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Association between blood pressure and postoperative hematomas in the patients undergoing head and neck cancer reconstruction

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Abstract

Background: Postoperative hematoma is one of the most common complications of free flap reconstruction and compromises the perfusion of pedicles and perforators. Therefore, we reviewed our patients to analyze the associated risk factors.

Method: This study involved a retrospective chart review from 2014 to 2016. We identified the patients undergoing free flap reconstructions for head and neck cancer. Patients with postoperative hematoma requiring surgical intervention were included.

Result: We enlisted 289 patients undergoing head and neck reconstructions. Eighteen patients (6.2%) had postoperative hematomas of which 12 hematomas occurred within the first 3 days and 9 in the first 24 hours. Elevated systolic blood pressure increased the risk of hematoma formation, but hematoma was not associated with higher failure rate. Tachycardia was observed in the patients with hematoma.

Conclusions: Transient elevated blood pressure increased the risk of hematoma. We suggest controlling systolic blood pressure below 150 mm Hg for prevention of hematoma.

KEYWORDS

blood pressure, free flap, head and neck cancer, hematoma, oropharyngeal cancer

1 | INTRODUCTION

Although free flap transfer has evolved over the past 20 years and the success rate has increased to approximately 95%, it is still a complex procedure and is even more challenging if the free flap fails.[1] Numerous studies have been published on the risk factors for free flap transfer.[2-5] However, to the best of our knowledge, hematoma as a common complication following free flap transfer is yet to be investigated in detail.

Hematomas compress the pedicles of free flaps and lead to thrombosis in these pedicles. Therefore, early detection and reexploration before thrombosis formation is crucial for a higher salvage rate.[6,7] The first three postoperative days are critical and patients need to be closely monitored. Postoperative systolic blood pressure (SBP) is related to hematoma formation in many types of surgery, and controlling blood pressure has been proven to be effective in reducing the risk for postoperative hematoma in patients with acute cerebral hemorrhage.[8,9] Nevertheless, there has yet to be any detailed research on the effect of postoperative blood pressure in hematoma formation.

2 | MATERIALS AND METHODS

We retrospectively reviewed patients undergoing free flap transfer for head and neck cancer reconstruction during

TABLE 1 Comparison of basic characteristics of patients with head and neck cancer with free flap reconstruction, stratified by hematoma formation

			Total (N = 289)	
	Without hematoma (N = 271)	**With hematoma (N = 18)**	**Number**	***P* value**
Basic characters				
Sex (M)[a]	261 (96.3%)	18 (100%)	279	.25
Age[b]	55.6 ± 10.0	59.9 ± 12.2	55.9	.09
Body weight[b]	65.8 ± 13.9	65.2 ± 14.9	65.8	.84
Admission days[b]	23.6 ± 16.5	26.6 ± 15.1	23.7	.45
ICU days[b]	5.0 ± 1.9	7.3 ± 6.0	5.17	.13
Flap size[b]	99.0 ± 52.9	120.3 ± 62.0	100.5	.14
Blood loss[b]	476.1 ± 344.7	1005.6 ± 1802.0	509.1	.23
Stage[a]				
1	29 (10.7%)	2 (11.1%)	31 (10.7%)	.77
2	49 (17.0%)	5 (27.8%)	54 (18.7%)	
3	30 (10.4%)	2 (11.1%)	32 (11.1%)	
4	163 (56.4%)	9 (50.0%)	172 (59.5%)	
Cormobidities[a]				
Hypertension	77 (28.4%)	4 (22.2%)	81 (28.0%)	.56
Diabetes	66 (22.8%)	5 (27.8%)	71 (24.6%)	.75
CKD	20 (7.4%)	1 (5.6%)	21 (7.3%)	.76
CAD	14 (5.2%)	3 (16.7%)	17 (5.9%)	.09
Hazardous habits[a]				
Smoking	229 (84.5%)	16 (88.9%)	245 (84.8%)	.61
Alcohol	192 (70.8%)	10 (55.6%)	202 (69.9%)	.17
Betel nut	195 (72.0%)	10 (55.6%)	205 (70.9%)	.14
Results[a]				
Flap failure	12 (4.4%)	1 (5.6%)	13 (4.5%)	.83
Ischemia	8 (3.0%)	1 (5.6%)	9 (3.1%)	.57
Congestion	12 (4.4%)	2 (11.1%)	14 (4.9%)	.27
Flap types[a]				
ALT	116 (40.1%)	10 (55.6%)	126 (43.6%)	.76
Peroneal	74 (27.3%)	2 (11.1%)	76 (26.3%)	
Fibular	75 (27.7%)	6 (33.3%)	81 (28.0%)	
Medial sural	5 (1.8%)	0	5 (1.7%)	
Radial forearm	1 (0.4%)	0	1 (0.3%)	

Abbreviations: ALT, anterolateral thigh flap; CAD, coronary artery disease; CKD, chronic kidney disease.
[a]Variables are expressed as number (percentage).
[b]Variables are expressed as mean ± SD.

