Comparison of Perioperative Outcomes between the Supraclavicular Artery Island Flap and Fasciocutaneous Free Flap

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Abstract

Objective. Outcomes of the supraclavicular artery island flap (SCAIF) have not been extensively studied in comparison with free tissue transfer (FTT) flaps for head and neck reconstruction. We hypothesize that the pedicled SCAIF has decreased operating room time, length of stay, time to wound healing of recipient site, complications, and hospital charges as compared with FTT.

Study Design. Case series with chart review.

Setting. Tertiary care teaching hospital.

Subjects and Methods. Medical records were reviewed for patients who underwent SCAIF (n = 45) or FTT (n = 28) reconstruction between 2011 and 2013.

Results. Total operating room time was significantly lower for the SCAIF group vs the FTT group (6.7 vs 8.1 hours, P = .002). Procedural time was 5.7 hours for the SCAIF group, as compared with 7.2 hours for FTT group (P = .0015). Mean area for SCAIF donor site was 63.89 cm² vs 81.8 cm² for the radial forearm free flap group (P = .015). There was no significant difference in mean length of stay between SCAIF (8.8 days) and FTT (11 days, P = .12). Mean length of time to wound healing of the recipient site was similar in the SCAIF group vs the FTT group (17.3 vs 22.1 days, P = .071). Ratio of total hospital charges for SCAIF were 32% lower than that of FTT (P = .0001).

Conclusion. This is among the first studies to compare SCAIF with FTT in a large cohort analysis. We find decreased operating room times for SCAIF vs FTT, with similar length of stay and wound healing. Other outcomes between SCAIF and FTT were also comparable.

Keywords

supraclavicular artery island flap, head and neck reconstruction, total laryngectomy, outcomes
functional outcome. Free tissue transfer (FTT), specifically the radial forearm free flap (RFFF), remains the workhorse flap for reconstruction of a majority of defects of the head and neck. Many patients, however, may not be ideal candidates due to medical comorbidities or lack of recipient vessels for anastomosis. Furthermore, FTT requires additional microvascular training, as well as specialized instrumentation and postoperative care in an intensive care unit. To optimize and shorten operating room (OR) time, FTT often needs to be performed by 2 surgical teams composed of a surgeon and nursing staff for each team. These additional factors specific to FTT have the potential of adding to the cost of patient care.

The pedicled supraclavicular artery island flap (SCAIF) may have several advantages over FTT flaps in head and neck reconstruction. The precursor of the modern SCAIF was described by Kazanjian and Converse as the “in charretera” or acromial flap. Use of the flap remained controversial throughout the 1980s due to criticism of potential high incidence of distal necrosis despite reports by Cormack and Lamberty identifying the supraclavicular artery and demonstrating its anatomic reliability. In the late 1990s, interest in the flap was revived for the release of postburn contractures. In 2000, Pallua et al published the first description of reconstruction for oncologic head and neck defects using the SCAIF. More recently, reconstructive surgeons have used the flap for a variety of indications: partial and total pharyngectomy defects, skull base defects, postparotidectomy, as well as oropharyngeal defects. The SCAIF has also been shown to be a low-morbidity procedure with limited functional impact on the donor site and minimal wound care needed.

Contemporary studies on the SCAIF largely provide anatomic and surgical descriptions. Few studies, however, provide discrete comparisons of outcomes with a free tissue comparison cohort. In this study, we hypothesize that the SCAIF is associated with improved perioperative outcomes, including decreased OR time, procedure time, length of stay, time to wound healing, and complications. Furthermore, we propose that the SCAIF may be a more cost-effective option in head and neck reconstruction as compared with FTT.

Methods

Institutional review board approval was obtained from the Massachusetts Eye and Ear Infirmary. We retrospectively reviewed medical records for all patients who underwent SCAIF reconstruction at our institution for parotidectomy/temporal bone resection, cutaneous defect repair, or total laryngectomy reconstruction between 2011 and 2013 (n = 45). For total laryngectomy, the SCAIF or FTT was utilized to reconstruct the pharynx and/or serve as an onlay to reinforce the suture line and vary by patient. A cohort of patients who underwent RFFF or anterolateral thigh (ALT) free flap reconstruction during the study period for similar indications was used as a comparison group (n = 28).

