day (POD) 0 hypertension (systolic blood pressure [BP] > 150 or diastolic BP > 100 for 2 consecutive readings or systolic BP > 200 once), preoperative hemoglobin and hematocrit, postoperative platelet count, free flap type, and operative time. Flaps were grouped as radial forearm free flap (RFFF)/osteocutaneous RFFF, rectus/anterior lateral thigh (ALT), scapula/latissimus dorsi, and fibula free flap. Primary endpoints were the rate of postoperative pRBC transfusions and postoperative hematoma at either the reconstructive or flap donor sites. Postoperative pRBC transfusions were defined as those occurring within the first 72 hours after surgery as well as for the duration of the postoperative inpatient stay. A postoperative hematoma was defined as a hematoma that required operative intervention during the same hospital stay as the free flap surgery.

Statistical Analysis

Statistical analysis was performed using GraphPad Prism (version 9.5.1). Descriptive univariate statistics were used to characterize the study population and summarized as frequency and percentage for categorical variables and mean and standard deviation for continuous variables. Antiplatelet use was compared based on the frequency of postoperative transfusion and hematoma rates using a χ^2 test. Predictor variables for postoperative hematoma and postoperative pRBC transfusion were analyzed using linear regression models (continuous variables) and logistic regression models (categorical variables). Both bivariate and multivariate analyses are reported with odds ratio (OR) and 95% confidence interval (CI). Statistical significance was defined as $P < .05$.

Results

Patient Characteristics

A total of 843 microvascular reconstructive surgeries for head and neck defects were performed across 3 institutions (UAB, UC, and UCI) on 834 patients between August 2013 and July 2021. Patient characteristics are displayed in **Table 1**. Patients were predominantly male (N = 617, 74%) and white (N = 688, 82.4%) with a mean age of 63 years (±13.4) at the time of surgery. Soft tissue reconstruction comprised the majority of reconstructive surgeries (N = 707, 83.9%) with RFFF (N = 475, 56.3%) as the most commonly performed flap. Free flaps reconstructed a diverse array of primary sites with an oral cavity (N = 329, 41.2%) being the most prevalent. Twenty-eight percent (N = 229) of patients were smoking at the time of their reconstructive surgery and 40% (N = 335) had prior radiation. The mean operative time was 554.2 minutes (±166.3). Preoperatively, the mean hemoglobin was 12.6 (±2.1), and the mean hematocrit was 37.8 (±6.0).

Preoperative Antithrombotic Therapy

There were 128 (15.3%) patients on preoperative antiplatelet therapy, including 81 or 325 mg aspirin, clopidogrel, and/or ticagrelor. Forty-three (5.2%) were on preoperative anticoagulation, including SQH, coumadin, rivaroxaban, dabigatran, apixaban, or enoxaparin. On bivariate analysis, neither preoperative antiplatelet therapy nor anticoagulation was associated with an increased operative time (OR = 20.06, 95% CI [−12.01, 52.13], $P = .220$ and OR = 26.64, 95% CI [−16.16, 88.42], $P = .175$, respectively). Preoperative anticoagulation (OR = 1.015, 95% CI [0.517, 2.142], $P = .968$) did not demonstrate an association with postoperative transfusion rates in the first postoperative 72 hours nor over the

Table 1. Study Population Demographics

Variable	N = 834	Percent
Age		
Mean	63 (±13.4)	
Min, Max	16, 93	
Gender		
Male	617	74
Female	217	26
Race		
White	688	82.4
Black	63	7.5
Other	69	8.3
Unknown	15	1.8
Smoking		
Current	229	27.6
Former	299	36
Never	303	36.5
Alcohol		
Current	249	30
Former	64	7.7
Never	518	62.3
Primary site	N = 799	
Oral cavity	329	41.2
Oropharynx	61	7.6
Larynx	122	15.3
Hypopharynx	31	3.9
Nasopharynx	3	0.4
Cutaneous	108	13.5
Neck	13	1.6
Temporal bone	32	4.0
Parotid	22	2.8
Orbit	13	1.6
Sinonasal	48	6.0
Osteoradionecrosis	10	1.3
Other (trauma, etc)	7	0.9
Prior radiation	N = 834	
No	499	59.8
Yes	335	40.2
Prior chemotherapy		
No	670	80.3
Yes	164	19.7
Reconstruction	N = 843	
Fibula	87	10.3
RFFF	475	56.3
Scapula	24	2.8
ALT	189	22.4
Latissimus	38	4.5
OCRFFF	25	3.0
Rectus	5	0.6
Preoperative hemoglobin		
Mean	12.6 (±2.1)	
Min, Max	5.6, 19.2	
Preoperative hematocrit		
Mean	37.8 (±6.0)	
Min, Max	17.3, 57	

