

Investigation of risk factors on the final outcome of supraclavicular flap in the reconstruction of patients with head and neck surgery

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ABSTRACT

Introduction: Supraclavicular flap is one of the most widely used cases in the reconstruction of head and neck surgeries. However, despite its great importance, a comprehensive study of risk factors affecting its final survival has not been carried out. Therefore, the aim of this study was to investigate the effect of demographic factors, medical history and reconstructive surgery information on the incidence of these complications.

Implementation Method: In this case-series study, the medical records of 25 patients who underwent reconstruction of head and neck defects using supraclavicular flaps during August 2015 to August 2020 in Amir A'lam Hospital were reviewed. Information on demographic characteristics of patients (age and gender), medical history of patients (previous radiation therapy, previous head and neck surgery, smoking status, blood pressure, diabetes, hypothyroidism, type of pathology of the initial disease, harvest time) and site of reconstruction were recorded. Surgical information such as complications of the supraclavicular flap donor site, such as seroma and wound dehiscence, and the final flap status examined, including complete flap loss and partial necrosis, were investigated.

Results: According to our results, 32% of patients had diabetes and 60% had hypertension. Also, 44% smoked, 8% had a history of surgery, 16% had previous radiotherapy alone, and 4% had chemotherapy with radiotherapy. The site of reconstruction was 32% in the mouth, 24% in the parotid and 44% in the lateral cranial base (temporal). During the study, 20 patients (80%) survived the final uncomplicated supraclavicular flap, 5 patients (20%) had partial flap necrosis and no complete flap necrosis was seen. Also in this study, 4 patients (16%) had suture dehiscence at the flap donor site and no seroma was observed at the flap donor site. In addition, a significant relationship was observed between the incidence of wound dehiscence at the flap site and high blood pressure. Also, a significant relationship was observed between partial flap necrosis with hypertension and a history of radiotherapy.

Conclusion: Our results showed that hypertension and previous radiotherapy affect the final outcome, i.e. relative necrosis. Also, hypertension was significantly related to the wound dehiscence at the flap donor site.

Keywords: Supraclavicular Flap Reconstruction, Complications of Flap Donor Site Surgery, Final Outcome of Surgery, Necrosis

INTRODUCTION

The supraclavicular artery islet flap (SCAIF) is an axial flap supported by the supraclavicular artery. This type of surgery has been increasingly used over the past 10 years to reconstruct complex oncological defects in the head and neck. These types of reconstructions not only cover 3D defects, but also aim to restore swallowing function and speech production [1]. SCAI was defined as an axial pedicle flap in 1979 by Lamberty, but its use was limited due to the high incidence of distal flap necrosis [2]. In 1997, Palua and Mackenzie succeeded in reconstructing the neck structure in 6 cases by making modifications in the flap [3]. Then, over time, with increasing knowledge about vascular anatomy of the shoulder area, the reproducibility and the validity of the flap increased [4].

The SCAIF is a type of fasciocutaneous flap that is harvested from the supraclavicular and deltoid regions. The blood supply to this flap is provided by the supraclavicular artery. In 93% of cases, this artery is separated from the transverse artery of the neck and in 7% of cases from the suprascapular artery. The transverse artery of the neck is a branch of the thyrocervical trunk that separates from the third part of the subclavian artery and divides into two branches, and finally divides into the supraclavicular

branches and the circulatory branch of the trapezius muscle [5]. One of the anatomical features of this flap is its thickness and flexibility similar to the radial forearm free flap (RFFF), which has more advantages such as better color matching [5, 6]. Non-oncological indications for SCAI include ulcers that result from burns, trauma, and exposure to acid or base in the lower third of the face [7]. This flap is used to reconstruct different areas of the head and neck, including the oral cavity, oropharynx, laryngopharynx, esophagus and trachea, temporal skin and cervicofacial skin [5]. Possible postoperative complications include wound dehiscence at the site of the flap recipient or donor, wound infection, fistula, pain or discomfort in the shoulder area, partial or complete necrosis of the flap [8, 9]. It has been shown that supraclavicular nerves may be cut during flap resection. These nerves are superficial and sensory that provide sensation on the clavicle, anterior shoulder, and chest [1, 10].