During the study period, patients were not preselected for FTT or SCAIF reconstruction. Only D.D. or K.E. performed the ablation and reconstruction portions in standard fashion as previously described. One nursing team was utilized for SCAIF. For patients who underwent FTT, a 2-surgeon team (J.W.R., D.L.) performed the ablation and reconstruction portions in parallel. Each surgeon had a dedicated nursing staff, including surgical assistant and circulator. Residents participated in all cases. All surgeons are microvascular-trained surgeons and perform both pedicled and FTT flaps.

Descriptive analysis was performed to characterize patient age, indication for SCAIF or FTT (total laryngectomy, parotid/temporal bone resection, or cutaneous defect repair), defect size, and prior radiation and/or chemotherapy. We measured several outcomes:

- OR times—including total OR time (defined as the time from entry into the OR until departure) and procedure time (time from incision until closure)
- Length of stay
- Flap size (cm²)
- Flap-related complications—including flap dehiscence, hematoma, and wound infection within 1 month of the procedure
- Time to wound healing of recipient site
- Total hospital charges

The OR nursing staff records OR times during the operation, and they become part of a patient’s medical record. Total charge data were derived from an internal financial database and represent amount billed for a patient’s entire hospital stay. Percent ratios were calculated to compare differences between SCAIF and FTT patients. Time to wound healing was extracted from the patient’s medical record and was defined as the time from operation to the time when the surgeon deemed the recipient site to be completely healed.

Demographics and outcomes were compared between the SCAIF and FTT groups. Differences in means were tested with unpaired 2-sided Student’s t test, and differences in proportions were tested by chi-square test and Fisher’s exact test where appropriate. Stratified comparisons were also performed to account for potential confounding by surgical indication. Statistical significance was defined by a type I error threshold of 0.05. Statistical analyses were performed with STATA 13 (StataCorp LP, College Station, Texas). A post hoc power analysis was performed for the outcomes of total OR time, length of stay, wound healing, and total hospital charges with an alpha threshold of .05.

Results

Patient Demographics

Patient demographics were similar between SCAIF and FTT cohorts. There was no significant difference between percentage of men in SCAIF vs. FTT groups (68.9% vs. 78.6%, n = 0.43). Average patient age for the SCAIF group
was 67.2 vs 66.6 years for the FTT group ($P = .19$). Previous radiation was received by 22 (49%) patients with SCAIF vs 12 (46%) with FTT reconstruction ($P = .824$). Indication for reconstruction was balanced between cohorts ($P = .367$; Table 1). After stratification by indication, there continued to be no significant differences in patient demographic between the 2 study cohorts (see Supplemental Tables S1-S3 at www.otojournal.org/supplemental).

**OR Times**

We found that the overall total time in the OR was significantly lower for the SCAIF group vs the FTT group (6.7 hours vs 8.1 hours, $P = .002$). Procedure time was 5.7 hours for SCAIF group vs 7.2 hours for FTT group ($P = .0015$). When stratified by indication, neither total OR time or procedure time between SCAIF and FTT reconstruction after total laryngectomy or parotid/temporal bone resection yielded a significant difference. We did find a significant difference in total OR and procedural time to repair cutaneous defect via SCAIF compared with FTT (Figure 1; Supplemental Table S4 at www.otojournal.org/supplemental).

**Flap Characteristics**

We also examined flap donor site characteristics. The overall mean area for the SCAIF donor site was 63.89 cm² (SD = 24.1, n = 39), compared with 81.8 cm² (SD = 30.6, n = 24) for the RFFF group ($P = .015$). The SCAIF donor site was also significantly smaller than that of the ALT group (425 cm², SD = 35.4, n = 3; $P < .001$). After stratifying by indication and excluding ALT group, the patients that underwent total laryngectomy had a SCAIF donor site of 56.1 cm² (SD = 22.9, n = 12), compared with RFFF at 80.2 cm² (SD = 28.6, n = 11), $P = .036$. For the parotid/temporal bone resection group, the SCAIF donor site was 74.9 cm² (SD = 30.8, n = 13), compared with RFFF at 101.0 cm² (SD = 32.2, n = 7; $P = .089$). For the cutaneous defect group, the SCAIF donor site was 60.4 cm² (SD = 13.5, n = 14), compared with RFFF at 58.2 cm² (SD = 20.6, n = 5; $P = .79$).

