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ORIGINAL RESEARCH

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The submental island flap in head and neck reconstruction: A 10-year experience examining application, oncologic safety, and role of comorbidity

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Abstract

Background: We present our experience on reconstructive versatility and risk of nodal transfer with the submental island flap (SIF). We also examine the role of comorbidity as a predictor of complications.

Methods: Retrospective cohort study of patients undergoing SIF over 10-year period. Comorbidity determined using Adult Comorbidity Evaluation 27 index (ACE-27). Univariable/multivariable logistic regressions performed to determine association of these characteristics and rates of major complications.

Results: Fifty-eight patients underwent SIF reconstruction, 27 (45%) patients had moderate/severe comorbidity, and 24 (41%) experienced major complication. Multivariable analysis identified ACE-27 scores >2 predictive of major flap complications (OR: 17.38, 95% CI: 1.96–153.74, $p = .01$) and medical complications (OR: 5.8, 95% CI: 1.11–30.23, $p = .037$). There were no cases of pathologic nodal transfer.

Conclusion: The SIF is a versatile flap and oncologically safe in carefully selected patients. The ACE-27 index is strongly predictive of major postoperative complications.

Level of Evidence: 4

KEYWORDS
comorbidity, reconstruction, submental island flap

1 | INTRODUCTION

Since it was originally introduced by Martin et al in 1993,[1] the submental island flap (SIF) become a useful addition to the armamentarium of the head and neck reconstructive surgeon. Its use has been demonstrated for defects of the tongue, floor of the mouth, buccal mucosa, palate, oropharynx, hypopharynx, lateral skull base, and face.[2–9] The benefits of the SIF include a pedicled vascular supply, consistent tissue color and texture, minimal donor site morbidity, as well as decreased operative times, duration of hospitalization, and hospital costs when compared to free flaps without compromising functional outcomes.[10–13] Finally, as experience with this flap has evolved, additional options for flap vascularization have been described such as retrograde flow, hybrid flow, and free tissue transfer.[7,14,15]

In this study, we report our 10-year experience with the use of the SIF for reconstruction of various defects of the head and neck.

The first goal of this study is to highlight our experience with the types of defects reconstructed as well as strategies for flap vascularization. The second goal is to provide further data on the safety profile of SIF with regards to the risk of transfer of nodal disease from level 1A. Finally, we identify potential predictors of medical, surgical, and flap-specific complications associated with the SIF utilizing a previously validated comorbidity index. Though comorbidity as a predictor for postoperative complications following free tissue transfer has been examined, there are no studies to date examining the role of comorbidity status in the context of the SIF.

2 | MATERIAL AND METHODS

This was a single institution study with patients drawn from an academic tertiary medical center (Dartmouth-Hitchcock Medical Center). Approval from the institutional review board at Dartmouth-Hitchcock Medical Center was obtained (STUDY02000931). The study population included all patients who underwent reconstruction of defects of the head and neck utilizing the SIF from January 1, 2007 until December 31, 2017. Patient data abstracted from the medical record included demographics, comorbidities, primary tumor site, prior treatment history, staging of the tumor, and adjuvant therapy. Reconstructive data included skin paddle dimensions, type of SIF (cutaneous, osseocutaneous, fascial), and flap vascularization (anterograde pedicled, retrograde pedicled, anterograde hybrid, retrograde hybrid, and free flap). Flap related and non-flap related surgical complications as well as medical complications were abstracted from the record. Length of follow-up was determined by date of surgery and date of last follow-up appointment or date of death. Disease status (alive without disease, alive with disease, died of disease, died with disease) at last follow-up or death was also abstracted.

2.1 | Surgical technique

All flaps were performed by the senior author (JP) and were performed as described by Patel et al.[16] For patients undergoing oral cavity or oropharyngeal reconstruction, nasal intubation was performed. If tracheostomy was required, this was performed at the conclusion of the procedure once the neck incision had been closed. Neck dissection was also performed in the standard fashion and included routine removal of the peri-facial lymph nodes as part of the level 1B dissection.

