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Reconstructive

Supraclavicular Artery Island Flap for Head and Neck Oncologic Reconstruction: 15-year Experience, Past, Present, Future

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Background: Head and neck reconstruction poses unique challenges due to the complex structure of the region. Primary goals include soft-tissue coverage, adequate color and texture match, and minimal donor-site morbidity. Local and musculocutaneous regional flaps have largely been replaced with fasciocutaneous free flaps (FFF) over recent years. The supraclavicular artery island flap (SCAIF), a locoregional, fasciocutaneous, axially-based flap, has been shown to produce similar outcomes to FFF. We present our 15-year experience using the SCAIF for head and neck reconstruction, discuss its evolution, and provide case examples for its range of indications.

Methods: Retrospective chart review identified 128 patients who underwent reconstruction of the head and neck with the SCAIF between the years 2006-2021 at Tulane University Medical Center. Patient demographics, lengths of stay, operative times, surgical indications, and complications were recorded.

Results: The cohort mean age was 66.9 years. Mean lengths of stay and follow-up times were 6.9 days and 9.1 months, respectively. The most common indications for SCAIF reconstruction were recurrent radiated neck disease (n=27, 21.1%), pharyngeal wall defects (n=23, 18.0%), and parotidectomy defects (n=21, 16.4%). Overall complication rate was 17.2%. Partial thickness flap loss (5.5%), contained pharyngeal leak (3.2%), and distal tip necrosis (2.4%) were the most common complications. No functional donor site morbidity was encountered.

Conclusions: The SCAIF is a versatile, fasciocutaneous, axially-based flap able to produce similar outcomes to FFF in the reconstruction of the head and neck region while reducing costs, lengths of stay, operative times, and donor site morbidity. *(Plast Reconstr Surg Glob Open 2023; 11:e5052; doi: 10.1097/GOX.0000000000005052; Published online 19 June 2023.)*

INTRODUCTION

Head and neck reconstruction poses unique challenges due to the complex three-dimensional nature of the region, as well as the necessity to preserve form, function, and aesthetics. There are a variety of options that should be taken into consideration when planning cervicofacial reconstruction, but primary goals include reliable soft tissue coverage, adequate color and texture match, and minimal donor-site morbidity. Local flaps, such as the submental artery flap, can provide excellent color and texture match, but lack the area to cover larger defects and can also maintain the ability to regenerate hair, which could be troublesome for oropharyngeal reconstruction. Many regional flaps, such as the deltopectoral flaps, provide more than adequate tissue coverage, but their musculocutaneous nature can lead to significant donor site morbidity and excess bulk. Free tissue transfer techniques have evolved rapidly over recent years, and flaps, such as the anterolateral thigh and radial forearm flaps, have been shown to be excellent options for the cervicofacial region. However, these techniques require more technical expertise and are associated with increased operative time, length of stay, and overall cost.

A regional flap that has recently regained traction for the reconstruction of the head and neck is the supraclavicular artery island flap (SCAIF). The SCAIF is a

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locoregional, fasciocutaneous, pedicled flap based on the axial supply from the supraclavicular artery (SCA), a branch of the transverse cervical artery. The flap has gone through multiple iterations, originally described by Toldt in 1903 as the "arteria cervicalis superficialis," and later coined by Lamberty et al in 1979 as the "cervicohumeral flap."[1] However, due to high incidence of distal flap necrosis, its use fell out of favor. Extensive anatomical studies were performed in the 1990s to describe the anatomy of the supraclavicular region and its vascular supply. Pallua et al[2] illuminated a consistent arterial supply of the supraclavicular region by the SCA, with multiple perforators to the overlying fascia and skin, and the name was changed to the SCAIF. The pedicle of the SCA was found uniformly within the supraclavicular fossa, bordered by the sternocleidomastoid (SCM) muscle, external jugular vein or trapezius, and clavicle. The group harvested the flap for the reconstruction of cervical contractures following burns, but the indication for its use has expanded significantly to include coverage of oncologic and tracheostomal defects as well as pharyngeal and tongue reconstruction.[3–13]

The fasciocutaneous nature of the SCAIF makes it an ideal candidate for the resurfacing of defects of the head and neck following oncologic resection, providing reliable tissue coverage without excessive bulk as well as an excellent color match for the region. With proper patient selection, the SCAIF should be considered a workhorse flap for head and neck reconstruction. Here, we present our 15-year experience using the SCAIF for head and neck reconstruction following oncologic resection, discuss its evolution, provide case examples for its wide range of indications, and discuss future directions.

Takeaways

Question: What is the utility of the supraclavicular artery flap (SCAIF) for head and neck reconstruction?