Abbreviations: ALT, anterolateral thigh; Max, maximum; Min, minimum; OCRFFF, osteocutaneous radial forearm free flap; RFFF, radial forearm free flap.

duration of the hospital length of stay (LOS) (OR = 1.055, 95% CI [0.553, 2.126], $P = .875$), and neither did preoperative antiplatelet therapy (OR = 0.709, 95% CI [0.472, 1.078], $P = .102$ and OR = 0.689, 95% CI [0.466, 1.028], $P = .065$) (**Table 2**). Finally, neither preoperative antiplatelet therapy (OR = 1.506, 95% CI [0.681, 3.995], $P = .356$) nor anticoagulation (OR = 0.514, 95% CI [0.211, 1.543], $P = .181$) were associated with postoperative hematoma formation (**Table 3**).

Intraoperative Antithrombotic Therapy

Intraoperative heparin bolus was more frequent in the early years of the study period with 207 (24.8%) of patients receiving a bolus of heparin in the operating room. Administration of a heparin bolus was not associated with postoperative transfusion (OR = 1.104, 95% CI [0.769, 1.606]; $P = .702$) or hematoma formation (OR = 0.999, 95% CI [0.544, 1.939]; $P = .997$) (**Tables 2** and **3**).

Postoperative Anticoagulation Therapy

Seven hundred and twenty-three patients were treated with either prophylactic enoxaparin or SQH (86.6%) in the postoperative period. A majority of patients were treated with SQH (N = 610, 84% of patients treated with anticoagulation; 73.1% of all patients), while enoxaparin was given to a minority of patients (N = 116, 16% of patients treated with anticoagulation; 13.9% of all patients). Ninety-nine patients (11.9%) were given no postoperative prophylactic anticoagulation therapy. Use of postoperative prophylactic anticoagulation had no association with postoperative hematoma on bivariate analysis (OR = 1.220, 95% CI [0.521, 2.528], $P = .617$) (**Table 3**). However, the use of postoperative prophylactic anticoagulation was a positive predictor of postoperative transfusion in the first 72 hours on bivariate analysis (OR = 1.577, 95% CI [1.00, 2.452], $P = .046$). This was not observed when examining transfusion rates over the duration of the hospital LOS (OR = 1.338, 95% CI [0.859, 2.059], $P = .190$) nor on multivariate analysis accounting for preoperative hemoglobin, operative time, and type of microvascular reconstruction (**Table 2**).

Postoperative Antiplatelet Therapy

A total of 652 patients (78.2%) were treated with aspirin in the postoperative period. The majority were treated with 325 mg (N = 575, 88.2% of patients on aspirin; 68.9% of all patients), and the minority were treated with 81 mg (N = 77, 11.8% of patients on aspirin; 9.2% of all patients). A total of 182 patients were not treated with any aspirin postoperatively (21.8%). Postoperative use of either dose of aspirin did not affect transfusion rates in the first postoperative 72 hours or over the duration of the hospital LOS on bivariate analysis (**Table 2**). Finally, on

Table 2. Predictors of Postoperative Transfusion on Bivariate (BVA)/Multivariate Analysis (MVA)

