Supraclavicular Flap Reconstruction of Cutaneous Defects Has Lower Complication Rate than Mucosal Defects

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Abstract

Background   The objective of this study was to determine whether there was a difference in complication rate between cutaneous and mucosal defects reconstructed with the supraclavicular artery flap.

Methods   Retrospective review of postoperative complications in 63 patients from 2008 to 2015 with cutaneous and mucosal head and neck defects following oncologic ablation reconstructed with the supraclavicular flap, with a minimum follow-up duration of 6 months. Of the 63 patients, 38 patients had cutaneous defects, whereas 25 had mucosal defects. Patients were followed up postoperatively to determine the presence of wound infection, partial flap necrosis, complete flap necrosis, and fistula formation. Complications in both defect groups as well as a statistical comparison of total complications were analyzed.

Results   Patients with cutaneous defects reconstructed with the supraclavicular flap had significantly lower postoperative complications than those with mucosal defects ($p = 0.002$). Flap necrosis, both partial and complete, was also lower in this same group ($p = 0.0052$).

Keywords
► supraclavicular
► complications
► island flap

Conclusion   The supraclavicular artery flap may be a more suitable option for patients with cutaneous defects, given the reliability and lower propensity for postoperative complications

Level of Evidence   The level of evidence is 4.

The head and neck regions involve multiple complex structures that serve vital functions, which results in challenging decision making for reconstruction after oncological resection. Reconstructive surgeons can use a host of free and regional flaps depending on characteristics of the specific defect as well as the overall health of the patient. The supraclavicular artery island flap (SCAIF), a regional flap, is commonly used due to its versatility and ease of harvest, especially in cases when a free flap may not be the best option for the patient.

The SCAIF was initially used by Pallua et al (1997) for the treatment of postburn mentosternal contractures; however, it was not until much later when the flap gained popularity for use in the head and neck for postoncologic

reconstruction.[1–3] In contrast to the commonly used pectoralis major rotational flap, the SCAIF is a thin fasciocutaneous flap, generally not harvested with muscle. Although SCAIF is not considered to provide bulky tissue for large defects, it can be an excellent option for head and neck reconstruction because of its versatility, similar skin texture, and ability to harvest a large size that can be used internally or externally.

The anatomy of the SCAIF was described in detail from a cadaver study using 19 cadaveric bodies.[2] The main arterial supply was found to be the supraclavicular artery, a branch of the transverse cervical artery, which was consistently found among the sternocleidomastoid muscle, the external jugular vein, and the medial aspect of the clavicle.[2] The venous drainage of the flap comes from the supraclavicular vein, which runs in tandem with the artery, as well as an additional vein, which drains into the external jugular system. Using India ink, the angiosome of the supraclavicular artery was identified; it included the supraclavicular region and shoulder cap. The area of this angiosome ranged from 10 to 16 cm in width to 20 to 30 cm in length.[2] An illustration of the anatomy of the SCAIF is presented in ►Fig. 1, and an illustration of the underlying musculature as the flap is raised is presented in ►Fig. 2.

The SCAIF has been successfully used in various types of defects including both cutaneous and mucosal defects throughout the head and neck, including the face, neck, oral cavity, oropharynx, and hypopharynx.[4–6] Studies have described this regional flaps' use in more complex repairs, such as the parotid region and lateral skull base, showing its versatility.[7] Most current studies show favorable success rates with the use of this flap. Su et al have even reported 100% SCAIF survival rate in nine patients with previous radiation therapy and numerous previous neck surgeries.[8]