**Length of Stay, Wound Healing, and Complications**

Overall, there was no statistically significant difference in mean length of stay between SCAIF (8.8 days) and FTT (11 days) patient cohorts ($P = .12$). Median length of stay was 7.5 and 10 days for SCAIF and FTT, respectively. Mean length of time to wound healing of the recipient site was similar in the SCAIF group compared with FTT group (17.3 vs 22.1 days, respectively; $P = .071$).

A minority of patients had wound infections at either the donor or recipient site. There was no significant difference

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**Table 1. Overall Patient Demographics.**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Supraclavicular</th>
<th>Free Flap</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>67.2 ± 10</td>
<td>64 ± 10.1</td>
<td>.1876</td>
</tr>
<tr>
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<td>66.6</td>
<td>65.2</td>
<td></td>
</tr>
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<td></td>
<td></td>
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<tr>
<td>Total laryngectomy</td>
<td>14</td>
<td>31.1</td>
<td>13</td>
</tr>
<tr>
<td>Parotid/temporal bone</td>
<td>16</td>
<td>35.6</td>
<td>9</td>
</tr>
<tr>
<td>Cutaneous defect</td>
<td>15</td>
<td>33.3</td>
<td>6</td>
</tr>
<tr>
<td>Prior radiation therapy</td>
<td></td>
<td></td>
<td></td>
</tr>
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</tr>
<tr>
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<td>23</td>
<td>51.1</td>
<td>14</td>
</tr>
<tr>
<td>Prior chemotherapy</td>
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<td></td>
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</tr>
<tr>
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<td>11</td>
<td>25</td>
<td>7</td>
</tr>
<tr>
<td>No</td>
<td>33</td>
<td>75</td>
<td>19</td>
</tr>
</tbody>
</table>

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*a* Values in number and percentage, except for age.

*b* Denotes missing data point for select variable.

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![Comparison of Total and Procedural Operating Room Time](oto.sagepub.com)
in the overall number of wound infections at either site (SCAIF [n = 4] vs FTT [n = 6], \( P = .106 \)). In the SCAIF group, 2 patients had a wound infection at the donor site and 2 at the recipient site. In the FTT cohort, 3 patients had wound infections at the donor site, 2 at the recipient site, and 1 at both sites. There was also no significant difference in wound dehiscence between the 2 study groups (Table 2).

In the FTT group, there were 4 cases of dehiscence, all in the recipient site. There were 3 postoperative hematomas in the FTT group and none in the SCAIF group.

**Charge Analysis**

Overall, total hospital charges for SCAIF were 32% lower than that of FTT \(( P = .0001 \)). After stratification, SCAIF charges for total hospital stay were 16%, 46%, and 25% lower than that of FTT for total laryngectomy, parotid/temporal bone resection, and repair of cutaneous defect, respectively (Figure 2). These differences were significant only among the parotidectomy/temporal bone resection patient cohort.

**Discussion**

In this study, we directly compare several perioperative outcomes between patients undergoing SCAIF and FTT reconstruction for 3 primary oncologic indications. We identified several important findings between study groups, including decreased OR time and hospital charges, as well as equivalent complications, length of stay, and wound healing.

In terms of OR times, total OR time and procedure time for SCAIF reconstruction were significantly shorter for repair of cutaneous defects as compared with FTT. OR times were equivalent for SCAIF and FTT after total

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**Table 2. Wound Healing of Supraclavicular Artery Island Flap vs Free Tissue Transfer.**