Findings: Our retrospective review demonstrated that the SCAIF can be used for a wide range of head and neck reconstructive dilemmas. The ease of harvest, relatively low complication rates, and minimal donor site morbidity make this a viable alternative to fasciocutaneous free flaps.

Meaning: The SCAIF is a versatile, fasciocutaneous, axially-based flap able to produce similar outcomes to fasciocutaneous free flaps for head and neck reconstruction with minimal donor site morbidity, comparable complication rates, and reduced cost.

MATERIALS AND METHODS

Operative Technique

The patient should be placed in the supine position with the head turned to the contralateral side. A shoulder bump is placed under the ipsilateral shoulder to aid in exposure. The patient is then prepped and draped in sterile fashion, ensuring the neck, anterior chest, and shoulder regions are exposed. The external landmarks of the supraclavicular fossa are marked, which include the clavicle, external jugular vein, and posterior border of the SCM muscle. The origin of the SCA within this triangle is identified with a Doppler probe, and its path is traced to the acromion. The skin island is then marked with its dimensions dependent on the recipient site.

Table 1. Patient Demographics and Indications

Indication	n (%)	Mean Age (y)	Mean LOS (d)	Mean Follow-up (mo)
Pharyngeal wall defect	23 (18.0)	74	12	8
Radiated recurrent neck disease (exposed neck vessels)	27 (21.1)	68	7	12
Mandibular defect	5 (3.9)	69	7	6
Radiated parastomal wound	8 (6.3)	73	5	12
Exposed mandibular hardware	2 (1.6)	67	5	12
Cheek defect 2/2 parotidectomy	21 (16.4)	57	3	12
Oropharyngeal defect	18 (14.1)	61	10	6
Lateral skull defect	8 (6.3)	68	8	6
Cheek skin resurfacing	6 (4.7)	65	5	8
Total	128 (100%)	66.9	6.9	9.1

Table 2. Complications Stratified by Surgical Indication

Indication	n (%)	Complications
Pharyngeal wall defect	23 (18.0)	1 Donor site dehiscence
		2 Donor site cellulitis
		4 Pharyngeal leaks (contained)
Radiated recurrent neck disease (exposed carotid vessels)	27 (21.1)	2 Full-thickness flap loss
		1 Hematoma
		1 Venous congestion
Mandibular defect	5 (3.9)	
Radiated parastomal wound	8 (6.3)	1 Partial-thickness flap loss
Exposed mandibular hardware	2 (1.6)	1 Partial-thickness flap loss
Cheek defect 2/2 parotidectomy	21 (16.4)	2 Excess volume (debulked)
Oropharyngeal defect	18 (14.1)	4 Partial-thickness flap loss
Lateral skull defect	8 (6.3)	1 Venous congestion
		2 Distal tip necrosis
Cheek skin resurfacing	6 (4.7)	1 Distal tip necrosis
Total	128 (100)	6 Partial-thickness flap loss (4.8%)
		4 Pharyngeal leak (contained) (3.2%)
		3 Distal tip necrosis (2.4%)
		2 Venous congestion (1.6%)
		2 Donor site cellulitis (1.6%)
		2 Full-thickness flap loss (1.6%)
		2 Excess volume (debulked) (1.6%)
		1 Donor site dehiscence (0.8%)
		1 Hematoma (0.8%)

The skin is incised sharply down to the level of the deep fascia. Elevation of the flap is performed in a lateral to medial fashion in the subfascial plane over the deltoid, trapezius, and SCM muscles and above the periosteum of the clavicle. Monopolar electrocautery may be used for the distal two-thirds of the flap but should be switched to either sharp dissection or bipolar electrocautery once the proximal one-third is reached to avoid inadvertent injury to the vascular pedicle. Skeletonization of the pedicle should be avoided to prevent inadvertent injury.

Once the vascular pedicle has been dissected, the proximal portion of the skin island is incised sharply to complete the elevation of the flap and allow rotation. The distal tip is trimmed until adequate bleeding is noted to prevent distal flap necrosis. If the flap is intended to be tunneled, the proximal portion of the flap is deepithelialized, taking care to preserve the subdermal venous plexus. The flap is then rotated, shaped, and inset into the defect.

The donor site can be closed primarily in the majority of cases after undermining in the subcutaneous plane over the pectoralis major anteriorly and the trapezius posteriorly. If this is unable to be accomplished without undue tension, a split-thickness skin graft or other local flap may be required. A closed-suction drain can also be placed in the donor or recipient sites to prevent seroma or hematoma formation.