2.2 | Medical comorbidities and complications

Comorbidity was measured using the Adult Comorbidity Evaluation 27 (ACE-27) tool, a validated comorbidity index, which reports comorbidity in the context of bodily systems and is a well-accepted tool in assessing comorbidity in cancer patients[17] (http://otooutcomes.wustl.edu/Research/Research-Focus/Cancer/Comorbidity-Data-Collection). The 27 comorbid conditions examined in the index are evaluated separately and graded as none (0), mild (1), moderate (2), or severe (3) based on severity of organ decompensation and overall prognosis. The ACE-27 score is based on the highest ranked individual comorbidity. If there are two comorbidities ranked as moderate, then a score of severe is assigned. Complications were categorized as flap related complications, non-flap surgical complications, and postoperative medical complications. Medical and surgical complications, excluding flap-specific complications, were categorized as either none, mild, moderate, or severe as previously defined by Farwell et al[18] and Ferrier et al.[19] Flap complications were categorized as follows: mild—flap dehiscence alone requiring no procedural intervention; moderate—any partial necrosis requiring bedside debridement or flap dehiscence plus any additional flap complication; severe—any flap complication requiring operative intervention such as pedicle revision, extensive debridement, or flap failure. None and mild complications were grouped as "Minor Complications" and moderate and severe complications were grouped as "Major Complications."

2.3 | Statistical analysis

All statistical analyses were performed using SAS software, version 9.4 (SAS Institute Inc.). A total of 59 patients were in the dataset as of May 24, 2018. Patient demographics and complications were summarized (Tables 1 and 2). Univariable logistic regression models were used to examine associations between potential predictors of complications and moderate or severe complications. Joint effects of potential predictors of complications on moderate or severe complications were then assessed by using multivariable logistic regression with a stepwise variable selection procedure (enter the model $p < .10$; remain in the model $p < .05$). In addition, we explored the multivariable logistic regression with "age at date of surgery" to serve as a control variable. Statistical significance was defined as $p < .05$ based on a two-sided hypothesis test with no adjustments made for multiple comparisons.

3 | RESULTS

3.1 | Demographics

A total of 59 patients underwent attempted SIF reconstructions with 43 men and 16 women. The demographics of these patients are presented in Table 1. The age of patients at the time of resection and reconstruction ranged from 28 to 88 years old with mean age of 62.7 years old. Most pathologies treated were squamous cell carcinoma (95%) with one case of adenocarcinoma of the soft palate, one case of melanoma of the face, and one case of ameloblastoma of the maxilla. American Joint Committee on Cancer 7th edition staging ranged from Stage I to Stage IV. Twenty-six (44%) tumors were staged as T2 and with 10 (17%) tumors staged as T4. Nodal status ranged from N0 to N2b. One patient had undergone prior radiation therapy of the neck and two patients had undergone prior chemoradiation therapy of the neck. Eighteen patients underwent adjuvant radiation therapy and 12 underwent adjuvant chemoradiation therapy. All patients were followed-up for 12 to 116 months with a mean and

Laryngoscope Investigative Otolaryngology

TABLE 1 Characteristics of patients and flaps

	$n = 59$[a]
Age at surgery, mean (SD), year	63 (13)
Male, *n* (%)	43 (73%)
Tumor location, *n* (%)	
Tongue	23 (39%)
Floor of mouth	12 (20%)
Oropharynx	7 (12%)
Maxilla	7 (12%)
Buccal	5 (9%)
Lateral skull base	2 (3%)
Face	2 (3%)
Total lower lip	1 (2%)
Tumor stage (T), *n* (%)	
1	12 (20%)
2	26 (44%)
3	11 (19%)
4	10 (17%)
Nodal stage (N), *n* (%)	
0	35 (59%)
1	11 (19%)
2	13 (22%)
ACE 27 score, *n* (%)	
Zero or one	31 (53%)
Two or three	27 (47%)
Preoperative radiation, *n* (%)	3 (5%)
Flap size area, mean (SD), cm^2	40.0 (17.5)
Operative time, mean (SD), min	609.2 (142.3)
Flap type	
Mycocutaneous	52
Myofascial	4
Osseocutaneous	2
Vascularization	
Anterograde pedicled	49 (84%)
Retrograde pedicled	5 (9%)
Anterograde hybrid	1
Retrograde hybrid	2
Free flap	1

Note: Values presented are means (standard deviations [SD]), or numbers (%).
Abbreviation: ACE-27, Adult Comorbidity Evaluation 27 index.
[a]Flap harvest was aborted in one patient due to metastatic adenopathy identified in level 1A during flap elevation. Comorbidity and flap related outcomes and data are not included for this patient.

median follow-up duration of 33 and 22 months, respectively. Within this period, a total of 6 patients died of disease, 3 patients died with disease, and 12 patients died without any evidence of disease, including one perioperative death.