<table>
<thead>
<tr>
<th>Type of Procedure</th>
<th>Supraclavicular Flap</th>
<th>Free Flap</th>
<th>P Value</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>Total laryngectomy</td>
<td>14</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Wound infection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2</td>
<td>14.3</td>
<td>2</td>
</tr>
<tr>
<td>No</td>
<td>12</td>
<td>85.7</td>
<td>9</td>
</tr>
<tr>
<td>Wound dehiscence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>4</td>
<td>28.6</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>10</td>
<td>71.4</td>
<td>10</td>
</tr>
<tr>
<td>Parotid/temporal bone</td>
<td>16</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Wound infection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>0</td>
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</tr>
<tr>
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<td>15</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>Wound dehiscence</td>
<td>3</td>
<td>81.3</td>
<td>0</td>
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<td>No</td>
<td>13</td>
<td>18.7</td>
<td>9</td>
</tr>
<tr>
<td>Cutaneous defect</td>
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</tr>
<tr>
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<td>11</td>
<td>73.3</td>
<td>3</td>
</tr>
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</table>

*aDenotes missing data point for select variable.
laryngectomy and parotid/temporal bone resection. These findings have important implications for personnel resource utilization. The SCAIF required only 1 surgeon and 1 nursing team to achieve a favorable operative time. Thus, the SCAIF may offer improved efficiency from a surgical standpoint, as well as minimize anesthesia and nursing resources, which is imperative in today’s health care landscape. The potential for shorter operative time with SCAIF may also be an important consideration for patients with significant comorbidities that increase general anesthesia–related risks.

In addition, nonprocedure OR time (overall total OR time minus procedure time) was longer in the SCAIF cases. This may be due to the fact that in FTT cases at our institution, there are typically many more individuals in the OR assisting—2 full scrub teams as well as additional residents. OR time outcomes should also be considered in the context of the relatively short total OR time for FTT. At our institution, like many others, we perform FTT efficiently due to surgeon experience and a dedicated OR teams and setup. The mean procedure time for the FTT was 7.2 hours. In some institutions, the FTT time may be longer and, if compared with the SCAIF group, would potentially show a more dramatic difference in these 2 groups.

In terms of hospital stay, wound outcomes, and complications, SCAIF demonstrated either equivalent or improved outcomes compared with FTT. SCAIF offers several advantages, including its pedicled design that minimizes risk of anastomotic complications and wound-healing complications. While several factors influence a patient’s length of stay, SCAIF precludes the need for donor site observation. At our institution, patients undergoing RFFF reconstruction are observed until the forearm cast/splint has been removed (typically 7 days). SCAIF patients do not require a skin graft, which is associated with postoperative pain and may delay postoperative rehabilitation. In this setting, where the donor site is the limiting factor, SCAIF can decrease hospital stay.

Discharge from the inpatient service following a complex ablative and reconstruction is incumbent on meeting milestones unrelated to the reconstructive technique used. For example, patients must meet certain physical and occupational therapy criteria prior to discharge, and laryngectomy patients must learn to care for their stomata. These factors may have a stronger association with length of stay; however, they were not the primary focus of our investigation. While patients may have faster wound-healing time, this may not significantly hasten their ability to overcome other postoperative hurdles necessary for discharge. One must also consider the success rate for FTT in a given institution. In our experience, these techniques are equally reliable in terms of survival; therefore, we would expect similar outcomes in terms of recipient and donor site complications.

The nature of the hospital stay following reconstructive surgery should also be considered. In our institution, FTT patients spend 48 hours in an intermediate care unit (IMCU), while in other institutions patients are frequently sent to an intensive care unit. In the case of laryngectomy patients, SCAIF patients typically spent 24 hours in only the IMCU, and none of the temporal bone or cutaneous defects required IMCU stay. In patients who do not need monitored care for nonflap reasons, the SCAIF can obviate the need for higher levels of care, including specialized nurse monitoring. Unfortunately, our electronic medical record system did not allow us to investigate these requirements. Thus, in considering this outcome, one needs to evaluate one’s institutional practices.

Finally, to our knowledge, this study is among the first to compare hospital-wide charges between free flap and SCAIF patients. We find that SCAIF charges for total hospital stay were 16%, 46%, and 25% lower than those of FTT for total laryngectomy, parotid/temporal bone resection, and repair of cutaneous defect, respectively. Institutions that routinely send patients to the intensive care unit would also expect to see a more dramatic and likely statistically significant difference between these groups. Our total hospital stay charge data should be evaluated cautiously. Hospitals charges incorporate a host of variables, including insurance type, which may have led to unknown confounding. Furthermore, hospital charges are notably not actual hospital costs. Nevertheless, in this study, we establish discussion regarding cost of SCAIF vs other flaps and highlight a potential role for SCAIF in changing the health care climate.