Anatomical Variants

- Arterial supply: The SCA is most commonly a branch of the transverse cervical artery (branch of the thyrocervical trunk). The SCA may also originate from the suprascapular artery (also a branch of the transverse cervical artery) in the minority of cases.[1–4]
- Venous return: A majority of patients will have paired venae comitantes, most commonly accompanying the SCA, which drain into the transverse cervical vein. Less frequently, one of the two venae comitantes may alternatively drain into the external jugular or subclavian veins.[2,5,7,14,15]

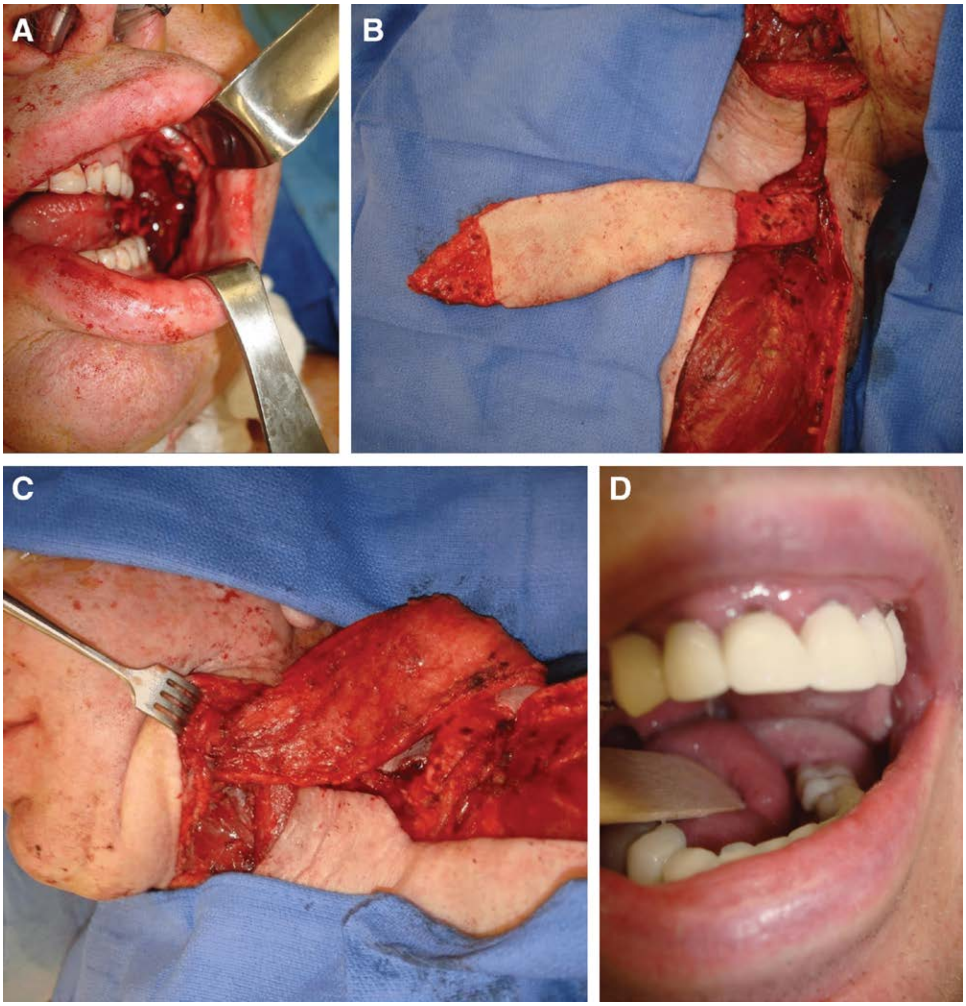

Fig. 1. Clinical case 1: a 45-year-old man with a left tonsillar carcinoma. A, Left tonsillar defect status post resection. B, SCAIF harvested. C, SCAIF inset with tunneling underneath mandible. D, 1-year postoperative results, with excellent flap healing and coverage.