TABLE 2 Moderate to severe medical, non-flap surgical, and flap complications[a]

	No. (%)
Total medical complications	10 (17)
Cardiovascular	2 (3)
Arrhythmia	2 (3)
Myocardial ischemia	DNO
Myocardial infarction	DNO
Congestive failure	DNO
Code Blue	DNO
Pulmonary	4 (7)
Hypoxia	3 (5)
Ventilator support >24 h	3 (5)
Pneumonia	2 (3)
Adult respiratory distress syndrome	3 (5)
Bronchospasm	DNO
Pulmonary embolism	1 (2)
Other pulmonary	1 (2)
Neurologic	3 (5)
Delirium	3 (5)
Other neurologic	DNO
Infection	6 (10)
Surgical site infection deep	1 (2)
Bacteremia	1 (2)
Abscess	1 (2)
Sepsis	3 (5)
Other infectious	1 (2)
Miscellaneous	10 (17)
Deep venous thrombosis	DNO
Renal insufficiency	DNO
Alcohol withdrawal	7 (12)
Fall	DNO
Other miscellaneous	5 (8)
Unexpected transfer	DNO
Death	1 (2)
Total non-flap surgical complications	10 (17)
Wound breakdown	2 (3)
Fistula formation	2 (3)
Wound hematoma	3 (5)
Need for additional unexpected procedure	1 (2)
Total flap related complications	11 (19)
Flap dehiscence	7 (12)
Partial flap necrosis (nonoperative management)	7 (12)
Partial flap necrosis (operative management)	4 (7)
Flap congestion	3 (5)
Flap failure	1 (2)

Abbreviations: DNO, did not occur.
[a]Complications as defined by Farewll et al. and Ferrier et al.

3.2 | SIF reconstruction

One SIF flap was aborted partway through flap elevation due to metastatic disease identified in level 1A despite an N0 clinical and PET/CT preoperative evaluation. This patient was excluded from comorbidity and flap outcomes analysis. For the remaining flaps, flap type, vascularization, flap size, and duration of surgery are shown in Table 1. Flap vascularization was via anterograde pedicle in 49 (84%) cases. Vascularization in 5 (9%) flaps was via retrograde pedicle. Three (5%) flaps required a hybrid approach as described by Hayden et al.[14] In these cases, a venous anastomosis was required due to the presence of a valve in the facial vein in two cases of retrograde flow and to improve pedicle length in one case of anterograde flow. Free tissue transfer was performed in 1 (2%) flap. Sites of reconstruction are broken down in Table 1 and include floor of mouth (FOM), tongue, oropharynx, maxilla, soft palate, buccal mucosa, face, lateral skull base, orbit, and one case of total lower lip reconstruction. Flap sizes ranged from 18 to 96 cm^2 with a mean flap size of 40.3 cm^2.

3.3 | ACE-27 scores

For all 58 patients who underwent successful flap elevation, an ACE-27 score could be determined. Patient comorbidity type and severity,

TABLE 3 Comorbidity status of patients undergoing submental island flap reconstruction

System	Mild (score = 1)	Moderate (score = 2)	Severe (score = 3)
Cardiovascular			
Myocardial infarction	2	5	0
Coronary artery disease	2	0	0
Congestive heart failure	3	0	0
Arrhythmias	1	10	0
Hypertension	20	0	0
Venous disease	2	0	0
Peripheral arterial disease	3	0	1
Respiratory system	6	0	0
Gastrointestinal system			
Hepatic	1	1	
Stomach/intestine	0	0	0
Pancreas	2	0	0
Renal			
End-stage renal disease	2	0	0
Endocrine			
Diabetes mellitus	8	1	1
Neurological system			
Stroke	2	1	0
Dementia	1	0	0
Paralysis	0	0	0
Neuromuscular	0	0	0
Psychiatric	2	0	0
Rheumatologic	0	2	0
Immunological system			
AIDS	1	0	0
Malignancy			
Solid tumor	2	2	1
Leukemia and myeloma	0	0	0
Lymphoma	1	0	0
Substance abuse			
Alcohol	8	10	2
Illicit drugs	0	0	0
Body weight			
Obesity	0	1	0