72 h postoperative	BVA		MVA	
Variable	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Aspirin (postoperative)				
No	Reference		Reference	
81 mg	1.185 (0.649, 2.226)	.587	1.597 (0.780, 3.386)	.209
325 mg	1.350 (0.928, 1.948)	.112	1.205 (0.780, 1.846)	.394
Prophylactic AC POD1				
No	Reference		Reference	
Yes	1.577 (1.000, 2.452)	.046*	1.655 (0.981, 2.755)	.055
Preoperative AC				
No	Reference		Reference	
Yes	1.015 (0.517, 2.142)	.968	1.843 (0.851, 4.324)	.137
Preoperative antiplatelet				
No	Reference		Reference	
Yes	0.709 (0.472, 1.078)	.102	0.763 (0.467, 1.263)	.285
Intra-Op heparin bolus				
No	Reference			
Yes	1.104 (0.769, 1.606)	.702		
Free flap type				
RFFF/OCRFFF	Reference		Reference	
ALT/rectus	2.934 (2.017, 4.267)	<.0001*	2.302 (1.509, 3.508)	.0001*
Scapula/latissimus	2.046 (1.097, 3.697)	.020*	1.119 (0.555, 2.188)	.747
Fibula	1.515 (0.852, 2.607)	.143	1.389 (0.729, 2.567)	.304
Preoperative hemoglobin	1.522 (1.398, 1.664)	<.0001*	1.494 (1.364, 1.643)	<.0001*
Preoperative hematocrit	1.149 (1.114, 1.186)	<.0001*		
Operative time	1.002 (1.001, 1.003)	<.0001*	1.002 (1.001, 1.003)	.0025*
Hospital length of stay	BVA		MVA	
Variable	Odds ratio (95% CI)	P value	Odds ratio (95% CI)	P value
Aspirin (postoperative)				
No	Reference		Reference	
81 mg	1.030 (0.577, 1.872)	.921	1.771 (0.873, 3.699)	.120
325 mg	1.149 (0.802, 1.636)	.445	1.015 (0.661, 1.546)	.946
Prophylactic AC POD1				
No	Reference		Reference	
Yes	1.338 (0.859, 2.059)	.190	1.402 (0.788, 2.456)	.243
Preoperative AC				
No	Reference		Reference	
Yes	1.055 (0.553, 2.126)	.875	1.874 (0.881, 4.226)	.114
Preoperative antiplatelet				
No	Reference		Reference	
Yes	0.689 (0.466, 1.028)	.065	0.672 (0.414, 1.101)	.111
Intra-Op heparin bolus				
No	Reference			
Yes	1.301 (0.919, 1.859)	.143		
Free flap type				
RFFF/OCRFFF	Reference		Reference	
ALT/rectus	2.731 (1.905, 3.921)	<.0001*	1.943 (1.270, 2.969)	.0021*
Scapula/latissimus	2.256 (1.263, 3.977)	.0052*	1.126 (0.571, 2.182)	.727
Fibula	1.556 (0.914, 2.595)	.095	1.305 (0.694, 2.394)	.398
Preoperative hemoglobin	1.549 (1.426, 1.691)	<.0001*	1.508 (1.378, 1.657)	<.0001*
Preoperative hematocrit	1.158 (1.123, 1.194)	<.0001*		
Operative time	1.002 (1.001, 1.003)	<.0001*	1.002 (1.001, 1.003)	.0042*

Abbreviations: AC, anticoagulation; ALT, anterolateral thigh; CI, confidence interval; HTN, hypertension; OCRFF, osteocutaneous radial forearm free flap; Op, operative; POD, postoperative day; RFFF, radial forearm free flap.
*Statistically significant result.