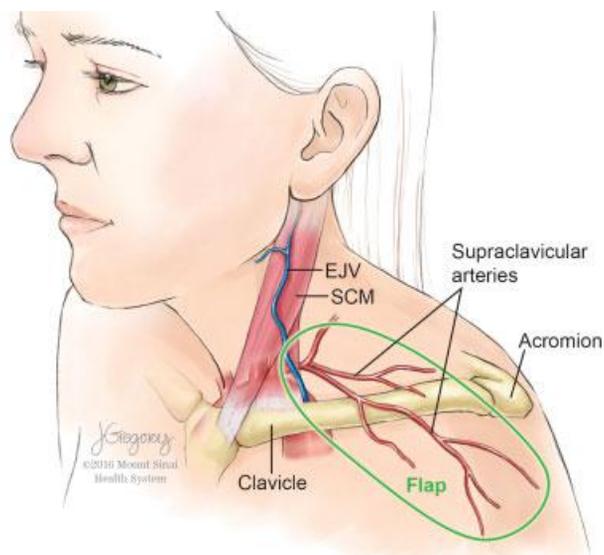Some of the most common complications reported with the SCAIF include flap loss, flap or skin necrosis, fistula
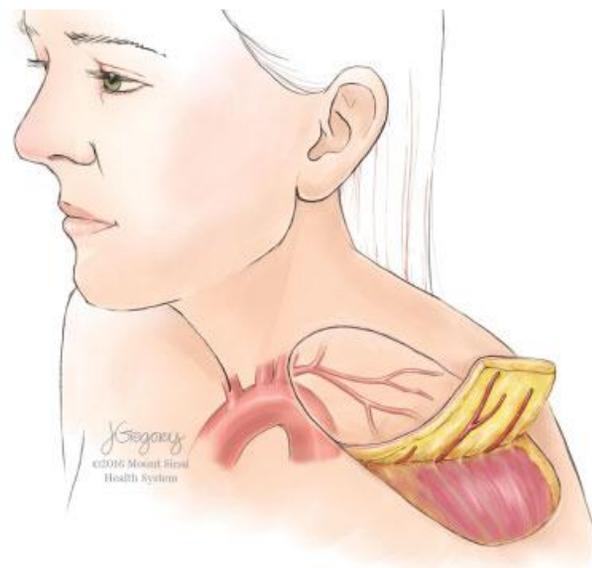

Fig. 2 Underlying musculature noted while raising flap.

formation, hematoma, and infection.[9–11] There is limited literature investigating if certain types of primary defects, such as cutaneous or mucosal, contribute more to overall complications rates or specific types of complications. A recent study shows an increased risk of infection in oral cavity and laryngeal reconstruction for malignancy when using the SCAIF after a clean-contaminated surgery; however, the study reports no complete flap loss.[12]

In this study, we sought to analyze complication rates from SCAIF reconstruction in cutaneous and mucosal defects to determine if one region lends itself to a more complicated postoperative course. This study would be the single largest study in the English literature discussing this subject and would assist surgeons in determining optimal flap choices for postablative defects.

Methods

Prior to beginning, approval was received from the Institutional Review Board at John Peter Smith Hospital, Fort Worth, TX.

This study was a retrospective review of the complications associated with the SCAIF when used for reconstruction of cutaneous versus mucosal defects. Oncologic surgical patient records from February 2008 to December 2015 were reviewed to determine the type of defect present after primary oncologic ablation, the method of reconstruction, and resulting complications during the postoperative period. Patients who were reconstructed with the SCAIF alone for repair of cutaneous or mucosal defects were included in the study. All of the patients were treated by the senior author (Y.D.) at a busy cancer treatment center in Texas with a minimum follow-up of 6 months.

After reviewing the records, 63 total patients met the inclusion terms for the study. There were 48 males, average age 57.5 years ranging from 39 to 91 years, and 15 females,

Fig. 1 Anatomy of supraclavicular flap. EJV, external jugular vein; SCM, sternocleidomastoid.

Fig. 3 Patient with large facial cutaneous defect with appropriate markings for supraclavicular artery island flap prior to reconstruction.

Fig. 5 Supraclavicular artery island flap held approximately at level of inset.

average age 64.2 years ranging from 53 to 84 years. The majority of patients had a significant smoking history prior to surgery. Of the 63 patients, 38 patients required the SCAIF for repair of cutaneous defects, whereas 25 patients required SCAIF for repair of mucosal defects. The maximum defect size was 30 cm^2 and was not significantly different between both groups. Of the 38 patients in the cutaneous defect group, 21 had defects of the auricular/temporal bone region, 10 of the cervical skin, 3 of the mentum, and 4 of the stoma. Of the 25 patients with mucosal defects, 9 had hypopharyngeal defects, 3 had pharyngocutaneous fistulas, 7 had floor of mouth defects, 3 had oropharyngeal defects, and 3 required repair of the buccal mucosa.