TABLE 4 Bivariate logistic regression investigating associations between potential predictors and complications

	Flap complication		Non-flap surgical complication		Nonsurgical complication	
	Odds ratio (95% CI)	***p***	**Odds ratio (95% CI)**	***p***	**Odds ratio (95% CI)**	***p***
Age at surgery, year	1.04 (0.99–1.1)	.14	1.04 (0.98–1.11)	.18	1.03 (0.97–1.09)	.31
Male (vs female)	1.41 (0.33–5.95)	.64	0.6 (0.15–2.45)	.48	1.94 (0.37–10.21)	.43
Flap size area, cm^2	0.99 (0.96–1.03)	.77	1.02 (0.98–1.06)	.27	0.96 (0.92–1.02)	.17
Operative time, min	1 (0.999–1.01)	.11	1 (0.998–1.01)	.26	1 (0.995–1)	.99
Tumor location: oral cavity (vs other)	0.41 (0.1–1.7)	.22	1.03 (0.19–5.6)	.98	2.61 (0.3–22.86)	.39
Tumor stage						
1 vs 4	1.33 (0.18–10.12)	.74	0.36 (0.03–4.74)	.39	3 (0.26–34.57)	.3
2 vs 4	0.73 (0.11–4.77)	.42	0.95 (0.15–5.94)	.65	2.14 (0.22–21.05)	.56
3 vs 4	1.5 (0.2–11.54)	.59	0.89 (0.1–7.86)	.8	0.9 (0.05–16.59)	.52
Nodal stage						
0 vs 2	0.83 (0.18–3.86)	.96	0.43 (0.08–2.26)	.18	1.38 (0.25–7.67)	.43
1 vs 2	0.74 (0.1–5.49)	.81	1.25 (0.2–7.96)	.42	0.55 (0.04–7.03)	.51
ACE27 score of “two or three” (vs “zero or one”)	**19.41 (2.3–163.65)**	**.0064**	3.11 (0.72–13.48)	.13	**5.8 (1.11–30.23)**	**.037**
Radiation (vs none)	2.05 (0.17–24.65)	.57	2.61 (0.21–31.94)	.45	NA[a]	

Abbreviation: CI, confidence interval.
[a]Not estimable due to data sparsity.
Bold values significes *p* < 0.5.

TABLE 5 Multiple logistic regression results for predictors of complications[a]

	Model adjusted for age				Model selection without adjusting for age			
	Flap complication		Nonsurgical complication		Flap complication		Nonsurgical complication	
	Odds ratio (95% CI)	***p***	**Odds ratio (95% CI)**	***p***	**Odds ratio (95% CI)**	***p***	**Odds ratio (95% CI)**	***p***
Age at surgery	1.01 (0.95–1.08)	.67	1.01 (0.95–1.08)	.77				
ACE27 score, “two or three” (vs “zero or one”)	**17.38 (1.96–153.74)**	**.01**	5.35 (0.95–30.03)	.057	**19.41 (2.3–163.65)**	**.006**	**5.8 (1.11–30.23)**	**.037**

Note: Candidate predictors: Age at surgery, gender, flap size area, operative time, tumor location, tumor stage, nodal stage, ACE27 score, and radiation status.
Abbreviation: CI, confidence interval.
[a]Multiple logistic regression model was used to investigate joint effects of predictors of complications with a stepwise variable selection method (enter the model *p* < .10; remain in the model *p* < .10) with and without adjusting for age.
Bold values significes *p* < 0.5.

according to the ACE-27 index, are listed in Table 2. The most common specific comorbidities among patients were hypertension and alcohol abuse. The most common moderate or severe comorbidities were arrhythmias, history of myocardial infarction, and current alcohol abuse. A total of 31 (53%) of patients had mild or no comorbidity (ACE-27 < 2), 18 (31%) of patients had moderate comorbidities (ACE-27 = 2), and 9 (16%) patients had severe comorbidities (ACE-27 = 3).

