

Submental Island Pedicled Flap vs Radial Forearm Free Flap for Oral Reconstruction

Comparison of Outcomes

Joseph A. Paydarfar, MD; Urjeet A. Patel, MD

Objective: To compare intraoperative, postoperative, and functional results of submental island pedicled flap (SIPF) against radial forearm free flap (RFFF) reconstruction for tongue and floor-of-mouth reconstruction.

Design: Multi-institutional retrospective review.

Setting: Academic tertiary referral center.

Patients: Consecutive patients from February 2003 to December 2009 undergoing resection of oral tongue or floor of mouth followed by reconstruction with SIPF or RFFF.

Intervention: Two groups: SIPF vs RFFF.

Main Outcome Measures: Duration of operation, hospital stay, surgical complications, and speech and swallowing function.

Results: The study included 60 patients, 27 with SIPF reconstruction and 33 with RFFF reconstruction. Sex, age, and TNM stage were similar for both groups. Mean flap size was smaller for SIPF (36 cm²) than for RFFF (50 cm²) ($P < .001$). Patients undergoing SIPF reconstruction had shorter operations (mean, 8 hours 44 minutes vs 13 hours 00 minutes; $P < .001$) and shorter hospitalization (mean, 10.6 days vs 14.0 days; $P < .008$) compared with patients who underwent RFFF. Donor site, flap-related, and other surgical complications were comparable between groups, as was speech and swallowing function.

Conclusions: Reconstruction of oral cavity defects with the SIPF results in shorter operative time and hospitalization without compromising functional outcomes. The SIPF may be a preferable option in reconstruction of oral cavity defects less than 40 cm².

Arch Otolaryngol Head Neck Surg. 2011;137(1):82-87

OPTIONS FOR RECONSTRUCTING the oral tongue and floor of mouth after cancer resection vary from primary closure to free tissue transfer. Choice of reconstruction depends on the size and location of the defect, with the main goal of reconstruction being the ability for the patient to maintain speech and swallowing function. For small defects, primary closure or healing by secondary intention may be sufficient. For larger defects, free tissue transfer has traditionally been used. The radial forearm free flap (RFFF) is considered the flap of choice for soft tissue reconstruction of oral cavity defects because it confers good tongue mobility resulting in acceptable long-term articulation and swallowing ability. Many consider RFFF to be the optimal method for tongue and floor-of-mouth reconstruction; however, it requires microvascular surgery and the accompanying requisites. Such cases often

result in long operative duration, prolonged hospital stay, and possible donor-site morbidity.

The submental island artery flap has become increasingly popular since its introduction by Martin et al in 1993.¹ Its use in head and neck reconstruction has been described, and it has been shown to be well suited for defects of the tongue, floor of the mouth, buccal mucosa, palate, and external face.²⁻⁶ Particularly when used for intraoral reconstruction, submental island artery flap possesses many advantages of the RFFF in that it is thin, pliable, and allows a large surface area to be harvested. Although submental island artery flap can be harvested for free tissue transfer, its main advantage for intraoral reconstruction is that it can be used as a pedicled flap and tunneled into the defect. Accordingly, one might expect shorter operative time with the submental island pedicled flap (SIPF) than is seen with free-flap alternatives. Without the need for mi-

Author Affiliations:
Departments of Otolaryngology–Head and Neck Surgery, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire (Dr Paydarfar), and Northwestern University, Chicago, Illinois (Dr Patel); and Division of Otolaryngology–Head and Neck Surgery, John H. Stroger Jr Hospital of Cook County, Chicago (Dr Patel).

crovascular anastomosis, it requires less intensive postoperative flap monitoring and may also demonstrate shorter hospital stay. The SIPF is believed to offer good functional results, although there have been no reports to date comparing it with other reconstructive options. The purpose of this study was to compare intraoperative, postoperative, and functional results of the SIPF with those of the RFFF for reconstruction of tongue and floor-of-mouth defects.