Table 3. Predictors of Postoperative Hematoma on Bivariate Analysis (BVA)

	BVA	
Variable	Odds ratio (95% CI)	P value
Aspirin (postoperative)		
No	Reference	
81 mg	0.410 (0.150, 1.135)	.079
325 mg	0.747 (0.333, 1.512)	.444
Prophylactic AC POD1		
No	Reference	
Yes	1.220 (0.521, 2.528)	.617
Preoperative AC		
No	Reference	
Yes	0.514 (0.211, 1.543)	.181
Preoperative antiplatelet		
No	Reference	
Yes	1.506 (0.681, 3.995)	.356
HTN (postoperative)		
No	Reference	
Yes	0.936 (0.533, 1.696)	.823
Intra-Op heparin bolus		
No	Reference	
Yes	0.999 (0.5443, 1.939)	.997
POD0 platelets	1.002 (0.9989, 1.006)	.281
Free flap type		
RFFF/OCRFFF	Reference	
ALT/rectus	0.654 (0.352, 1.258)	.188
Scapula/latissimus	1.128 (0.385, 4.812)	.847
Fibula	1.617 (0.558, 6.858)	.437

Abbreviations: AC, anticoagulation; ALT, anterolateral thigh; CI, confidence interval; HTN, hypertension; OCRFF, osteocutaneous radial forearm free flap; Op, operative; POD, postoperative day; RFFF, radial forearm free flap.

bivariate analysis, neither postoperative use of 81 mg aspirin (OR = 0.410, 95% CI [0.150, 1.135], P = .079) nor 325 mg aspirin (OR = 0.747, 95% CI [0.333, 1.512], P = .444) demonstrated an association with hematoma rates (**Table 3**).

Postoperative pRBC Transfusion

The overall pRBC transfusion rate was 26.4% (N = 220), and the rate of transfusion in patients on 81 versus 325 mg aspirin was 25.4% and 22.2%, respectively (P = .55). One hundred fifty patients (68.2%) received fewer than 3 transfusions, whereas 70 patients (31.8%) received 3 or more transfusions over the duration of the hospital LOS. Factors associated with postoperative transfusion in the first postoperative 72 hours and over the duration of the hospital LOS were investigated using multivariate analyses designed to approximate clinically relevant antithrombotic regimens. Preoperative hemoglobin and hematocrit were positive predictors of postoperative transfusion rates on bivariate analysis, both in the first 72 hours (OR = 1.522,

95% CI [1.398, 1.664], P < .0001 and OR = 1.149, 95% CI [1.114, 1.186], P < .0001, respectively) and the entire hospital LOS (OR = 1.549, 95% CI [1.426, 1.691], P < .0001 and OR = 1.158, 95% CI [1.123, 1.194], P < .0001, respectively), and they remained significant on multivariate analysis. In addition, flap type was a predictor of transfusion rates with rectus/ALT free flaps significant on both bivariate (P < .0001) and multivariate analyses (P = .0021). Increasing operative time also correlated with transfusion rates (P < .0001) (**Table 2**). To model the use of antithrombotic therapy and postoperative transfusion rates, a multivariate model was constructed utilizing preoperative antiplatelet therapy, preoperative anticoagulation therapy, postoperative antiplatelet therapy, postoperative prophylactic anticoagulation, preoperative hemoglobin, operative time, and flap type as independent variables. None of the antithrombotic variables investigated emerged as independent predictors of transfusion rates both in the initial 72 hours and hospital LOS (**Table 2**).

Postoperative Hematoma

The overall postoperative hematoma rate was 6.5% (N = 54) with 31.5% (N = 17) occurring at the donor site, 63% (N = 34) in the neck, and 5.5% (N = 3) underneath the flap reconstruction. Hematomas occurred in 11.3% of patients taking 81 mg aspirin and 6.5% of patients on 325 mg aspirin (P = .14). The majority of OR interventions for hematoma evacuation occurred on POD 1 (26.7%) with a range of POD 0 to 15. To further analyze the association of antithrombotic therapy and the development of postoperative hematoma, a multivariate model was constructed utilizing preoperative antiplatelet therapy, preoperative anticoagulation therapy, intraoperative heparin bolus, postoperative antiplatelet therapy, postoperative prophylactic anticoagulation, and postoperative hypertension as independent variables. None of the variables we investigated emerged as an independent predictor of postoperative hematoma (**Table 3**). Finally, flap type was not a predictor of postoperative hematoma.