3.4 | Complications

All perioperative complications are reported in Table 3. Ten patients (17%) developed a major medical complication, 10 patients (17%) had major surgical, non-flap, complications, and 11 patients (19%) had a major flap complication. Overall, major complications affected a total of 24 patients (41%), with some patients developing a mix of flap, non-flap, and medical complications. Among flap complications, there was one total flap loss, four cases of partial necrosis requiring operative debridement, seven cases of partial necrosis requiring bedside debridement, and seven cases of flap dehiscence. Donor site complications were limited to one case of donor site skin dehiscence. One patient died during the postoperative course due to septic shock and respiratory failure secondary to aspiration pneumonia in the setting of severe alcohol withdrawal.

3.5 | Predictors of major perioperative complications

Univariate logistic regression of predictors of major flap, non-flap surgical, and medical complications are shown in Table 4. As seen, the only significant predictor of major flap and medical complications was high comorbidity status as indicated by ACE-27 ≥ 2. None of the factors were found to be predictive of non-flap surgical complications. Multivariable logistic regression was the performed in a stepwise manner to include for all factors with a cutoff of $p < .1$ and remained if $p < .05$. ACE-27 ≥ 2 remained the single predictor of major flap complications (OR, 19.41, 95% CI 2.3–164.65, $p = .006$) and major medical complications (OR, 5.8, 95% IC 1.11–30.23, $p = .037$) (Table 5). Patient age at time of surgery, gender, duration of surgery, tumor stage, location, and radiation status were not found to be predictive of major complications.

3.6 | Tumor recurrence risk

There were no local recurrences within the submental flap inset. Ten patients developed recurrence with local recurrence in three patients, regional recurrence in five patients, and distant recurrence in two patients.

4 | DISCUSSION

In this study, we present our institutional experience with the SIF for head and neck reconstruction. The goals of this study were to highlight the reconstructive versatility of the SIF as well as provide additional data on the safety profile of this flap with regards to the risk of transfer of metastatic disease. Finally, we examined the role of comorbidity and postoperative complications associated with SIF reconstruction as this has not been reported previously.

Since its introduction in 1993 by Martin et al,[1] the SIF has been increasingly utilized for defects of the oral cavity, oropharynx, face, lateral, and anterior skull base.[2–9] Prior studies have demonstrated that application of the SIF for head and neck reconstruction results in shorter operative times, duration of hospitalization, and decreased hospital costs when compared to free tissue transfer without significant differences in complication rates or functional outcomes.[10–13] The results of our 10-year study highlight this flaps versatility applied to various defects of the head and neck. Although the primary vascularity of the SIF was via an anterograde pedicled approach, our series does highlight alternative vascularization approaches previously described such as retrograde,[5,15,20] hybrid,[14] and free tissue transfer.[7] The use of retrograde flow allows for this pedicled flap to be used for regions such as the upper face and hard palate. While we report on three flaps that were vascularized via retrograde flow, it should be noted that two additional flaps were initially attempted with retrograde venous outflow but required microvascular revision of the vein (hybrid flap) due to the presence of valves in the facial vein. Although the literature on the presence of valves in the facial vein is sparse, they appear to be most commonly found along the lower border of the mandible[21]; therefore, the reconstructive surgeon considering this flap should be aware of this variation and be prepared to modify the venous outflow accordingly. In line with previous studies, the SIF is highly versatile as not only a skin flap but can also be harvested as a fascial or osteocutaneous flap. Flap size ranged from 18 to 96 cm^2 with 15 flaps (25%) being greater or equal to 50 cm^2 with no increased rates of flap or donor site complications, suggesting larger skin paddles can be considered in select patients. Three patients in our series who underwent SIF reconstruction had prior radiation. Of these cases, only one flap developed partial necrosis requiring nonoperative debridement. There were too few patients with prior radiation in this series to provide any conclusive statements; however, our experience seems to support the findings of others who have shown that the SIF can be safely utilized in patients with prior neck irradiation.[22,23]

Another aim of this study was to examine the oncologic safety of this technique due to the concern of direct extension of tumor into the submental space or transfer of metastatic nodal disease from level 1A. We found no evidence of transfer of metastatic disease for our 58 patients who had successful flap harvest and inset. Our study supports the conclusion reached from multiple authors[11,24,25] that there is minimal risk of cancerous nodal transfer with SIF. However, we do report one case in which metastatic nodal disease was identified in level 1A during flap harvest despite N0 preoperative PET/CT imaging and physical exam. In this case, the SIF was aborted, and reconstruction converted to a pectoralis flap. This cautionary note should reinforce to the reader the importance of careful imaging workup to rule out pathologic lymph nodes in level 1A, a high index of suspicion for metastatic disease during flap harvest, and a contingency reconstructive plan.