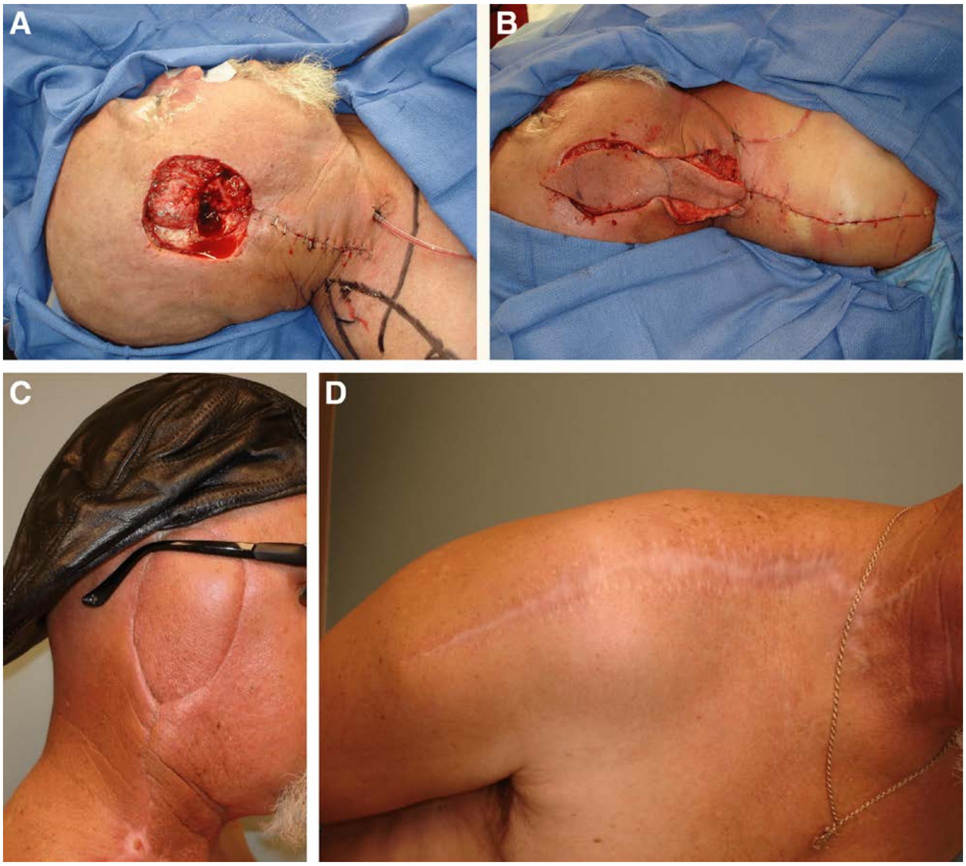

Fig. 2. Clinical case 2: a 54-year-old man with malignant melanoma of the right ear and pre-auricular area. A, Intraoperative view following radical resection with exposed skull and mandible. B, SCAIF inset into defect. C, One year postoperative with excellent coverage and color match. D, One year postoperative results, demonstrating well-healed donor site.

Patients

Retrospective chart review was performed and identified 128 patients who underwent reconstruction of the head and neck region using the SCAIF from the years 2006 to 2021. Mean follow-up time was 9.1 months. Indications for reconstruction of the head and neck region were recorded, which included pharyngeal wall defects, radiated recurrent neck disease with exposed carotid vessels, mandibular reconstruction, radiated parastomal wounds, exposed mandibular hardware, parotid malignancy defects, intraoral malignancy defects, lateral skull base defects, and cheek skin resurfacing. Complications, such as venous congestion, partial flap necrosis, full-thickness flap necrosis, surgical site infections, and pharyngeal leaks, were recorded. Patient demographic information and surgical indications are listed in Table 1.

RESULTS

The mean age of the cohort was 66.9 years. Average length of stay was 6.9 days, and mean follow-up time was 9.1 months. The most common indications for SCAIF reconstruction were recurrent radiated neck disease (n = 27, 21.1%), pharyngeal wall defect (n = 23, 18.0%), and cheek defects secondary to parotidectomy (n = 21, 16.4%). All flaps were harvested in less than 1 hour, and all but one donor site were closed primarily, which required a split-thickness skin graft.

The overall complication rate was 17.2%. The most common type of complication was partial flap loss, which occurred in six patients (5.5%). Three patients experienced distal tip necrosis (2.4%), whereas two patients had complete flap loss (1.6%). Both patients who experienced complete flap failure originally underwent neck reconstruction for exposed carotid vessels secondary to recurrent radiation. Pharyngeal reconstruction was performed for 23 patients, four of whom experienced contained pharyngeal leaks (17.4% of pharyngeal reconstructions), which were able to be treated conservatively. Venous congestion was encountered in two patients (1.6%), which was treated with leech therapy without any long-term sequelae. There was minimal donor site morbidity, with only two patients who had donor site cellulitis, treated conservatively with antibiotics (1.6%). There was no functional morbidity of the shoulder or arms reported by any patients; however, some patients did report referred shoulder sensation when swallowing after pharyngeal reconstruction. Two patients, both of whom underwent cheek reconstruction following parotidectomy, required