Discussion

Here, we demonstrate the effect of antithrombotic therapy on postoperative transfusion and hematoma rates in head and neck microvascular free flap reconstruction. Most notable is no effect of pre or postoperative antithrombotics was observed on transfusion and hematoma rates while both preoperative hemoglobin and hematocrit and flap type predicted postoperative transfusion rates at both 72 hours and the entire hospital LOS. The decision of antithrombotic therapy in patients who undergo microvascular reconstruction is complex. The ideal antithrombotic regimen would prevent the formation of venous and arterial thrombi, while not posing an additional risk of postoperative complications. Additionally, anticoagulation therapy for the prevention of deep venous thromboses

(DVTs) is a vital component of postoperative care for head and neck cancer patients.[12,13] A recent study by Kovatch et al in 2019 surveyed 71 US institutions to determine current practices of antithrombotic use in head and neck free flap patients.[14] They found 83.6% of programs include aspirin in their antithrombotic regimen (53.6% use 325 mg and 46.4% use 81 mg), and for anticoagulation, 37.5% use SQH and 36.4% use enoxaparin. Patients in our study were more likely to be treated with 325 mg aspirin (68.9%). In 2019, 2 of the institutions transitioned to 81 mg aspirin postoperatively only if the patient was on a preoperative aspirin regimen.

The greatest risk of thrombosis in microvascular reconstruction is the first day after anastomosis.[15] Recent studies demonstrate no change in free flap failure rates based on antithrombotic treatment,[3,16,17] raising the question, "Does the perioperative use of antithrombotics increase complication rates with limited benefit on free flap outcomes?" Free flap failure is rare, but postoperative complications remain common. We examined whether antithrombotic medications are associated with pRBC transfusion rates. Patients undergoing free flap reconstruction typically have longer operative time with significant fluid shifts. We hypothesized that the hemodynamic status of patients within the first 72 hours after surgery could be further affected by pharmacologic manipulation of the body's natural clotting system but also wanted to examine transfusion rates over the entire hospital LOS. There is data in the orthopedic surgery literature suggesting antithrombotic therapy is associated with a higher perioperative hemoglobin decrease and longer hospital LOS.[18,19] Controversy exists over the role of perioperative blood transfusions in patients undergoing free flap reconstruction. On one hand, a low hematocrit impairs oxygen delivery, thereby reducing flap perfusion and survival,[20,21] but fluid overload can increase the risk of venous congestion. Other studies have concluded that pRBC transfusions do not impact flap failure or take-back rates.[22,23] The rate of transfusion in the current study (26.4%) is lower than previously reported studies. For example Purum et al[21] reported a rate of 48.9% in a cohort of free flap patients from 2011-2013, potentially reflecting the changing practice to a more judicious approach to pRBC transfusion.

The current study is the first to specifically examine antithrombotic use as it relates to pRBC transfusions in head and neck free flaps. In our study, preoperative and postoperative aspirin (either 81 or 325 mg) had no effect on transfusion rates. This is interesting, as it is widely accepted that aspirin can promote blood loss. There is data in the orthopedic and cardiovascular surgery literature, however, demonstrating that patients on long-term aspirin therapy do not have increased rates of transfusion in the postoperative setting,[24,25] and our findings support this in the head and neck. We found that patients who received prophylactic anticoagulation therapy on POD 1 (enoxaparin or SQH) had an increased

transfusion rate (first 72 hours) on bivariate analysis, but this did not remain significant on multivariate analysis accounting for preoperative hemoglobin and flap type. Our results confirm prior studies demonstrating a higher transfusion requirement in patients with ALT compared to RFFF reconstructions,[21,26] though smaller studies have not seen an association between transfusion and flap type.[22] Previous studies have also demonstrated an association between transfusions and decreased preoperative hemoglobin[26,27] and elevated coagulation labs.[22] We confirm a significant effect of preoperative hemoglobin and hematocrit on postoperative transfusion rates in both the first 72 hours and the duration of the hospital LOS, but we did not have complete data on coagulation labs to examine the impact those values have on transfusion rates. Finally, a study utilizing the American College of Surgeons National Surgical Quality Improvement Program to examine outcomes in head and neck microvascular reconstructive surgery observed that increased duration of anesthesia (operative time) was associated with increased rates of postoperative transfusions.[26,28] Similar findings were seen in the current study. These findings have clinical implications, as blood transfusions have been correlated with worse overall survival and recurrence-free survival, and with higher postoperative wound infection rates and longer hospital LOS in patients undergoing head and neck microvascular reconstruction.[21,29] Prophylactic anticoagulation therapy is an important aspect of the postoperative care of head and neck cancer patients. Here, antithrombotic use did not affect blood transfusion rates when accounting for other contributing patient and surgical factors and demonstrates no significant reason to delay the initiation of therapy.