Comorbidity as a predictor for postoperative medical and surgical complications following major head and neck surgery and specifically free tissue transfer has been well documented in the literature[18,19,26–33]; however, we are not aware of any studies specifically examining the role of comorbidity in the context of the SIF. To answer this question, we applied the ACE-27 comorbidity index to our cohort of patients. The ACE-27 tool, which has been validated for assessing comorbidity in cancer patients grades comorbidity on a 0–3 scale based on assessment of 27 comorbid conditions. This index has been correlated with medical[26,34] and surgical complications[19,32] in patients undergoing major head and neck surgery. Overall, approximately 81% of patients had some comorbidity with 46% having major comorbidity. ACE-27 index scores ≥2 were the single predictive factor for both medical and flap-specific complications following multivariable logistic regression. The most common major flap complication involved partial necrosis requiring either bedside or operative debridement. This would suggest that higher comorbidity may increase the risk of vascular insufficiency, independent of factors such as flap size, operative time, or age.

We did find it interesting that there was no significant correlation between age at the time of the surgery and development of complications. There is mixed evidence in the literature as to whether age is an independent risk factor for complications in patients undergoing head and neck free flap reconstruction with some authors reporting a correlation,[27,28,34] while others reporting no significant difference in outcomes.[29,33] Even with age designated as a control variable in our multivariable logistic regression model, the significant relationship between comorbidity status and development of complications remained. It is possible that a greater sample size of SIF cases could reveal an underlying association but as previously described,[11–13] patients undergoing SIF had significantly reduced operative time, anesthesia exposure, and hospitalization course when compared to free flap reconstruction. Consequently, it could be that these benefits afforded by SIF help to reduce the association of age on complication rates. Therefore, the results of this cohort study support this notion of focusing on optimizing comorbidity status rather than age by itself.

For cases where SIF is being considered and tracheostomy is planned, placement of the tracheostomy should be delayed until after flap elevation. If tracheostomy is placed at the outset of the operation, it is possible that with the skin undermining necessary to close the SIF donor site, the skin incision of the tracheostomy will need to be revised. Therefore, our protocol has been to perform nasal intubation and then decide on tracheostomy at the conclusion of the procedure. Generally, our protocol has been to refrain from tracheostomy altogether. However, we did experience one patient death following glossectomy and FOM resection due to aspiration pneumonia and respiratory failure in the setting of acute alcohol withdrawal. Additionally, two other patients had a similar postoperative course involving aspiration pneumonia and respiratory failure requiring ventilatory support, secondary to alcohol withdrawal. We have since revised our protocol to include tracheostomy for patients with higher comorbidity scores, especially with regards to pulmonary disease and alcohol abuse.

In conclusion, the present study demonstrates that the SIF is a reliable and highly versatile flap for head and neck reconstruction; however, comorbidity as measured by the ACE-27 index is a strong predictor of both major medical and flap-specific surgical complications. Given the multiple factors that influence reconstructive decision making, high comorbid status alone should not preclude the utilization of SIF; as with free flap reconstruction, careful patient selection and optimization of comorbid diseases prior to surgery are essential to improving postoperative outcomes. Furthermore, early identification of such high-risk patients may help dictate the level of surveillance for postoperative complications and the need for additional interventions such as prophylactic tracheostomy.

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CONFLICT OF INTEREST

The authors report no conflicts of interest.