METHODS

PARTICIPANTS

This was a multi-institutional study with patients drawn from an urban medical center (John H. Stroger Jr Hospital of Cook County, Chicago, Illinois) and a rural tertiary medical center (Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire). At each institution, a prospectively created database of the Head and Neck Tumor Conference was reviewed to identify all patients who underwent oral cavity resection with flap reconstruction (SIPF or RFFF) from February 2003 to December 2009. Approval from the institutional review boards at each location was obtained for data analysis of this patient population. All patients underwent surgical treatment by surgeons trained in pedicled and microvascular reconstruction. Extent of surgical resection, need for neck dissection, tracheotomy placement, and choice of flap reconstruction were at the discretion of the surgeon. At both institutions, tracheotomy placement was performed in the same surgical field as the main resection (ie, the field does not require resterilization or replacement of drapes) and generally was performed with a chief or attending physician and a junior resident. The RFFF cases were performed with a 2-team approach and SIPF cases were performed with a single attending surgeon. Both institutions represented in this study are involved in resident training; as such, resident surgeons participated in surgery and were often being taught neck dissection regardless of the reconstructive method. Technical details regarding harvest of the SIPF have been well described.^{7,8} For patients undergoing submental flap in conjunction with neck dissection, level IB is removed as specimen, and the half of level IA ipsilateral to the submental pedicle must be incorporated into the flap. To focus on the issue of tongue mobility and function, the study population was restricted to patients with resections involving the tongue and/or floor of the mouth. Patients with buccal or palate lesions were excluded.

DATA COLLECTION

Patients to be included in the study were identified and their medical records were reviewed. A data extraction form was created to obtain relevant information from the records. Demographic information (age and sex) was obtained. Tumor-related data were collected including primary site, tumor stage, and history of prior treatment. Tumor staging was performed according to American Joint Committee on Cancer 2002 criteria.⁹ Operative notes were reviewed for information on extent of resection, use of tracheotomy, choice of flap, and flap dimensions. Anesthesia operating room logs were used to measure total operative time, which was not broken down into separate components of tracheotomy, resection, and reconstruction. The medical record was reviewed for complications, which were divided into flap complications, recipient site and other complications, and donor site complications. Length of hospital stay was calculated from the time of surgery to discharge from the hospital.

FOLLOW-UP AND FUNCTIONAL ASSESSMENT

The length of follow-up was measured for each patient from the time of surgery to the last documented follow-up or date of death. Data regarding local, regional, and distant disease recurrence were extracted. Office notes were reviewed to assess speech and swallowing function after the surgery. Swallowing function was stratified into the following 5 categories: full diet, soft diet, liquid diet, combined oral and gastric tube, and exclusively gastric tube. Speech intelligibility was measured as excellent (>80% intelligibility), good (50%-80% intelligibility), and poor (<50% intelligibility). Grading of speech was performed at the time of data collection and was based on information found in the most recent office notes.

DATA ANALYSIS

The study cohort was separated according to choice of flap: those reconstructed with SIPF and those reconstructed with RFFF. Bivariate analysis was performed to assess any differences in pretreatment and tumor-related variables between the 2 groups. Flap size, operative time, and length of hospital stay were calculated for patients in each group, and *t* test was used to assess statistical differences. Box and whisker plots were constructed to display median values and interquartile ranges, with removal of outliers. Postoperative therapy, disease recurrence, and speech and swallowing function were tabulated in a bivariate fashion with appropriate statistical tests applied (χ^2 and Fisher exact tests). Statistical analysis was performed using SPSS, version 16 (SPSS Inc, Chicago, Illinois).

RESULTS

PATIENT AND TUMOR CHARACTERISTICS

Patient and tumor characteristics are summarized in **Table 1**. Sixty flaps were performed on 60 patients between the 2 institutions. The patients in the RFFF and SIPF groups were of similar age and sex distribution. Pathologic diagnoses in the majority of cases was squamous cell carcinoma; 2 exceptions were 1 adenoid cystic carcinoma of the sublingual gland and 1 mucoepidermoid carcinoma of the sublingual gland. The majority of tumors in both groups were staged as T2, although there were twice as many combined T3 and T4 tumors in the RFFF group; however, this was not significantly different. Nodal disease was evenly distributed between the 2 groups. Fifty-nine of the 60 patients underwent neck dissection in conjunction with primary resection and reconstruction, with an almost equal division of unilateral vs bilateral neck dissection in both groups of patients. Six patients had received radiation therapy before reconstruction: 5 in the RFFF group and 1 in the SIPF group. Two of these patients had received prior chemoradiotherapy: 1 for a separate tonsil cancer that remained under control and the other for a T3N2b lateral tongue cancer. All 6 patients subsequently developed recurrent disease after a disease-free interval, requiring surgical resection and reconstruction that entered them into the study reported here.