Hematomas are of particular concern in free flap surgeries due to the potential devastating effects. The relationship between hematomas and the various pathophysiological processes contributing to flap compromise is complex. Experimental models of hematoma effects on flap have suggested that hematomas induce flap necrosis through cytokine-mediated inflammation, neutrophil recruitment with subsequent reactive oxygen species production, and endothelial dysfunction. These processes ultimately lead to intimal thrombosis and tissue ischemia.[30,31] Balancing the potential benefit of preventing thrombus formation while minimizing the risk of hematoma formation is the goal when creating an antithrombotic regimen. Our study shows no increased risk of postoperative hematoma with preoperative or postoperative antiplatelet or anticoagulation therapy. This is consistent with findings from other retrospective series that have concluded that neither heparin nor aspirin increases the risk of postoperative hematoma.[32,33]

Our findings are in contrast with some studies that have shown an increased risk of postoperative hematoma with SQ LMWH. Zou et al conducted a double-blind, controlled, randomized clinical trial comparing free flap

outcomes across 3 different patient cohorts: group A received 40 mg of aspirin in addition to 500 mL IV Dextran-40 for 5 days postoperative, group B received SQ LMWH daily for 5 days postoperative, and group C received no antithrombotic therapy. They found that the incidence of hematoma rates was significantly higher in group B, concluding that LMWH increases the risk of hematoma formation while failing to demonstrate a protective role for the development of thromboses.[34] Lighthall et al also concluded that patients receiving LMWH had a higher rate of postoperative hematoma.[35] They found that aspirin, whether used alone or in addition to an anticoagulant, did not increase the risk of hematoma formation.

The retrospective data was not complete enough to examine the duration of the antithrombotic holiday prior to surgery and how that impacted transfusion and hematoma rates. Typical practice at our institutions is to continue 81 mg aspirin prior to surgery but to hold other antiplatelets and anticoagulation. Another limitation of our study is we had very sparse data on perioperative coagulation studies including PT, PTT, and INR. Finally, we did not examine the impact of the day of surgery preoperative administration of SQH on transfusion and hematoma rate. This would be interesting to examine in the future as many institutions have moved to routine administration of preoperative SQH in OR cases of long duration or patients with malignancy to decrease DVT and pulmonary embolism formation.

Conclusion

There is yet to be a strong consensus regarding the optimal perioperative antithrombotic regimen in patients undergoing free flap reconstruction. A delicate balance must be considered between effective prevention of thrombus formation and postoperative complications. This study demonstrates that the use of anticoagulation/antiplatelet therapy does not significantly increase the risk of postoperative transfusion requirements or hematoma rates. Preoperative hemoglobin and hematocrit as well as select microvascular flap types do predict transfusion rates, and this information can help with perioperative planning and counseling.

Author Contributions

Melanie D. Hicks, design, data collection, manuscript writing, presentation; **Milind Vasudev**, data collection; **Jessica L. Bishop**, data collection, manuscript writing; **Natalie Garcia**, data collection; **Farshad Chowdhury**, data collection; **Tiffany T. Pham**, data collection; **Gabriela Heslop**, data collection; **Benjamin Greene**, data collection; **Hari Jeyarajan**, data collection; **Jessica W. Grayson**, statistical analysis; **Julie A. Goddard**, data collection; **Tjoson Tjo**, data collection; **Yarah Haidar**, data collection; **Carissa M. Thomas**, concept and design, statistical analysis, manuscript editing.

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