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REFERENCES

1. Martin D, Pascal J, Baudet J, Mondie J. The submental island flap: a new donor site. Anatomy and clinical applications as a free or pedicled flap. *Plast Reconstr Surg*. 1993;92(5):867-873.
2. Chang BA, Ryan Hall S, Howard BE, et al. Submental flap for reconstruction of anterior skull base, orbital, and high facial defects. *Am J Otolaryngol*. 2019;40(2):218-223. doi:10.1016/j.amjoto.2018.11.008
3. Tsai WC, Yang JM, Liu SC, et al. Management of different kinds of head and neck defects with the submental flap for reconstruction. *Eur Arch Otorhinolaryngol*. 2014;272(12):3815-3819. doi:10.1007/s00405-014-3461-0
4. Yilmaz M, Menderes A, Barutçu A. Submental artery island flap for reconstruction of the lower and mid face. *Ann Plast Surg*. 1997;39(1):30-35.
5. Chen W, Yang Z, Huang Z, Chai Q, Zhang D. Facial contour reconstruction after benign tumor ablation using reverse facial-submental artery deepithelialized submental island flaps. *J Craniofac Surg*. 2010;21(1):83-86. doi:10.1097/SCS.0b013e3181c3ba90
6. Taghinia AH, Movassaghi K, Wang AX, Pribaz JJ. Reconstruction of the upper aerodigestive tract with the submental artery flap. *Plast Reconstr Surg*. 2009;123(2):562-570. doi:10.1097/PRS.0b013e3181977fe4
7. Higgins KM, Backstein R. The submental island flap: a regional and free flap with a myriad of reconstructive applications. *J Otolaryngol*. 2007;36(02):88. doi:10.2310/7070.2007.0011
8. Merten SL, Jiang RP, Caminer D. The submental artery island flap for head and neck reconstruction. *ANZ J Surg*. 2002;72(2):121-124.
9. Multinu A, Ferrari S, Bianchi B, et al. The submental island flap in head and neck reconstruction. *Int J Oral Maxillofac Surg*. 2007;36(8):716-720. doi:10.1016/j.ijom.2007.03.008
10. Forner D, Phillips T, Rigby M, Hart R, Taylor M, Trites J. Submental island flap reconstruction reduces cost in oral cancer reconstruction compared to radial forearm free flap reconstruction: a case series and cost analysis. *J Otolaryngol*. 2016;45(1):1-8. doi:10.1186/s40463-016-0124-8
11. Patel UA. The submental flap for head and neck reconstruction: comparison of outcomes to the radial forearm free flap. *Laryngoscope*. 2020;130(S2):S1-S10. doi:10.1002/lary.28429
12. Paydarfar JA, Patel UA. Submental island pedicled flap vs radial forearm free flap for oral reconstruction: comparison of outcomes. *Arch Otolaryngol Head Neck Surg*. 2011;137(1):82-87. doi:10.1001/archoto.2010.204
13. Jørgensen MG, Tabatabaeifar S, Toyserkani NM, Sørensen JA. Submental island flap versus free flap reconstruction for complex head and neck defects. *Otolaryngol Head Neck Surg*. 2019;161(6):946-953. doi:10.1177/0194599819875416
14. Hayden RE, Nagel TH, Donald CB. Hybrid submental flaps for reconstruction in the head and neck: part pedicled, part free. *Laryngoscope*. 2014;124(3):637-641. doi:10.1002/lary.24266
15. You Y-H, Chen W-L, Wang Y-P, Liang J, Zhang D-M. Reverse facial-submental artery island flap for the reconstruction of maxillary defects after cancer ablation. *J Craniofac Surg*. 2009;20(6):2217-2220. doi:10.1097/SCS.0b013e3181bf84d7
16. Patel UA, Bayles SW, Hayden RE. The submental flap: a modified technique for resident training. *Laryngoscope*. 2007;117(1):186-189. doi:10.1097/01.mlg.0000246519.77156.a4
17. Piccirillo JF, Tierney RM, Costas I, Grove L, Spitznagel EL. Prognostic importance of comorbidity in a hospital-based cancer registry. *JAMA*. 2004;291(20):2441-2447. doi:10.1001/jama.291.20.2441
18. Gregory Farwell D, Reilly DF, Weymuller EA, Greenberg DL, Staiger TO, Futran NA. Predictors of perioperative complications in head and neck patients. *Arch Otolaryngol Head Neck Surg*. 2002;128(5):505-511. doi:10.1001/archotol.128.5.505
19. Ferrier MB, Spuesens EB, Le Cessie S, Baatenburg De Jong RJ. Comorbidity as a major risk factor for mortality and complications in head and neck surgery. *Arch Otolaryngol Head Neck Surg*. 2005;131(1):27-32. doi:10.1001/archotol.131.1.27
20. Kim JT, Kim SK, Koshima I, Moriguchi T. An anatomic study and clinical applications of the reversed submental perforator-based Island flap. *Plast Reconstr Surg*. 2002;109(7):2204.