This surgery is time consuming and cannot be repeated and puts a lot of financial and psychological burden on the patient, its success is very important. Therefore, such a study is necessary and in this study we intend to investigate the effect of demographic factors,

medical history and reconstructive surgery information on the occurrence of these complications.

Implementation method: In this case-series study, patients who underwent reconstruction of head and neck defects using supraclavicular flap between 2015 and 2020 were studied. Information about patients' demographic characteristics (age and sex) was recorded and a code was used for each patient instead of patients' names. Other information includes the patient's medical history (previous radiation therapy, previous head and neck surgery, smoking status, immunodeficiency, diabetes, hypothyroidism), surgical information such as flap harvest time, flap dimensions, cause of defect (reconstruction surgery indication), reconstruction site (mouth, parotid, lateral cranial base) were also recorded. The final outcome of the flap, including complete flap necrosis, partial flap necrosis, and survival of the flap without complication. Complete flap necrosis means loss of the entire flap, which necessitates reoperation. This complication usually occurs when the main vessels of the flap, unable to supply blood and causes necrosis and complete loss of the flap. On examination, this complication manifests itself as complete cyanosis and blackening of all areas of the flap. Relative necrosis means partial necrosis of the end of the flap or loss of only the superficial epithelium of the flap without loss of the deeper layer of the flap, which on examination manifests as partial cyanosis and bruising of the end of the flap. This necrosis affects only the epidermal layer of the distal part of the flap, and its distinctive feature is not required for re-surgery, and the reconstruction site is repaired conservatively and secondarily. Complications of the donor site include opening of the suture and wound and the formation of seroma in the donor site. Finally, information about the final outcome of the flap and complications of the flap was extracted using the available information in the records and progressive notes recorded during hospitalization and recorded in a questionnaire.

Also, before conducting the research, a letter of introduction was obtained from the Research Council and the Ethics Committee of Tehran University of Medical Sciences with the registration number IR.TUMS.AMIRALAM.REC.1399.012 and the necessary coordination was made with the officials of Amir A'lam Hospital. Since the identity information of patients (name, religion, ethnicity, etc.) is not registered for study and the study has a retrospective design, the consent was not obtained, however, issues such as the principle of confidentiality of information of research units and presentation of the results of the research project were observed.

Statistical analysis: Statistical analysis was carried out using SPSS software version 23. Chi-square and Fisher tests were used to analyze qualitative data and independent t-test and Mann-Whitney test were used to compare quantitative variables between groups. Qualitative data were presented as prevalence and percentage and quantitative data were reported as mean, and standard deviation. Kolmogorov-Smirnov test was used to evaluate the normality of the data. Using correlation tests (Chi-square and Spearman), the relationship of these factors with the occurrence of each complication was investigated

and a regression model was designed for them. P less than 0.05 was also considered significant.

RESULTS

Examination of 25 patients undergoing reconstruction of head and neck defects using supraclavicular flap showed that the mean age was 61.8 ± 13.7 years, so that the minimum age was 27 and the maximum age was 83 years.

The distribution frequency of gender also showed that 56% of patients were male and 44% were female. Also, the results related to the frequency distribution of the reconstruction site, prevalence of diabetes, smoking, previous treatment including radiotherapy or chemoradiotherapy, blood pressure, history of surgery, hypothyroidism, type of injury and pathology, final condition of the flap and flap donor site complications are reported in Table 1. Our results showed that the largest site of reconstruction was in the lateral base of the skull (11 patients, 44%). 68% and 66% of patients were negative for diabetes and non-smokers, respectively. 20 patients (80%) had no previous chemo/radiotherapy and 60% of them (15 patients) had hypertension. Regarding the history of surgery and hypothyroidism, 92% of patients (23 patients) had no history of surgery and negative for hypothyroidism, eitherly. The most common type of pathology (19 patients, 76%) was squamous cell carcinoma (SCC). Also, 20 patients (80%) and 21 patients (84%) had successful survival of flap and no flap donor site complication, respectively.