2014 to 2016 at Kaohsiung Veterans General Hospital. Basic characteristics, including age, sex, comorbidities, heart rate, and both arterial and noninvasive oscillometric blood pressures were all acquired from all patients. Oscillometric pressures were analyzed. Data were analyzed with IBM SPSS 23 (Statistical Product and Service Solutions). Nominal variables were compared using the Chi-square test. Continuous variables were analyzed using the independent *t* test. Dispersion of distribution was investigated by determining a coefficient of variation. A *P* value of <.05 was considered to be

TABLE 2 Mean postoperative blood pressure every hour

	No hematoma (n = 280) (mm Hg)[a]	Hematoma (n = 9) (mm Hg)[a]	Independent *t* test
Immediate post-op	153.8 ± 28.7	144.0 ± 30.9	$P = .34$
1st hour	142.1 ± 27.4	150.4 ± 45.7	$P = .65$
2nd hour	126.4 ± 21.1	140.7 ± 28.7	$P = .08$
3rd hour	121.3 ± 18.1	131.9 ± 25.2	$P = .11$
4th hour	116.4 ± 17.2	129.4 ± 28.4	$P = .24$
5th hour	113.2 ± 15.4	112.2 ± 20.2	$P = .86$
6th hour	111.1 ± 15.5	100.9 ± 7.8	$P = .06$
7th hour	109.5 ± 14.3	105.6 ± 10.3	$P = .45$
8th hour	110.0 ± 13.9	120.9 ± 35.1	$P = .38$
9th hour	112.0 ± 13.6	107.3 ± 13.4	$P = .30$
10th hour	111.4 ± 13.8	107.1 ± 12.8	$P = .35$
11th hour	111.4 ± 14.4	107.9 ± 8.9	$P = .50$
12th hour	111.9 ± 14.9	100.9 ± 9.9	$P = .04$
13th hour	112.7 ± 15.6	101.8 ± 8.6	$P = .05$
14th hour	113.3 ± 16.9	104.6 ± 7.9	$P = .15$
15th hour	113.9 ± 16.2	107.3 ± 12.8	$P = .22$
16th hour	114.2 ± 17.0	109.3 ± 9.1	$P = .39$
17th hour	113.8 ± 16.9	110.6 ± 7.9	$P = .28$
18th hour	115.6 ± 18.4	108.8 ± 20.1	$P = .28$
19th hour	114.0 ± 17.5	111.9 ± 14.7	$P = .72$
20th hour	115.8 ± 17.5	111.6 ± 13.0	$P = .47$
21st hour	115.6 ± 17.2	114.4 ± 30.2	$P = .85$
22nd hour	115.2 ± 17.1	124.3 ± 34.2	$P = .45$
23rd hour	115.6 ± 17.5	115.8 ± 20.5	$P = .98$
24th hour	116.2 ± 16.9	122.3 ± 23.0	$P = .32$

[a]Blood pressure was expressed as mean ± SD.

statistically significant. This study was approved by the Institutional Review Board at the Kaohsiung Veterans General Hospital (IRB number: VGHKS17-CT12-10).

3 | RESULT

In total, 289 patients were enrolled, of whom 172 (59.5%) had stage IV cancer, 71 (24.6%) had diabetes, and 81 (28.0%) had hypertension. Most of the patients were either smokers (245, 84.8%), alcoholics (202, 69.9%), or betel nut chewers (205, 70.9%). Hematoma group has longer ICU days, larger flaps, more blood loss, and older age. Postoperative complications were as follows: 13 (4.5%) free flap failures, 18 (6.2%) hematomas, 14 (4.8%) congestions, and 9 (3.1%) ischemias. Donor flap types were as follows: anterolateral thigh flap (126, 43.6%), peroneal flap (76, 26.3%), fibular osteocutaneous flap (81, 28.0%), medial sural flap (5, 1.7%), and radial forearm flap (1, 0.3%). There was no statistically significant difference in hematoma formation between tumor stages, comorbidities, cigarette smoking, alcohol consumption, betel nut chewing, or flap types (Table 1). Overall, 13 free flap failures were observed. All of them were smokers. Smoking significantly increased the risk of free flap failures ($P = .04$, Fisher's exact test).