One notable retrospective review examined SCAIF vs FTT.27 This study by Granzow et al provides an excellent initial examination of the 2 reconstructive approaches as well as a single-surgeon approach. Major findings of this study demonstrated that flap size area was larger for SCAIF compared with FTT, which was different from our findings. Similar to our study, total OR time for SCAIF was shorter in the Granzow et al study even with a 2-surgeon approach to FTT in the OR. In many respects, our study builds on the prior study: larger SCAIF cohort, stratification of analysis by indication, inclusion of hospital charge data, and use of a team-based OR approach for FTT group. Ultimately, our study provides additional data regarding the utility of the SCAIF, as well as the largest study to date on the subject. Furthermore, our study demonstrates the need to begin to analyze outcomes by surgical indications to best understand when to utilize SCAIF vs FTT.

Our study has several limitations. First, as a retrospective review, this study is susceptible to selection bias. We attempted to limit this by matching the 2 cohorts in terms of indications and period of surgery. Second, in regard to flap size, exact defect size was not measured, and consequently, complexity of reconstruction necessitating flap reconstruction may be different. This potential bias is mitigated by the fact that patients were not preselected to undergo SCAIF or FTT. Third, measures of wound healing are inherently subjective and may vary by surgeon. Differences in estimates of when a wound is completely healed may lead to bias among the results. Flap loss, either partial or full, was not directly examined in this report. In addition, there may be differences among surgeons’ technical skill and efficiency that result in differential outcomes that are not related to the type of reconstruction. Finally, although our patient cohort
is relatively large compared with those of prior studies, it may not be large enough to identify significant differences in some of the outcomes studied. A post hoc power analysis for outcomes of total OR time, length of stay, wound healing, and total hospital charges among all patients yielded 96.2%, 65.9%, 51.4%, and 99.1%, respectively. We acknowledge that the study does not have an adequate number of patients to perform a statistically rigorous subgroup analysis for wound healing and total length of stay. Results reported in this study, however, suggest no obvious differences between the 2 groups.

Taken together, these findings have implications for clinical practice. Our data indicate that the SCAIF is a safe and effective flap with equivalent or improved outcomes as compared with FTT. As the use of this flap is still in its nascent compared with the FTT for head and neck reconstruction, our data demonstrate the clinical utility of this flap. Furthermore, as indicated by the shorter or equivalent OR times as well similar wound healing, the SCAIF may prove beneficial for patients with significant comorbidities that complicate wound healing, such as diabetes. Our institution has already demonstrated satisfactory functional outcomes for the SCAIF in terms of donor site healing as well as functional speech in laryngectomy or pharyngolaryngectomy patients who have primary tracheoesophageal puncture prosthesis placement at the time of SCAIF reconstruction.19,28 Future multicenter studies should evaluate short- and long-term outcomes, including swallowing function, as well as more robust cost-benefit analyses of pedicled vs free flap for head and neck reconstruction that take into account potential economic savings beyond the initial inpatient stay.

Conclusion

This is among the first studies to compare SCAIF with FTT for total laryngectomy, parotidectomy/temporal bone resection, and repair of cutaneous defect repair. We find either improved or equivalent outcomes between SCAIF and FTT, indicating utility of this reconstructive technique.

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Author Contributions

Elliott D. Kozin, conception of project, data collection and analysis, writing of manuscript final approval; Rosh K. Sethi, conception of project, data collection and analysis, writing of manuscript, final approval; Marc Herr, conception of project, writing of manuscript, final approval; Mark G. Shrime, conception of project, writing of manuscript; James W. Rocco, conception of project, writing of manuscript, data analysis, final approval; Derrick Lin, conception of project, writing of manuscript, data analysis, final approval; Daniel G. Deschler, conception of project, data collection and analysis, writing of manuscript, final approval; Kevin S. Emerick, conception of project, data collection and analysis, writing of manuscript, final approval.

Disclosures

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Supplemental Material

Additional supporting information may be found at http://otojournal.org/supplemental.

References