The technique used to raise the supraclavicular flap was fairly standard. A handheld Doppler probe was used to trace the signal of the supraclavicular artery onto the flap. After marking the flap appropriately, a relaxing proximal incision was made and the flap was raised in a superficial subcutaneous plane. Dissection of the flap continued from distal to proximal to raise the flap over the deltoid and periosteum of the clavicle. The flap was raised as an island flap. The flap was rotated into position when sufficient length was obtained. The flap was never used if there was tension at the rotation site, and the flap was never twisted. Ensuring no tension or twist increased chances of viability as the perfusion of the

flap was well maintained. Bleeding was checked distally with pinprick and Doppler prior to inset into the defect. All flaps were inset using deep tacking sutures followed by another layer securing skin to mucosa.

During the follow-up period, complications such as partial flap, complete flap loss, infection, and fistula were documented. Using a Fisher exact test to determine statistical differences in these categorical variables, total complications between both defect types were compared, all forms of flap loss were compared collectively, and finally, complete flap loss was compared between the two defect sites.

Results

In this study, 63 patients were included, 38 with cutaneous defects closed with the SCAIF and 25 with mucosal defects. ►**Figs. 3** to **6** show a patient with a cutaneous defect reconstructed with a supraclavicular flap, whereas ►**Figs. 7** to **10** show a patient with a mucosal defect closed with supraclavicular island flap. Complications were analyzed and stratified based on the type of defect reconstructed with the supraclavicular flap (►**Table 1**).

Reviewing the results for patients with cutaneous defects, 5 of the 38 patients had postoperative complications; 4 patients had a partial loss of their SCAIF and 1 patient had complete flap loss. From patients with mucosal defects, 15 of the 25 patients had postoperative complications. Patients

Fig. 4 Supraclavicular artery island flap raised in preparation for inset into cutaneous defect.

Fig. 6 Supraclavicular artery island flap fully inset into cutaneous defect with closed donor site.

Fig. 7 Preresection image of patient with extensive oral cavity malignancy.

Fig. 10 Supraclavicular artery island flap approximated for final inset to reconstruct mucosal defect.

Fig. 8 Supraclavicular artery flap raised in preparation for reconstruction of mucosal and skin defect.

ison yielded a *p*-value of 0.002, suggesting a strong significance in the differing complication rates between the two categories of tissue defects. Next, the same type of test was used to compare differences in complete and partial flap loss between the two techniques; however, this was not found to be significantly different between the two categories ($p = 0.5165$). Finally, flap loss as a whole was analyzed by grouping partial and complete flap loss into one category and comparing between both defect types. Interestingly, this difference was also significantly different ($p = 0.0052$).

Discussion

The SCAIF represents a reliable technique in the reconstruction of head and neck defects following oncologic ablation because of its ease of harvest, versatile use, and low overall complication rate. In a study of 349 flaps, Nthumba has reported only 1.4% complete necrosis rate and a 6.9% partial flap necrosis.[13] However, defect type was not stratified in this report. To date, studies have reported complications in patients reconstructed with the SCAIF, but have not compared whether the complications are more likely in cutaneous or mucosal defects.

Our study represents the largest study to date examining the SCAIF complication differences in patients with mucosal versus cutaneous defects. In a comparison of 38 patients with cutaneous defects and 25 with mucosal defects, all reconstructed with the SCAIF, the overall complication rate was significantly lower in patients with cutaneous defects ($p = 0.0002$). Although the difference in partial and complete flap necrosis between defect types was not significantly different ($p = 0.5165$), flap necrosis overall was lower in patients with cutaneous defects ($p = 0.0052$). Taken together, it appears that the SCAIF is a more reliable and safer method of reconstruction in patients with cutaneous defects than those with mucosal defects according to our results.

Multiple studies in the English literature have reported complications in patients treated with SCAIF, but small sample sizes and lack of comparison between defect types have made conclusion difficult. In a study by Goyal et al (2016) examining infection rate in patients reconstructed

with mucosal failure at the oropharyngeal level were previously radiated. Seven patients had a partial flap loss, whereas four had complete flap loss. Patients with flap loss did not have larger defects than those without complications.