In addition, the minimum flap harvest time was 35 minutes and the maximum was 43 minutes with a mean of 40.16 minutes. The length of the flap was a maximum of 20 cm and a minimum of 9 cm with a mean of 14.6 cm. Flap length refers to the size of the largest flap length designed to be used in head and neck surgery.

Also, according to Table 2, the relationship between risk factors and risk factors such as age, time of flap harvest and flap length was investigated and our results showed that the mentioned variables had no significant effect on the final outcome of the flap ($P > 0.05$).

Also, previous surgical history, type of primary site pathology, history of hypothyroidism, hypertension and diabetes, history of smoking with final flap status, including uncomplicated flap status and relative necrosis were investigated (Table 3). According to Exact statistical test, the two variables of history of radiotherapy ($P=0.016$) and hypertension ($P=0.015$) with the final outcome of the flap, i.e. relative necrosis, were significant.

In addition, according to Tables 4 and 5, the relationship between risk factors and donor site complications was investigated. Site donor complications in this study included wound site dehiscence and seroma formation. Because seroma formation was not seen in any of the cases, it was excluded from the study and we only examined the relationship between risk factors and of wound site dehiscence. Our results showed that according to the Exact statistical test, wound dehiscence was significantly related to high blood pressure ($P=0.032$).

Table 1. Frequency distribution of the studied factors on the final flap outcome

Variables		Number	Percentage
Gender	Male	14	%56
	Female	11	%44
Reconstruction site	Oral cavity	8	%32
	Parotid skin	6	%24
	Lateral skull base (temporal)	11	%44
Prevalence of diabetes	Positive diabetes	8	%35
	Negative diabetes	17	%68
Smoking	Smoker	11	%44
	Non-smoker	14	%66
Previous treatment	No previous treatment	20	%80
	Radiotherapy only	4	%16
	Chemoradiotherapy	1	%4
Blood pressure	High blood pressure	15	%60
	Normal blood pressure	10	%40
History of primary site surgery	Positive surgical history	2	%8
	Negative surgical history	23	%92
Hypothyroidism	Positive hypothyroidism	2	%8
	Negative hypothyroidism	23	%92
Type of pathology	Squamous cell carcinoma(SCC)	19	%76
	Adenoid cystic carcinoma (ACC)	2	%8
	Mucoepidermoid carcinoma (MEC)	2	%8
	Trauma defect	2	%8
Final status of the flap	Survival, without flap complication	20	%80
	Relative flap necrosis	5	%20
	Complete flap necrosis	0	%0
Flap donor site complications	No complications	21	%84
	Wound dehiscence	4	%16
	Seroma formation	0	%0

Table 2. Frequency distribution of the final flap outcome in terms of age, surgery time and flap length

Final outcome of flap Variables	Uncomplicated			Relative necrosis			P-value
	Number	Mean \pm std. deviation	Min/Max	Number	Mean \pm std. deviation	Min/Max	
Age	20	14,6 \pm 62	27/83	5	11,1 \pm 61,2	47/87	0,91
Surgery time	20	2,3 \pm 39,9	35/43	5	1,6 \pm 41	39/43	0,357
Flap length	20	3,4 \pm 14,1	9/20	5	3,1 \pm 16,6	12/20	0,148

Table 3. Frequency distribution of the final flap outcome in terms of gender and medical history

Final outcome of flap Variables		Uncomplicated		Relative necrosis		P-value
		Number	Percentage	Number	Percentage	
Gender	Male	11	%78,6	3	%21,4	1
	Female	9	%81,8	2	%18,2	
Reconstruction site	Oral cavity	7	%87,5	1	%12,5	0,205
	Previcular and parotid	6	%100	0	%0	
	Lateral base of the skull (temporal)	7	%63	4	%36,6	
Diabetes status	Positive diabetes	5	%62,5	3	%37,5	0,21
	Negative diabetes	15	%88,2	2	%11,8	
Smoking	Smoker	7	%63,6	4	%36,4	0,133