There were 18 patients complicated with postoperative hematoma. Most hematomas occurred in the first 3 days of surgery (n = 12, 66.7%), particularly on the first day (n = 9, 50%). Oscillometric pressure was analyzed every hour on the first day postoperatively and no difference was observed between the group of patients with hematoma and without hematoma on the first day (Table 2). The risk of postoperative hematoma increased significantly if SBP ≥ 165 mm Hg (Table 3). Positive predictive value and negative predictive value of SBP at 165 mm Hg were 66.7% and 97.9% (Table 4). Heart rate is significantly higher in hematoma group (Table 5).

4 | DISCUSSION

Hematomas could compromise the blood flow to pedicles. Although hematomas have been reported to induce the inflammatory process including cellular inflammatory response and cytokine release, mechanical compression could be a more significant reason for free flap failure.[10] Early detection and early reexploration are beneficial for flap salvage.[6] Our patients were routinely admitted to the intensive care center, which was helpful for early detection. Moreover, we removed stitches once hematomas were identified. We believe that this is the reason our patients with hematomas did not have higher failure rates.

We observed 13 (4.5%) free flap failures. All of these patients were smokers. Univariate analysis showed that smoking was the only significant factor contributing to free flap failures ($P = .04$, Fisher's exact test). Nicotine activates the sympathetic nervous system, produces cutaneous vasoconstriction, and increases circulating concentrations of norepinephrine, which are known to be harmful to the free flap survival.[11] Although some researches doubt such results, our data proved again that smoking is a risk factor of free flap failure.[12-14] Although recent studies have revealed that preoperative alcohol consumption was associated with an increased risk of general postoperative morbidities and prolonged hospital stay in free flap reconstruction, our data did not reach a significant difference in failure rate between two groups (alcoholics vs non-alcoholics = 5.5% (11/199) vs 2.3% (2/90), $P = .18$, Fisher's exact test).[15,16]

Late-onset hematomas are believed to be due to delayed or missed detection, rather than the late development of hematomas.[6] Therefore, we reviewed the blood pressures of

TABLE 3 Number of postoperative hematomas in case of systolic blood pressure ≥165 mm Hg

	Time	Systolic blood pressure (SBP)		*P* value, Fisher's exact test
		SBP ≥ 165 mm Hg	SBP < 165 mm Hg	
Hematoma (no. of hematoma patients, %)	Immediate post-op	N = 2/88, 2.3%	N = 6/199, 3.0%	.72
	1st hour	N = 2/553, 3.8%	N = 5/233, 2.1%	.51
	2nd hour	N = 2/14, 14.3%	N = 6/274, 2.2%	.05*
	3rd hour	N = 0/5, 0%	N = 9/284, 3.2%	.57
	4th hour	N = 2/3, 66.7%	N = 6/285, 2.1%	.001*
	5th hour	N = 0/0	N = 7/287, 2.4%	-
	6th hour	N = 0/1, 0%	N = 8/284, 2.8%	.81
	7th hour	N = 0/0	N = 9/289, 3.1%	-
	8th hour	N = 1/1, 100%	N = 8/286, 2.8%	.008*
	9th hour	N = 0/0	N = 9/288, 3.1%	-
	10th hour	N = 0/0	N = 9/288, 3.1%	-
	11th hour	N = 0/1, 0%	N = 8/286, 2.8%	.81
	12th hour	N = 0/1, 0%	N = 8/286, 2.8%	.81
	13th hour	N = 0/1, 0%	N = 8/285, 2.8%	.81
	14th hour	N = 0/3, 0%	N = 8/282, 2.8%	.68
	15th hour	N = 0/1, 0%	N = 9/285, 3.2%	.80
	16th hour	N = 0/2, 0%	N = 9/284, 3.2%	.72
	17th hour	N = 0/1, 0%	N = 9/287, 3.1%	.80
	18th hour	N = 0/3, 0%	N = 9/282, 3.2%	.66
	19th hour	N = 0/0	N = 9/286, 3.1%	-
	20th hour	N = 0/2, 0%	N = 9/285, 3.2%	.72
	21st hour	N = 1/2, 50%	N = 8/286, 2.8%	.04*
	22nd hour	N = 1/3, 33.3%	N = 8/284, 2.8%	.07
	23rd hour	N = 0/2, 0%	N = 8/285, 2.8%	.74
	24th hour	N = 1/2, 50%	N = 8/287, 2.8%	.04*

*significant at p< 0.05.