To compare the overall complication risk, taking into account all types of complications, a Fisher exact test was performed, examining a 2×2 contingency table with a significance (α) threshold of 0.05. The results of this compar-

Fig. 9 Supraclavicular artery island flap folded on itself for mucosal lining.

Table 1 Complications stratified by defect subtype

	Total patients	Wound infection	Partial flap loss	Complete flap loss	Fistula	Total complications
Cutaneous defects						
Ear/temporal bone	21	0	2	0	0	2
Neck skin	10	0	2	0	0	2
Mentum	3	0	0	0	0	0
Stoma	4	1	0	0	0	1
Mucosal defects						
Hypopharynx	9	0	2	1	2	5
Pharyngocutaneous fistula	3	0	1	0	1	2
Floor of mouth	7	0	2	2	0	4
Oropharynx	3	0	0	1	0	1
Buccal mucosa	3	1	2	0	0	3

with the SCAIF, 42% of patients had cutaneous defects, none of which was infected postoperatively. The remaining patients had mucosal defects of which 10.93% had postoperative infections.[12]

In a study of 14 patients reconstructed with the SCAIF, 2 were reported to have partial necrosis with closure of mucosal defects.[14] In another study of six patients reconstructed with the SCAIF for repair of pharyngocutaneous fistulae after laryngectomy, one patient experienced complete flap necrosis, and one had a recurrent fistula.[15] In contrast, two different studies examining a total of nine patients with oropharyngeal defects reported no flap loss in the postoperative period.[16,17]

In contrast to our findings and selected reports in the literature, many authors have reported good success with the supraclavicular island flap for mucosal reconstruction. In 2012, Anand et al reported five patients with oropharyngeal defects reconstructed with the SCAIF. In the postoperative period, there were no flap losses and only one fistula.[16] These findings were similar to another study of four patients with pharyngeal defects resurfaced with the SCAIF reported in 2014, in which all four patients had no flap loss and satisfactory swallow function postoperatively.[17]

When examining outcomes from cutaneous defect closure, one study of 5 stomal reconstructions with SCAIF showed no partial or complete losses and another study of 10 patients needing SCAIF for cutaneous defects such as parotidectomy defects and lateral skull base defects showed only 1 partial loss, despite several patients receiving radiation.[7,18]

Although there were several patients in the current study having undergone previous radiation, namely those noted flap failures at the oropharyngeal level, the current study did not separate radiated and nonradiated patients. The use of locoregional flaps in the setting of radiation has been debated among surgeons. In a recent study of 22 patients undergoing SCAIF reconstruction, Razdan et al reported no association between flap loss and radiation status or neck dissection.[19]

Although the cited study included a small population of patients and may lack sufficient power to make a generalized recommendation, the results are encouraging toward the widespread use of the SCAIF.

One final comment must be made in regard to flap design. Flap design in the current study utilized the conventional approach, placing the skin paddle over the supraclavicular fossa extending to the deltoid. Although traditionally significant variability has not been noted in this realm, mention must be given to the anterior supraclavicular artery perforator flap, a modification of the conventional SCAIF with the placement of the skin paddle in the deltopectoral fossa. Proponents of this flap design tout the increased facial color match and decreased thickness as major advantages of using this variation.[20]

The above-mentioned studies, while suggestive of better outcomes with cutaneous closure compared with mucosal, lack a dedicated methodology for comparison, which the current study provides. Our study of 63 cases is highly suggestive of increased complication rates, namely flap necrosis, with closure of mucosal defects with the SCAIF. Although the SCAIF is a major asset to the armamentarium of the reconstructive surgeon, its use may perhaps be better suited for the closure of cutaneous defects. In the future, larger sample sizes across multiple institutions should be studied to determine any changes depending on surgeon technique and experience. Moreover, mucosal defects could be subdivided and individually compared as the role of saliva in wound breakdown is well noted.

Conclusion

Closure of mucosal defects with the SCAIF may lead to an increased number of complications, especially partial and complete flap necrosis, in comparison to cutaneous defects. Based on our results, we recommend that this flap be preferentially used for cutaneous defects to avoid potential untoward outcomes.

Conflict of Interest
The authors have no financial disclosure or conflict of interest.

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