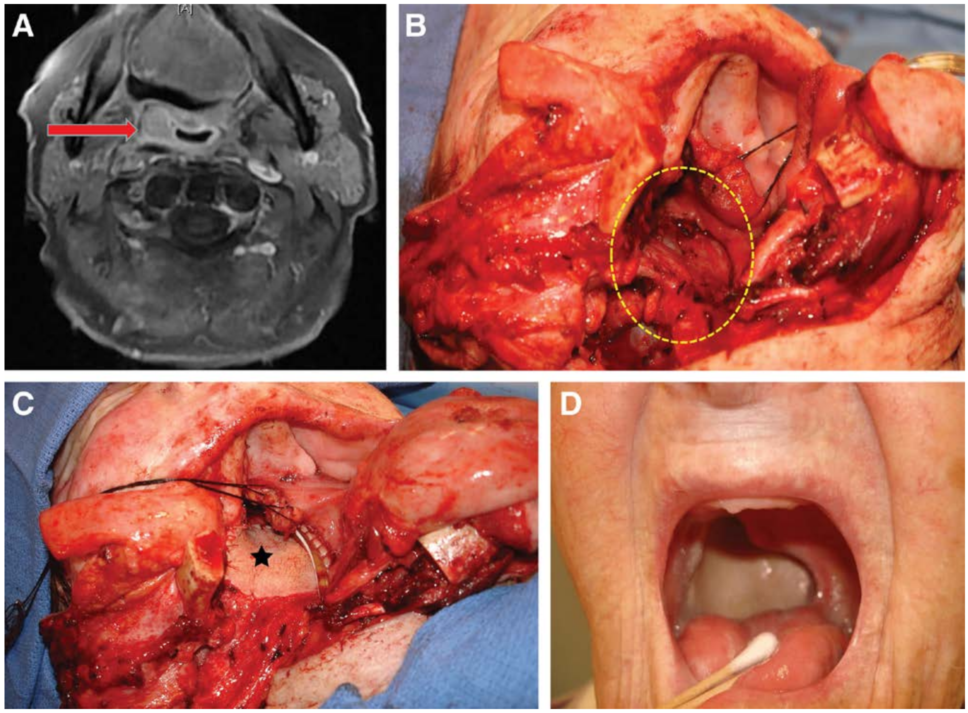

Fig. 3. Clinical case 3: a 72-year-old woman with right tonsillar carcinoma with invasion of the lateral pharyngeal wall. A, Preoperative CT scan showing carcinoma invading the right lateral pharyngeal wall. B, Intraoperative status post resection. C, SCAIF inset into oropharyngeal defect (skin paddle marked with a star). D, One year postoperative results, with excellent coverage and healing.

reoperation for debulking due to excessive flap volume (1.6%). Table 2 summarizes overall complications and is stratified by indication.

CASE EXAMPLES

Clinical case 1 was a 45-year-old man with a left tonsillar carcinoma. Figure 1A shows the left tonsillar defect status after resection. Figure 1B shows the SCAIF harvest. Figure 1C shows the SCAIF inset with tunneling underneath mandible. Figure 1D shows 1-year postoperative results, with excellent intraoral flap healing and coverage.

Clinical case 2 was a 54-year-old man with malignant melanoma of the right ear and preauricular area. Figure 2A shows the intraoperative view following radical resection with exposed skull and mandible. Figure 2B shows SCAIF inset into defect. Figure 2C shows 1-year postoperative results, with excellent flap healing, coverage, and color match. Figure 2D shows 1-year postoperative results demonstrating well-healed donor site.

Clinical case 3 was a 72-year-old woman with right tonsillar carcinoma with invasion of the lateral pharyngeal wall. Figure 3A shows a preoperative CT scan showing carcinoma invading the right lateral pharyngeal wall. Figure 3B shows the intraoperative view following resection. Figure 3C shows the flap inset into oropharyngeal defect (skin paddle marked with a star). Figure 3D shows 1-year postoperative results with excellent coverage and healing, with no oropharyngeal dysfunction.

Clinical case 4 was a 56-year-old man with malignant melanoma of the left infra-auricular area. Figure 4A shows infra-auricular defect following resection with exposed skull and mandible. Figure 4B shows SCAIF inset into the defect; the distal tip has been trimmed to approximate size and shape of the defect. Figure 4C shows postoperative venous congestion, treated with leech therapy. Figure 4D shows 6 months postoperative results, with excellent graft healing and color match.

Clinical case 5 was a 77-year-old man with a right temporal defect following resection of a squamous cell carcinoma. Figure 5A shows the right temporal defect following resection and SCAIF harvest. Figure 5B shows the SCAIF inset that appears viable. Figure 5C shows postoperative venous congestion at distal tip. Figure 5D shows distal tip necrosis, treated with local debridement and wound care.