21. Nishihara J, Takeuchi Y, Miki T, Itoh M, Nagahata S. Anatomical study on valves of human facial veins. *J Craniomaxillofac Surg*. 1995;23(3): 182-186. doi:10.1016/s1010-5182(05)80008-3
22. Karimi E, Badiei R, Aghazadeh K, Sohrabpour S, Yazdani N, Dabiri S. Effect of prior radiotherapy on the outcome of submental island flap in head and neck reconstruction. *J Craniofac Surg*. 2018;29(7):1821-1824. doi:10.1097/SCS.0000000000005041
23. Ramkumar A. Submental artery island flap in patients who have received prior neck irradiation. *Indian J Surg Oncol*. 2015;6(3):218-222. doi:10.1007/s13193-015-0400-5
24. Howard BE, Nagel TH, Donald CB, Hinni ML, Hayden RE. Oncologic safety of the submental flap for reconstruction in oral cavity malignancies. *Otolaryngol Head Neck Surg*. 2014;150(4):558-562. doi: 10.1177/0194599814520687
25. Kramer FJ, Böhrnsen F, Moser N, Schliephake H. The submental island flap for the treatment of intraoral tumor-related defects: no effect on recurrence rates. *Oral Oncol*. 2015;51(7):668-673. doi: 10.1016/j.oraloncology.2015.03.011
26. Datema FR, Poldermans D, Baatenburg de Jong RJ. Incidence and prediction of major cardiovascular complications in head and neck surgery. *Head Neck*. 2010;32(11):1485-1493. doi:10.1002/hed. 21351
27. Patel RS, McCluskey SA, Goldstein DP, et al. Clinicopathologic and therapeutic risk factors for perioperative complications and prolonged hospital stay in free flap reconstruction of the head and neck. *Head Neck*. 2010;32(10):1345-1353. doi:10.1002/hed.21331
28. Clark JR, McCluskey SA, Hall F, et al. Predictors of morbidity following free flap reconstruction for cancer of the head and neck. *Head Neck*. 2007;29(12):1090-1101. doi:10.1002/hed.20639
29. Peters TTA, Van Dijk BAC, Roodenburg JLN, Van Der Laan BFAM, Halmos GB. Relation between age, comorbidity, and complications in patients undergoing major surgery for head and neck cancer. *Ann Surg Oncol*. 2014;21(3):963-970. doi:10.1245/s10434-013-3375-x
30. McMahon JD, Maciver C, Smith M, et al. Postoperative complications after major head and neck surgery with free flap repair - Prevalence, patterns, and determinants: A prospective cohort study. *Br J Oral Maxillofac Surg*. 2013;51(8):689-695. doi:10.1016/j.bjoms.2013. 04.015
31. Borggreven PA, Kuik DJ, Quak JJ, De Bree R, Snow GB, Leemans CR. Comorbid condition as a prognostic factor for complications in major surgery of the oral cavity and oropharynx with microvascular soft tissue reconstruction. *Head Neck*. 2003;25(10):808-815. doi:10.10 02/hed.10291
32. Hwang K, Lee JP, Yoo SY, Kim H. Relationships of comorbidities and old age with postoperative complications of head and neck free flaps: a review. *J Plast Reconstr Aesthetic Surg*. 2016;69(12):1627-1635. doi: 10.1016/j.bjps.2016.08.018
33. Peters TTA, Post SF, van Dijk BAC, et al. Free flap reconstruction for head and neck cancer can be safely performed in both young and elderly patients after careful patient selection. *Eur Arch Otorhinolaryngol*. 2015;272(10):2999-3005. doi:10.1007/s00405-014-3268-z
34. de la Garza G, Militsakh O, Panwar A, et al. Obesity and perioperative complications in head and neck free tissue reconstruction. *Head Neck*. 2016;38(Suppl 1(10)):E1188-91. doi:10.1002/hed.24189

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