OPERATIVE AND POSTOPERATIVE OUTCOMES

Flap size, operative time, and length of hospital stay were compared between the RFFF and SIPF groups (**Figure**). Mean flap size in the RFFF group was significantly larger than in the SIPF group (50 cm² vs 36 cm², $P < .001$). Patients undergoing SIPF reconstruction experienced significantly shorter operative times (mean, 8 hours 44 minutes vs 13 hours 00 minutes; $P < .001$) and hospital length of stay (mean, 10.6 days vs 14.0 days; $P < .008$) when compared with the RFFF group. In the RFFF group, 25 pa-

tients (76%) had tracheotomy placement compared with 14 patients (52%) in the SIPF group ($P = .05$ by χ^2). Although the time required for tracheotomy placement was not documented in the operative records, based on our estimates, tracheotomy accounted for only 30 minutes of operative time.

COMPLICATIONS

Data on surgical complications are presented in **Table 2**. There was 1 case of complete flap loss in the RFFF group (3%) and no cases of partial flap loss. Conversely, the SIPF group had 3 patients (11%) with partial flap loss and no patients experienced complete SIPF loss. Donor site complications were more prevalent with RFFF reconstruction: 5 patients had partial loss of split-thickness skin grafts and 2 patients had temporary hypoesthesia in the thenar region. There were only 2 SIPF cases with donor site complications, both of which were dehiscence of the anterior neck closure that then healed by secondary intention. Three of the 5 cases of wound dehiscence in the RFFF group were also of the neck closure. There were no cases of permanent marginal mandibular nerve weakness in the SIPF group. Patients in the RFFF group developed a greater number of overall recipient site complications compared with those in the SIPF group.

FUNCTIONAL OUTCOMES

Postoperative adjuvant therapy was used in 46 patients, with 18 treated with postoperative radiation therapy alone and 28 with postoperative chemoradiotherapy (**Table 3**). Four patients (12%) who underwent RFFF required no further therapy compared with 10 such SIPF patients (37%); this difference was statistically significant ($P = .03$). Speech and swallowing function were graded and tabulated for both groups (Table 3). Speech results were noted to be excellent in most patients regardless of the reconstruction method, with 24 RFFF (73%) and 23 SIPF (85%) patients achieving excellent speech. Nine patients were thought to have only good

Table 1. Comparison of Patients With RFFF and SIPF

Characteristic	RFFF (n=33)	SIPF (n=27)	P Value
Age, mean (SD)	54.7 (38-75)	58.1 (34-82)	.24
Sex			
Male	22	20	.38
Female	11	7	
Tumor location			
Floor of mouth	9	6	.90
Tongue	14	12	
Tongue/floor of mouth	10	9	
Tumor stage (T)			
1	1	2	.38
2	15	17	
3	11	6	
4	6	2	
Nodal stage (N)			
0	15	16	.42
1	6	2	
≥ 2	12	9	
Prior treatment			
Surgery	0	1	.14
Surgery plus radiation therapy	4	0	
Chemoradiotherapy	1	1	
Extent of neck dissection			
None	0	1	.78
Unilateral	15	12	
Bilateral	18	14	

Abbreviations: RFFF, radial forearm free flap; SIPF, submental island pedicled flap.