DISCUSSION

Oncologic resections of the head and neck have historically required radical neck dissection with sacrifice of the SCM muscle, leaving the major vessels in the neck exposed and requiring coverage. As surgical techniques have improved over the years, modified radical neck dissections have been adopted with preservation of the SCM. However, salvage procedures with removal of the SCM are often required and have increased over recent years with the increased usage of radiation therapy and for locoregional recurrence. Therefore, it is of utmost importance that the planned oncologic resection is

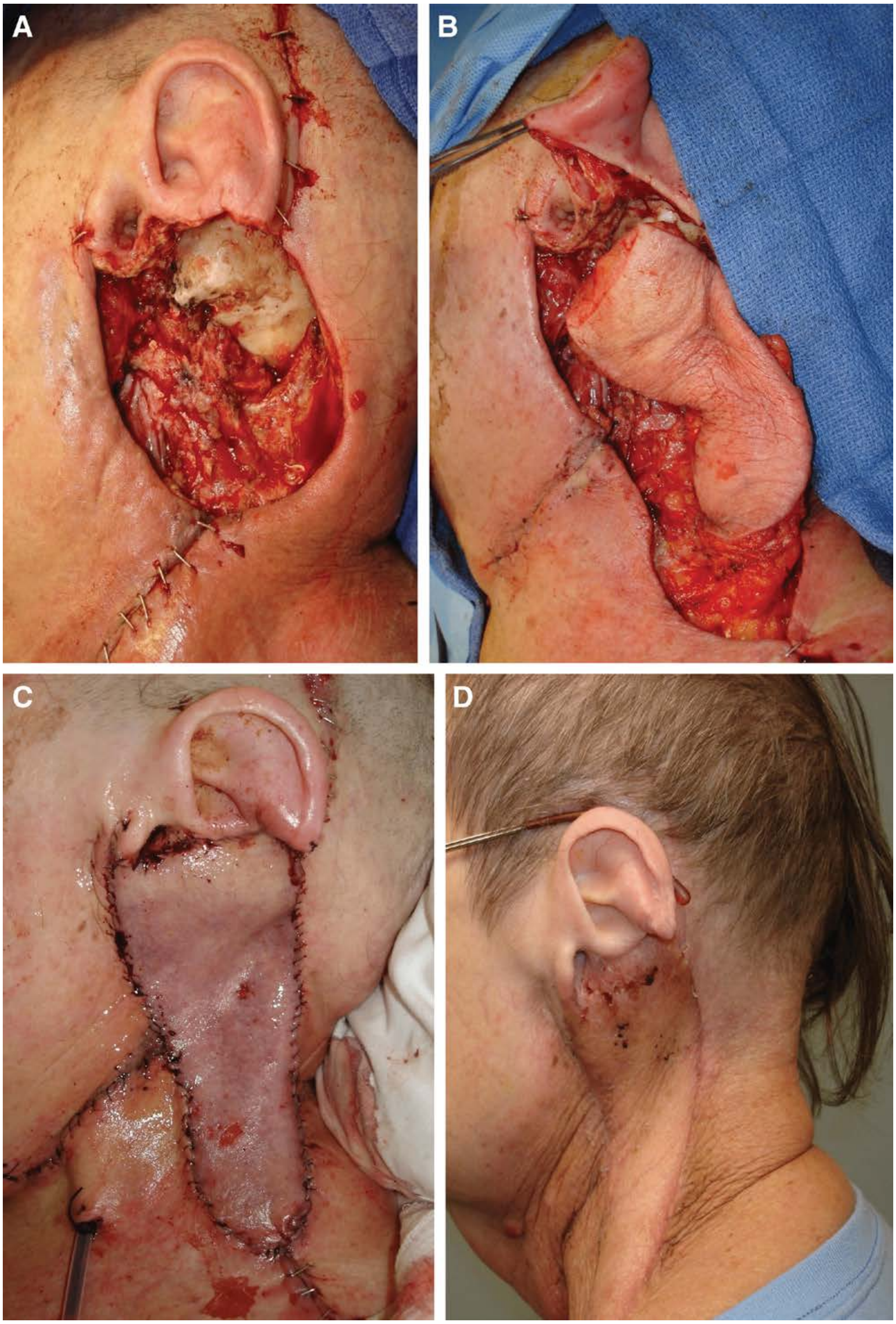

Fig. 4. Clinical case 4: a 56-year-old man with malignant melanoma of the left infra-auricular area. A, Infra-auricular defect following resection with exposed skull and mandible. B, SCAIF inset into defect; distal tip has been trimmed to fit into defect. C, Postoperative venous congestion. D, Six months postoperative result, with excellent graft healing and color match.

discussed with the plastic surgeon to preserve as many reconstructive options as possible.