	Non smoker	13	%92,9	1	%7,1	
History of chemoradiotherapy / radiotherapy	No history of chemoradiotherapy	18	%90	2	%10	0,016
	History of chemoradiotherapy	1	%100	0	%0	
	History of radiotherapy	1	%25	3	%75	
Blood pressure status	Existence of blood pressure	10	%66,70	5	%33,3	0,015
	Absence of blood pressure	10	%100	0	%0	
History of surgery	Positive surgical history	1	%50	1	%50	0,367
	Negative surgical history	19	%82,6	4	%17,4	
History of hypothyroidism	Positive	2	%100	0	%0	1
	Negative	18	%78,3	5	%21,7	
Primary pathology	SCC	15	%78,9	4	%21,1	0,781
	MEC	2	%100	0	%0	
	ACC	1	%50	1	%50	
	Trauma	2	%100	0	%0	

Table 4. Frequency distribution of wound condition at the donor site in terms of age, operation time and flap length

Final outcome of flap Variables	Normal			Wound dehiscence			P-value
	Number	Mean ± std. deviation	Min/Max	Number	Mean ± std. deviation	Min/Max	
Age	21	14±61	27/83	4	13,4±66,2	47/78	0,495
Operation time	21	2,3±40	35/43	5	1,73±41,5	39/43	0,196
Flap length	21	3,4±14,8	9/20	5	3,9±13,5	9/18	0,495

Table 5. Frequency distribution of wound condition at the donor site in terms of gender and medical history

Final outcome of flap Variables		Uncomplicated		Wound dehiscence		P-value
		Number	Percentage	Number	Percentage	
Gender	Male	13	%92,9	1	%7,1	0,288
	Female	8	%72,7	3	%27,3	
Diabetes status	Positive diabetes	6	%75	2	%25	0,288
	Negative diabetes	15	%88,2	2	%11,8	
smoking	Smoker	12	%85,7	2	%14,3	0,791
	Non smoker	9	%81,8	2	%18,2	
Blood pressure status	Existence of blood pressure	10	%100	0	%0	0,032
	Absence of blood pressure	11	%73,3	4	%26,7	
History of hypothyroidism	Positive	19	%82,6	4	%17,4	1
	Negative	2	%100	0	%0	

DISCUSSION

Following the increase in cost-effectiveness and compliance with the patient's comorbidities, SCAIF has emerged as a potential option for tissue transplantation in various cases and for soft tissue reconstruction. SCAIF, like RFFF, is strong, thin, and flexible and can be harvested without microvascular experience [11-14]. The present study was conducted to review the medical records of all patients (25 patients) who underwent reconstruction of head and neck defects using supraclavicular flap.

According to the results of the present study, 20 patients (80%) had final survival of the uncomplicated supraclavicular flap. 5 patients (20%) developed relative flap necrosis. Also, no complete flap necrosis was seen in this study. 4 patients (16%) had flap donor site suture opening and no seroma was observed at the flap donor site. After analyzing the data, a significant relationship was observed between the incidence of wound dehiscence at the flap donor site and high blood pressure. On the other hand, complete flap necrosis was not observed, however, there was a significant relationship between partial flap

necrosis with high blood pressure and a history of radiotherapy.

Flaps are mainly designed based on advancement and transposition. Flaps considered by the surgeon are occipitocervicoshoulder and then occipitocervicopectoral based on the occipital artery and finally supraclavicular flaps based on the supraclavicular artery of the cervical transverse artery trunk [15, 16].