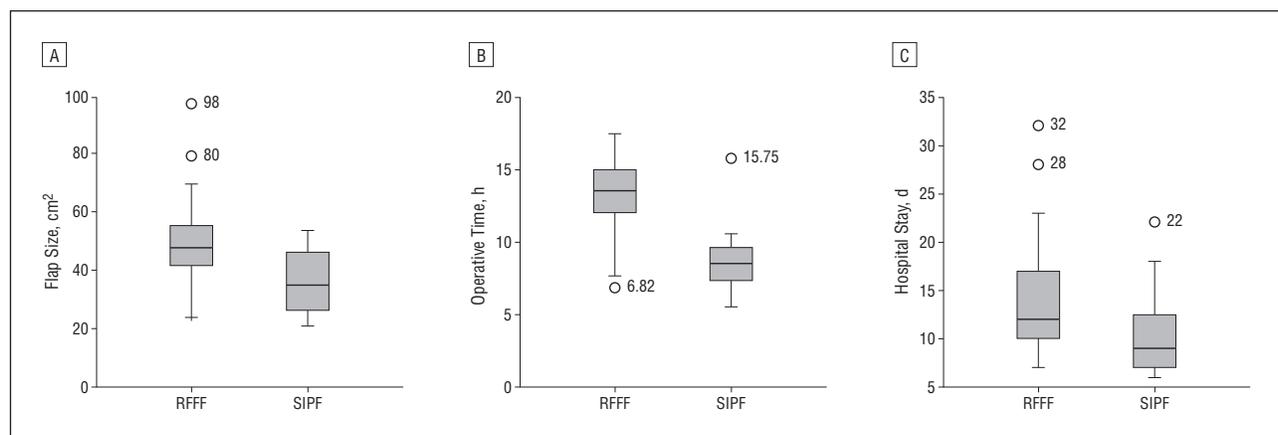


Figure. Box and whisker plots showing the median (horizontal line), interquartile range (outside the box), and high and low values (top and bottom of whiskers) excluding outliers (open circles). A, Flap size was notably larger for patients who underwent radial forearm free flap (RFFF) compared with those who underwent submental island pedicled flap (SIPF) ($P < .0013$). This is statistically significant; however, the median flap sizes for RFFF and SIPF were 6 × 8 cm and 5 × 7 cm, respectively, which does not seem clinically significant. B, Operative time was longer for RFFF than SIPF ($P < .001$). C, Length of hospital stay was also longer for RFFF compared with SIPF ($P > .007$).

Table 2. Complications of RFFF and SIFP

Complication	RFFF	SIFP
Flap complication	2	3
Flap failure	1	0
Partial flap necrosis	0	3
Venous obstruction	1	0
Recipient/other complication	16	5
Orocutaneous fistula	5	0
Wound dehiscence	5	0
Hematoma	2	2
Neck infection	2	2
Return to OR, other ^a	2	1
Donor site complication	7	2
Partial loss of skin graft	5	NA
Temporary ulnar hypoesthesia	2	NA
Wound dehiscence	0	2

Abbreviations: NA, not applicable; OR, operating room; RFFF, radial forearm free flap; SIFP, submental island pedicled flap.

^aTwo patients in the RFFF group had complications associated with their gastric tube that required operative intervention. One patient in the SIFP group had respiratory distress after decannulation and required a second tracheotomy.

speech and 4 were graded as having poor speech. Of these 13 patients with less than excellent speech, 9 underwent reconstruction with RFFF and only 4 with SIFP. Swallowing function was essentially normal in a high percentage of patients, with 19 RFFF (58%) and 20 SIFP (74%) patients on a full oral diet. Eight patients with RFFF and 4 with SIFP had some limitation of oral intake but did not require gastric-tube supplementation. Finally, 6 RFFF patients and 3 SIFP patients required gastric-tube feeding for some or all of their nutritional needs. Differences in speech and swallowing function were not significantly different between the 2 groups but tended to favor better outcomes with SIFP.

ONCOLOGIC OUTCOMES

Disease recurrence for both groups is demonstrated in **Table 4**. The median follow-up period was 16 months for patients who underwent RFFF and 13 months for those who underwent SIFP. During this period, recurrence rates were similar. Local recurrence was more common than regional or distant recurrence for both groups; all 3 types of recurrences were evenly distributed between the 2 reconstructive groups.

COMMENT

Since 1993, the SIFP has been used to reconstruct defects of the head and neck including the face, neck, tongue, buccal mucosa, and palate.^{1-6,10} The SIFP shares advantages of the RFFF in its thin skin and pliability. The SIFP can be harvested as a free flap; however, for most cases of oral cavity reconstruction, this flap is raised as a pedicled flap and tunneled from the submandibular space into the oral cavity. As such, it would be expected that use of the SIFP for oral reconstruction compared with the RFFF would result in surgery of shorter duration, shorter hospitalization, and presumably comparable functional outcomes.

Table 3. Speech and Swallowing Function Following Reconstruction

Characteristic	RFFF (n=33)	SIFP (n=27)	P Value
Postoperative adjuvant therapy			
None	4	10	.03
Radiation	13	5	
Chemoradiotherapy	16	12	
Speech			
Excellent	24	23	.57
Good	6	3	
Poor	3	1	
Swallowing			
Full oral	19	20	.60
Soft	5	3	
Liquids	3	1	
Oral plus gastric tube	2	2	
Gastric tube only	4	1	

Abbreviations: RFFF, radial forearm free flap; SIFP, submental island pedicled flap.

Table 4. Oncologic Outcomes for Patients Undergoing RFFF and SIFP

Outcome	RFFF (n=33)	SIFP (n=27)	P Value
Follow-up, mo, median	16	13	...
Disease recurrence	12	13	.51
Local	6	7	.77
Regional	3	2	
Distant	3	4	

Abbreviations: RFFF, radial forearm free flap; SIFP, submental island pedicled flap.