The SCAIF is an invaluable tool for plastic and reconstructive surgeons to have in their armamentarium for the reconstruction of the head and neck. The fasciocutaneous nature of the flap along with its reliable axial arterial supply makes it an ideal regional flap for the head and neck region in addition to having minimal donor site morbidity and providing adequate color and volume match.[3–5,7] Initially used for resurfacing of the head and neck region for patients with severe burn contractures, its indications have expanded significantly over the past

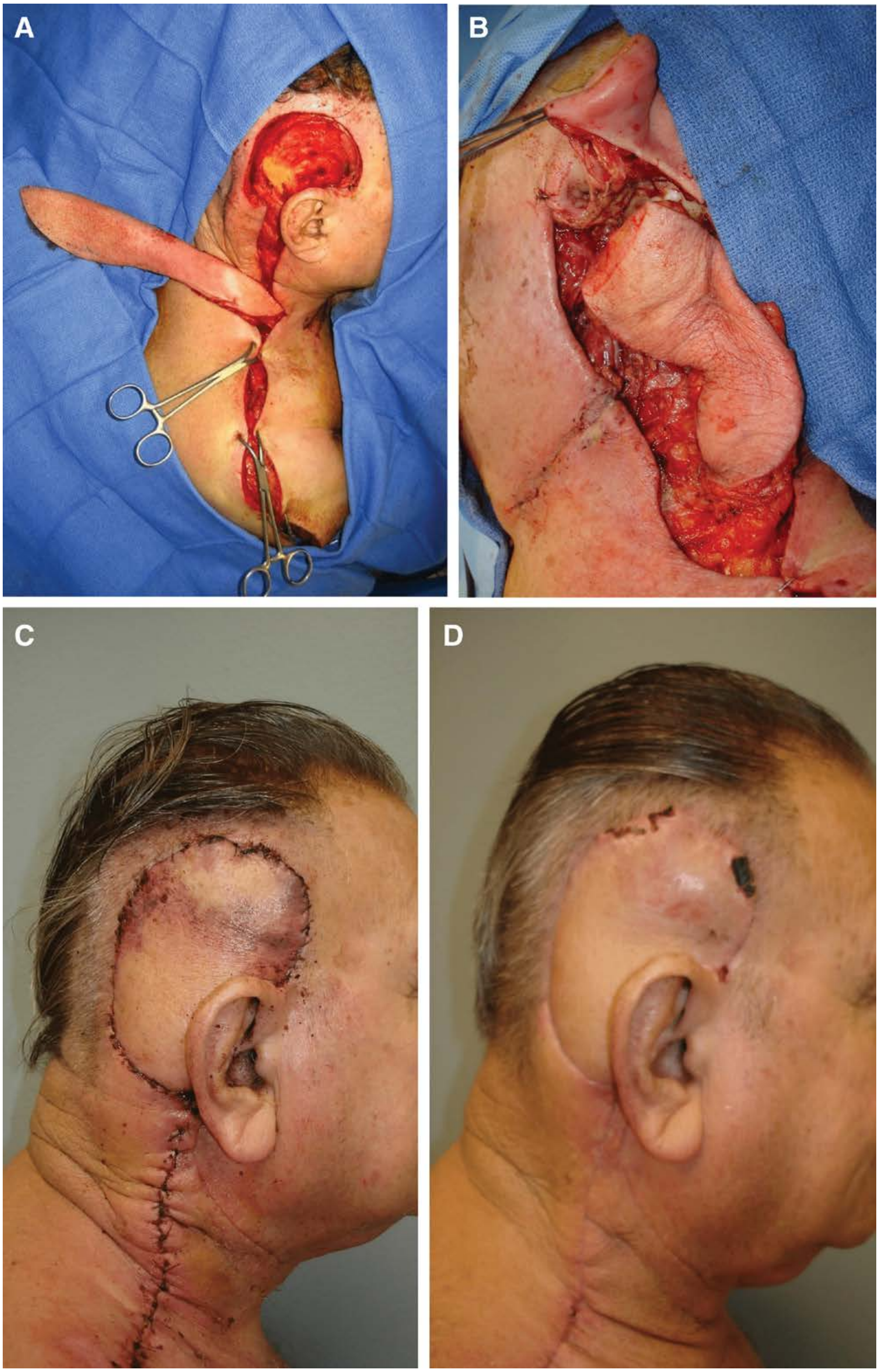

Fig. 5. Clinical case 5: a 77-year-old man with right temporal defect following resection of a squamous cell carcinoma. A, Right temporal defect following resection and SCAIF harvest. B, SCAIF inset that appears viable. C, Postoperative venous congestion at distal tip. D, Distal tip necrosis, treated with local debridement.