In a similar retrospective study, Goyal et al. reviewed the records of 64 patients who underwent supraclavicular flap reconstruction. According to their results, 86% of them had malignancy and 55% of them had a history of radiotherapy. 63% of surgeries were clean-contaminated. Also, in seven patients (11%) the surgical site infection developed at the flap receipt site (all in patients whose wound was clean-contaminated) and there was no case of complete flap loss. Reconstruction of the oral cavity and larynx and clean-contaminated surgery were factors associated with an increased risk of infection at the surgical site [17]. In their study, the examination of postoperative infection was considered as a complication of the operation, and wound dehiscence and seroma were not considered. In our study, these factors were taken into account and no infection of the surgical site was observed. Also, complete necrosis was zero in both studies and no cases were reported. However, relative flap necrosis was observed in 5 cases (20%) in our study. In the above study, the relationship between the history of radiotherapy and complications as well as the final outcome was not investigated. In our study, this relationship was investigated and there was a significant relationship with the final outcome of the flap, which was relative flap necrosis. In Razdan et al.'s study, complications at the flap receipt site included wound healing defects (2 cases), urocutaneous fistulas (1 case), and complete loss of the flap (1 case) and there was no relationship between radiotherapy history and neck dissection with flap loss [18]. Kokot et al. also used the supraclavicular flap for reconstruction in 45 patients with malignant and non-malignant head and neck defects. These defects included defects of the oral cavity, throat, larynx, esophagus, trachea, temporal bone, and cervicofacial skin, and the flap harvest time was less than 1 hour. According to their results, flap donor complications included wound healing defects in 6 patients and the need for long-term wound care in 2 patients. Partial flap necrosis was observed in 8 patients and complete necrosis was observed in 2 patients. Seven patients developed a salivary fistula, 4 of which healed spontaneously. Flap length more than 22 cm and smoking history were associated with an increased risk of flap necrosis [5]. Therefore, compared to the present study, the incidence of partial necrosis in the above study was almost equal to our study (approximately 20%). However, complete necrosis was observed in 2 patients in this study, which was not present in our study. Also, smoking had a significant relationship in their study, but this relationship was not significant in our study. In another study, Sandu et al. examined reconstruction in 50 patients after removal of head and neck tumors. 44 out of 50 patients had 100% flap survival with excellent wound healing and all flaps were harvested in less than 1 hour. 4 patients had distal flap necrosis and 2 patients had complete flap necrosis. Distal flap necrosis was seen in

cases of reconstruction of oral cavity oral tumors and required only conservative treatment measures. Total flap necrosis was observed in two patients who had failed previous chemotherapy for cancers of oral squamous cell carcinoma and tonsils. In total, in this study, 4% had complete flap necrosis, but in our study, they did not have complete necrosis and partial necrosis was 20%, which was similar to our study. Also, no significant relationship was observed between the site of the primary tumor and the incidence of complications in our study, but in the above study, oral cavity tumors were associated with an increase in adverse outcomes. In addition, in the above study, a relationship was observed between complete necrosis with chemotherapy and radiotherapy, which in our study there was also a significant relationship between the history of radiotherapy and relative necrosis [19]. In a study Mr. Wong et al. examined eight patients in whom supraclavicular flaps were used to reconstruct them. Although in their study, the possibility of flap necrosis was investigated and no significant result was observed in the relationship between necrosis and history of radiotherapy and malignancy, but this lack of association could be due to the lack of sufficient sample size [20].

In general, despite a comprehensive review of patients' records, the present study had some limitations. For example, since different surgeons have performed the surgeries, the complications may be due to mistakes made during the surgery. It is also possible that information about the incidence of complications in previous years has not been recorded in patients' records.

CONCLUSION

Our results showed that hypertension and a history of radiotherapy can affect the final condition of the flap, which includes uncomplicated flap and relative necrosis. Also, hypertension is significantly related to wound dehiscence at the flap donor site.