This study presents a multi-institutional experience comparing the SIFP with the RFFF for oral reconstruction and is one of the largest reported series of SIFP used for this indication. We examined a number of variables including patient and tumor characteristics, flap size, duration of surgery, length of hospital stay, donor and recipient site complications, speech and swallowing outcomes, and oncologic outcomes. As predicted, use of the SIFP resulted in significantly shorter operative times and duration of hospitalization. There was a 25% increased use of tracheotomy in the RFFF group; however, the time required for placement of tracheotomy would account for less than a 15-minute difference in mean operative time (when averaged across all patients in the study). Thus, although tracheotomy placement did add to the mean operative time, it did not dramatically affect the overall difference in mean operative time between the groups.

Flap size in the RFFF group was significantly larger than in the SIFP group, which could be partially explained by a greater number of T3 and T4 tumors in the RFFF group. Speech and swallowing functions between the 2 groups were comparable; there was a trend toward

slightly worse speech and swallowing function in the RFFF group. This trend could also be partially explained by the greater number of T3 and T4 tumors in the RFFF group. There was an overall greater incidence of recipient site complications, in particular orocutaneous fistula, in the RFFF group. Although this may be related to the slightly larger tumors in the RFFF group, increased operative time alone is a significant risk factor for postoperative complications in free-flap surgery.¹¹ Another possible explanation for the difference in the orocutaneous fistula rate involves the tissue included in the submental pedicle. Although the skin paddles for both flaps are relatively thin, the SIPF does include the ipsilateral anterior digastric and mylohyoid muscles.^{12,13} This results in a thicker pedicle. This extra vascularized muscle may help seal any potential fistula tract.

One of the greatest advantages of the SIPF is that the donor site is an extension of the neck incision; therefore, a separate donor site is avoided. Provided the SIPF can be closed primarily, the only potential donor site morbidity is wound dehiscence. In this study, the incidence of neck wound dehiscence was similar in both groups, suggesting that no dehiscence could be specifically attributed to donor site morbidity seen with the SIPF. By comparison, potential donor-site complications of the RFFF include tendon exposure from partial loss of the split-thickness skin graft, sensory changes, stiffness, cold intolerance, and cosmetic deformity.¹⁴ In this series, several patients in the RFFF group experienced partial skin graft loss, tendon exposure, and sensory deficits to the hand.

One limitation of this retrospective study is that because patients were not randomized, there are differences when comparing the SIPF and RFFF groups. Although not significantly different, there was a greater number of T3 and T4 tumors in the RFFF group as well as patients who had received treatment before surgery. There is likely an inherent bias for surgeons to opt for the RFFF when reconstructing a larger defect or perhaps in a patient who has received previous treatment. Both of these are likely independent risk factors for increased operative time, hospital stay, postoperative complications, and possibly impaired functional results. There was also a significant difference in postoperative adjuvant therapy. The RFFF group was more likely to receive postoperative therapy than was the SIPF group. As postoperative radiation therapy or chemoradiotherapy can adversely affect speech and swallowing function, this could explain the slightly worse functional results in the RFFF group. A study randomizing patients to a RFFF or an SIPF group would eliminate defect-driven surgeon biases and offer a more rigorous comparison of these 2 reconstructive options.

An additional limitation of this study is the method of assessing functional outcome. Both speech and swallowing were evaluated retrospectively through review of office notes and were not measured by formal speech assessment. Accordingly, a fairly simplistic scale to grade both speech and swallowing was used. It is possible that this grading system is too coarse to discern subtle differences in functional outcome between the 2 flaps. In future studies, formal speech assessment with validated

grading scales should be performed prospectively to more definitively show possible differences between functional outcomes.

There is some controversy regarding use of the SIPF for oral cavity reconstruction in the setting of oral carcinoma due to possible transfer of metastatic nodal tissue from level IA into the oral defect. Although the overall incidence of level IA nodal metastasis is low,¹⁵ a discussion of the SIPF would be incomplete without giving consideration to this possibility. Harvest of the SIPF requires inclusion of half of level IA, which poses potential risk for harboring occult disease. Dissection of bilateral level IB is not impaired by the submental harvest. With careful SIPF harvest, a greater length of the marginal mandibular nerve is dissected than is done for a typical level IB dissection. Accordingly, removal of periaxial nodes in level IB with SIPF harvest is at least comparable to a conventional dissection. Regardless, there have been no reported cases of metastatic nodal transfer with the SIPF and, in this study, we did not find a significant difference between the SIPF and RFFF in the incidence of local recurrence. With small numbers of local recurrences in both groups, it is difficult to generate meaningful Kaplan-Meier curves, which would typically be used to display recurrence data. The data suggest that choice of flap does not influence local recurrence.