few decades to now include reconstruction of the head and neck following oncologic resection, oropharyngeal resurfacing and reconstruction, tongue reconstruction following glossectomy, and coverage of tracheostomal defects.[3–5,8,16,17] Our experience has been primarily with head and neck reconstruction following oncologic resection, and although the procedural details have largely remained unchanged, its use has been expanded, and

Table 3. Expert Pearls

Expert Pearls	
Flap size	Maximal dimensions of 10 × 25 cm. Distal tip necrosis more likely for flaps larger than 25 cm in length. Primary closure of donor site more difficult for flaps larger than 10 cm in width.
Coverage	Lower two-thirds of face, neck, and occipital regions.
Pedicle dissection	Use of bipolar electrocautery when approaching vascular pedicle and avoid skeletonization of pedicle to prevent vascular injury.
Tunneling	Avoid tunneling in previously radiated field to prevent pedicle compression.
Distal tip necrosis	Distal tip should be trimmed until bleeding is encountered to avoid necrosis.
Supercharging	May be performed using posterior humeral circumflex artery (rarely necessary).

clinical pearls have been established to ensure optimal outcomes (Table 3).

Hand-held Doppler remains a mainstay in the preoperative evaluation of the SCA and its trajectory; however, newer imaging modalities have recently emerged to more reliably identify its course. Computed tomography with angiography (CTA) and/or magnetic resonance imaging with angiography are now used with increasing frequency, if not uniformly, during the evaluation of patients for oncologic resection and reconstruction of the head and neck region, as well as in the harvest of other flaps such as the deep inferior epigastric flap for breast reconstruction.[18–20] The use of multislice CTA has been shown to identify the vascular pedicle and accurately track its course in 60%–93.3% and 45%–76.7% of patients, respectively.[18–20] Indocyanine green angiography has also been used with success to identify the angiosome of the SCA, which can a useful intraoperative adjunct. Although this imaging modality is not currently the standard of care, future research regarding its utility is ongoing with the goal of being able to ensure distal tip perfusion and oxygenation.[21] Ultimately, a multidisciplinary approach including the oncologic and reconstructive surgeons as well as the radiologist should be pursued to ensure optimal outcomes.

Over recent years, the use of free tissue transfer techniques has grown exponentially. Microsurgical techniques have developed rapidly, allowing the expanded use of free flaps for various reconstructive dilemmas. The deltopectoral and trapezius musculocutaneous regional flaps, once considered the workhorse flaps for the head and neck, have been largely replaced by free tissue transfers, such as the anterolateral thigh. Although fasciocutaneous free flaps are being used with increasing frequency, they are associated with increased cost due to increased length of stay and ICU admission for flap monitoring in the immediate postoperative period, in addition to longer operating room times, which may not be tolerated by many patients in this population who have head and neck malignancies.[10,13,22] In many cases, the SCAIF may be able to accomplish the same reconstructive goal with reduced cost and similar postoperative outcomes.[10,22] When compared to other locoregional flaps, such as the submental flap, the SCAIF is able to provide a larger volume of tissue for coverage and generally lacks hair-bearing capacity, which must be taken into consideration when reconstructing oropharyngeal defects.[10,22] The SCAIF should, therefore, be considered as a first-line option (along with free tissue transfers) for reconstruction of this region as it is one of the few regional flaps above the clavicle able to establish coverage of a wide array of defects.

While our experience has been primarily with reconstruction following oncologic resection, the SCAIF has also shown utility in the resurfacing of mucosal surfaces of the oropharynx and reconstruction of the pharynx, tongue, and tracheostomal defects, all while maintaining low complication rates, minimal functional donor site morbidity, ease of harvest, and lower overall cost and length of stay. Its limitations include its range (limited to the neck and lower two-thirds of the face), a short vascular pedicle (1–7 cm), and potential donor site morbidity due to scarring, something which has been proven to be more problematic for women than men. We recommend a multimodal approach in the preoperative planning with the use of hand-held Doppler in addition to CTA or magnetic resonance imaging with angiography, with indocyanine green angiography as an intraoperative adjunct when there is a concern for distal tip perfusion. Additional areas that should be explored in the future include the use of implantable Doppler probes for cases in which the SCAIF requires burying with no visible skin paddle for monitoring, the use of hyperbaric oxygen therapy for threatened flaps, especially in the cases of distal tip ischemia or necrosis and venous congestion, and formal cost analyses. Although there remain a plethora of options for reconstruction of the head and neck, the authors' recommendation is that plastic and reconstructive surgeons maintain the SCAIF in their armamentarium as they ascend the reconstructive ladder and that the SCAIF should be considered as a first-line option in this population.

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DISCLOSURES

The authors have no financial interest to declare in relation to the content of this article.

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