REFERENCE

1. Spiegel, J.L., et al., Shoulder Morbidity in Patients after Head and Neck Reconstruction with the Pedicled Supraclavicular Island Flap. *Plast Reconstr Surg Glob Open*, 2018. 6(4): p. e1711.
2. Lamberty, B.G., The supra-clavicular axial patterned flap. *Br J Plast Surg*, 1979. 32(3): p. 207-12.
3. Pallua, N., et al., The fasciocutaneous supraclavicular artery island flap for releasing postburn mentosternal contractures. *Plast Reconstr Surg*, 1997. 99(7): p. 1878-84; discussion 1885-6.
4. Deramo, P. and J. Rose, Flaps, Muscle And Musculocutaneous. *StatPearls [Internet]*, 2020.
5. Kokot, N., et al., The supraclavicular artery island flap in head and neck reconstruction: applications and limitations. *JAMA Otolaryngol Head Neck Surg*, 2013. 139(11): p. 1247-55.
6. Sukato, D.C., et al., Systematic Review of Supraclavicular Artery Island Flap vs Free Flap in Head and Neck Reconstruction. *Otolaryngol Head Neck Surg*, 2019. 160(2): p. 215-222.
7. Loghmani, S., et al., The supraclavicular flap for reconstruction of post-burn mentosternal contractures. *Iran Red Crescent Med J*, 2013. 15(4): p. 292-7.
8. Tan, B.K., Y.C. Por, and H.C. Chen, Complications of head and neck reconstruction and their treatment. *Semin Plast Surg*, 2010. 24(3): p. 288-98.

9. Liang, J., et al., Free tissue flaps in head and neck reconstruction: clinical application and analysis of 93 patients of a single institution. *Braz J Otorhinolaryngol*, 2018. 84(4): p. 416-425.
10. Nathe, T., S. Tseng, and B. Yoo, The anatomy of the supraclavicular nerve during surgical approach to the clavicular shaft. *Clin Orthop Relat Res*, 2011. 469(3): p. 890-4.
11. Kozin, E.D., et al., Comparison of Perioperative Outcomes between the Supraclavicular Artery Island Flap and Fasciocutaneous Free Flap. *Otolaryngol Head Neck Surg*, 2016. 154(1): p. 66-72.
12. Granzow, J.W., et al., Supraclavicular artery island flap (SCAIF) vs free fasciocutaneous flaps for head and neck reconstruction. *Otolaryngol Head Neck Surg*, 2013. 148(6): p. 941-8.
13. Welz, C., et al., Oral Cancer Reconstruction Using the Supraclavicular Artery Island Flap: Comparison to Free Radial Forearm Flap. *J Oral Maxillofac Surg*, 2017. 75(10): p. 2261-2269.
14. Zhang, S., et al., Pedicled Supraclavicular Artery Island Flap Versus Free Radial Forearm Flap for Tongue Reconstruction Following Hemiglossectomy. *J Craniofac Surg*, 2015. 26(6): p. e527-30.
15. Shenoy, A., et al., Supraclavicular artery flap for head and neck oncologic reconstruction: an emerging alternative. *Int J Surg Oncol*, 2013. 2013: p. 658989.
16. Javadian, R., et al., Head and neck reconstruction: The supraclavicular flap: technical note. *Ann Chir Plast Esthet*, 2019. 64(4): p. 374-379.
17. Goyal, N., et al., Risk factors for surgical site infection after supraclavicular flap reconstruction in patients undergoing major head and neck surgery. *Head Neck*, 2016. 38(11): p. 1615-1620.
18. Razdan, S.N., et al., Safety of the supraclavicular artery island flap in the setting of neck dissection and radiation therapy. *J Reconstr Microsurg*, 2015. 31(5): p. 378-83.
19. Sandu, K., P. Monnier, and P. Pasche, Supraclavicular flap in head and neck reconstruction: experience in 50 consecutive patients. *Eur Arch Otorhinolaryngol*, 2012. 269(4): p. 1261-7.
20. Wong, S., et al., Supraclavicular Artery Island Flap in Head and Neck Reconstruction: A Case Series and Literature Review. *Perm J*, 2019. 23.