In summary, the SIPF should be considered when reconstructing partial glossectomy and floor-of-mouth defects, particularly in cases where maximum flap size will not exceed 46 cm² (6 × 8-cm flap). It may offer advantages of decreased operative time, length of stay, and reduced morbidity while maintaining acceptable speech and swallowing function when compared with RFFF. Further studies are needed to better establish the role of SIPF in larger defects and in patients who have received previous treatment.

Submitted for Publication: March 30, 2010; final revision received July 25, 2010; accepted July 29, 2010.

Correspondence: Urjeet A. Patel, MD, Department of Otolaryngology, Northwestern University, 676 N St Clair Ave, Ste 1325, Chicago, IL 60611 (upatel3@ccbhs.org).

Author Contributions: Both authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Paydarfar and Patel. *Acquisition of data:* Paydarfar and Patel. *Analysis and interpretation of data:* Paydarfar and Patel. *Drafting of the manuscript:* Paydarfar and Patel. *Critical revision of the manuscript for important intellectual content:* Paydarfar and Patel. *Statistical analysis:* Paydarfar and Patel. *Obtained funding:* Patel. *Administrative, technical, and material support:* Paydarfar and Patel. *Study supervision:* Patel.

Financial Disclosure: None reported.

Funding/Support: Support for the conduct of the study and preparation of the manuscript was provided in part by John H. Stroger Jr Hospital of Cook County, Department of Surgery, Minority-based Community Clinical Oncology Program Grant.

Previous Presentation: This study was presented at the American Head and Neck Society Annual Meeting; April 28, 2010; Las Vegas, Nevada.

REFERENCES

1. Martin D, Pascal JF, Baudet J, et al. 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. Merten SL, Jiang RP, Caminer D. The submental artery island flap for head and neck reconstruction. *ANZ J Surg*. 2002;72(2):121-124.
3. Sebastian P, Thomas S, Varghese BT, Iype EM, Balagopal PG, Mathew PC. The submental island flap for reconstruction of intraoral defects in oral cancer patients. *Oral Oncol*. 2008;44(11):1014-1018.
4. Abouchadi A, Capon-Degardin N, Patenôtre P, Martinot-Duquennoy V, Pellerin P. The submental flap in facial reconstruction: advantages and limitations. *J Oral Maxillofac Surg*. 2007;65(5):863-869.
5. Genden EM, Buchbinder D, Urken ML. The submental island flap for palatal reconstruction: a novel technique. *J Oral Maxillofac Surg*. 2004;62(3):387-390.
6. Uppin SB, Ahmad QG, Yadav P, Shetty K. Use of the submental island flap in orofacial reconstruction—a review of 20 cases. *J Plast Reconstr Aesthet Surg*. 2009;62(4):514-519.
7. Patel UA, Bayles SW, Hayden RE. The submental flap: a modified technique for resident training. *Laryngoscope*. 2007;117(1):186-189.
8. Curran AJ, Neligan P, Gullane PJ. Submental artery island flap. *Laryngoscope*. 1997;107(11, pt 1):1545-1549.
9. American Joint Committee on Cancer. *AJCC Cancer Staging Manual*. 6th ed. Philadelphia, PA: Lippincott-Raven Publishers; 2002.
10. Taghnia 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.
11. Singh B, Cordeiro PG, Santamaria E, Shaha AR, Pfister DG, Shah JP. Factors associated with complications in microvascular reconstruction of head and neck defects. *Plast Reconstr Surg*. 1999;103(2):403-411.
12. Vural E, Suen JY. The submental island flap in head and neck reconstruction. *Head Neck*. 2000;22(6):572-578.
13. Pistre V, Pelissier P, Martin D, Lim A, Baudet J. Ten years of experience with the submental flap. *Plast Reconstr Surg*. 2001;108(6):1576-1581.
14. Richardson D, Fisher SE, Vaughan ED, Brown JS. Radial forearm flap donor-site complications and morbidity: a prospective study. *Plast Reconstr Surg*. 1997;99(1):109-115.
15. Lindberg R. Distribution of cervical lymph node metastases from squamous cell carcinoma of the upper respiratory and digestive tracts. *Cancer*. 1972;29(6):1446-1449.