TABLE 4 Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) stratified by different systolic blood pressure

Cutoff point of NBP (mm Hg)[a]	Sensitivity	Specificity	PPV	NPV
140	37.5%	92.5%	12.5%	98.1%
150	25%	97.1%	20%	97.8%
160	25%	98.9%	40%	97.9%
165	25%	99.6%	66.7%	97.9%

[a]The statistical measures are calculated based on the blood pressure at 4th hour.

our patients on the first day postoperatively. There was no significant difference between patients with hematoma and those without. However, risk of hematoma increased significantly when SBP ≥ 165 mm Hg. Changes in blood pressure have been proven to be involved in the enlargement of spontaneous intracerebral hematomas.[17] Although there were some researches suggesting maintaining SBP below 150 mm Hg,[18-20] some showed that blood pressure is not associated with hematoma formation.[21] In our study, the overall mean of hematoma group did not have higher blood pressures. But in transient elevations, indicated by stratification of a threshold of 165 mm Hg, the association was statistically significant. We believe the transient elevated blood pressure, secondarily to noxious stimuli, such as cough, delirium, or IVC placement was a more important risk factor. In our analysis, SBP of 165 mm Hg had the highest PPV and NPV, but the hematoma rate increased sharply when SBP was above 150 mm Hg. According to the result, we suggested controlling SBP < 150 in clinical practice for

TABLE 5 Mean postoperative heart rate every hour

	No hematoma (n = 280) (beats/min)[a]	Hematoma (n = 9) (beats/min)[a]	Independent *t* test
Immediate post-op	95.6 ± 16.0	101.5 ± 13.6	*P* = .30
1st hour	92.4 ± 15.7	101.8 ± 19.1	*P* = .12
2nd hour	91.5 ± 15.6	98.4 ± 14.1	*P* = .22
3rd hour	93.0 ± 14.8	96.0 ± 14.7	*P* = .57
4th hour	93.1 ± 15.3	98.5 ± 14.0	*P* = .40
5th hour	95.3 ± 15.5	92.7 ± 13.5	*P* = .67
6th hour	96.8 ± 15.7	93.5 ± 11.4	*P* = .56
7th hour	96.0 ± 15.8	93.6 ± 9.7	*P* = .52
8th hour	95.0 ± 15.6	97.9 ± 13.0	*P* = .58
9th hour	93.3 ± 15.1	95.2 ± 11.2	*P* = .71
10th hour	92.1 ± 15.0	94.1 ± 12.3	*P* = .69
11th hour	91.1 ± 14.7	96.0 ± 12.5	*P* = .36
12th hour	89.2 ± 14.0	92.9 ± 11.9	*P* = .46
13th hour	88.7 ± 14.3	93.2 ± 12.1	*P* = .38
14th hour	88.4 ± 14.3	93.1 ± 11.7	*P* = .36
15th hour	87.1 ± 14.0	94.7 ± 9.5	*P* = .11
16th hour	87.0 ± 14.7	92.3 ± 7.3	*P* = .07
17th hour	85.7 ± 14.5	96.5± 12.8	*P* = .03
18th hour	85.9 ± 14.7	96.3 ± 13.5	*P* = .04
19th hour	85.0 ± 15.1	95.8 ± 10.3	*P* = .03
20th hour	85.1 ± 15.1	95.4 ± 9.2	*P* = .04
21st hour	85.4 ± 15.1	96.9 ± 12.2	*P* = .03
22nd hour	85.0 ± 14.7	95.6 ± 7.6	*P* = .003
23rd hour	84.6 ± 14.8	96.6 ± 10.6	*P* = .02
24th hour	84.8 ± 15.7	97.1 ± 8.5	*P* = .02

[a]Heart rate was expressed as mean ± SD.

free flap reconstruction in head and neck cancer. To the best of our knowledge, this is the first study to observe the blood pressure effect on head and neck reconstruction patient.

In addition to blood pressure, there was a significant association between increased heart rate and postoperative hematoma. Continuous blood loss leads to hemodynamic instability and tachycardia reflects the early phase of hypovolemic shock.[22] This finding gives us an alert. Whenever heart rate increased, postoperative bleeding or hematoma may present and we should examine surgical site for possible hematomas.

We recommended to control SBP < 150 mm Hg and we proved the association between transient elevated blood pressure and hematoma. Nevertheless, our number of patients is still limited. The limited number could also hinder the association between alcoholic consumption and free flap failure. Moreover, the use of nonsteroidal anti-inflammatory drugs, or different blood pressure medications was not included in this study, either.[23]

5 | CONCLUSION

Transient elevation of SBP increased the risk of postoperative hematomas. We suggested controlling SBP below 150 mm Hg for prevention of hematoma. Tachycardia could be the sign of postoperative hematoma. Once hematoma occurs, early detection and early reexploration could salvage the critical flap.

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DISCLOSURE OF INTERESTS

None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this manuscript.

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