


Flap Selection and Functional Outcomes in Total Glossectomy with Laryngeal Preservation

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Otolaryngology—
Head and Neck Surgery
149(4) 547–553
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Surgery Foundation 2013
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DOI: 10.1177/0194599813498063
http://otojournal.org


No sponsorships or competing interests have been disclosed for this article.

Received March 19, 2013; revised May 9, 2013; accepted June 16, 2013.

Abstract

Objective. Reconstruction of total glossectomy defects has been revolutionized by the popularity of free flap use in the head and neck. Challenging defects can be addressed with a variety of different free and pedicled flaps. The purpose of this study is to review our method of flap selection in cases of total glossectomy defects with laryngeal preservation, with an emphasis on the variations of these defects and patient body habitus.

Study Design. Case series with chart review.

Setting. Tertiary care referral center.

Subjects and Methods. All patients undergoing total glossectomy with laryngeal preservation (TGLP) by the senior author (YD) from September 1997 to May 2012. Objective data regarding patient demographics, existing defect, method of reconstruction, adjuvant treatment, operative details, outcomes, and complications were recorded. Both means and frequency of prolonged tracheostomy or gastrostomy tube were used to assess outcomes.

Results. One hundred and three patients were identified. Ninety-four met inclusion criteria. All patients were T3 or T4 stage tumors. Mean follow-up was 3.4 years. Fifty-nine patients (62%) underwent free flap reconstruction while the remaining 35 (37%) were treated with a pedicled pectoralis myocutaneous flap. Tracheostomy decannulation and gastrostomy tube removal rates were 84% and 29%, respectively. No patients were converted to total laryngectomy.

Conclusion. Optimal reconstruction of TGLP defects may be accomplished with either pedicled or free-tissue flap reconstruction. Selecting an ideal flap for reconstruction of total glossectomy defects should be patient specific and based on matching donor flap bulk. This treatment approach demonstrates high tracheostomy and gastric tube independence.

Keywords

total glossectomy, laryngeal preservation, tongue cancer, tongue defect, oral cavity defect, oral cavity reconstruction, free flap reconstruction, pectoralis muscle flap

Introduction

The advent of microsurgery has provided significant improvements in total glossectomy reconstruction. Most commonly these defects are the result of tumor extirpation and are universally devastating if not properly re-created. While reconstruction does provide some aesthetic benefit, resultant functionality is the more important endpoint. While defects of oral cavity tongue alone are commonly treated with a variety of smaller flaps, those of total glossectomy require greater tissue bulk.

Traditional treatment options include concurrent total laryngectomy in patients undergoing total glossectomy to prevent chronic aspiration. Such additional resection adds greatly to the overall surgical morbidity and may be obviated with improved methods of reconstruction.^{1,2} Obviously, laryngeal preservation should only be pursued when adequate surgical margins can be obtained while preserving sufficient supraglottis.

Paramount to total glossectomy with laryngeal preservation is the ability to provide reconstruction that allows for long-term function of swallow and airway protection. As tissue bulk is directly related to these goals, flap choice appears to be a critical factor.^{3,4} Body habitus has a major influence on flap selection in our practice and is felt to affect longevity of flap volume. While free tissue transfer commonly provides sufficient volume, pedicled flap transfer, if adequate adipose volume is present, may also be appropriate in some patients.

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The purpose of this study was to review our experience with flap selection in total glossectomy reconstruction performed with laryngeal preservation.

Patients and Methods

All patient undergoing total glossectomy with laryngeal preservation by the senior author (YD) between September 1997 and May 2012 were reviewed. Patients requiring concurrent total laryngectomy or partial/segmental mandibulectomy were excluded. All flaps were either myocutaneous or fasciocutaneous flaps. Approval was obtained by the Institutional Review Board of John Peter Smith Hospital.

Data were collected regarding patient demographics, surgical defect and method of reconstruction, adjuvant treatment, functional outcomes, and overall complications. Specific details regarding tracheostomy tube decannulation and gastrostomy tube removal status were examined to provide insight into airway protection and nutritional stabilization, respectively. Means and frequency of prolonged tracheostomy or gastrostomy tube were defined as its use greater than 1 year duration following surgical intervention.

Tracheostomy tube decannulation was performed when patients were able to handle their secretions and had no significant airway edema. This was confirmed on flexible endoscopic evaluation of swallowing (FEES) and stroboscopy performed by a licensed speech therapist. In addition, removal of gastrostomy tube was performed when patients were capable of maintaining nutritional requirements via per oral intake. All patients were formally assessed by a certified speech therapist.

Statistical analysis was performed using a chi-square contingency table analysis for subjects from each of the flap groups to assess for differences in tracheostomy and G-tube dependency rates.

Results

A total of 103 patients were identified to meet the inclusion criteria. Seven patients were lost to follow-up and were excluded from the study. Two patients died of perioperative complications (1 = myocardial infarction and 1 = ischemic bowel). Overall, 94 patients were included in the study. Patient age ranged from 35 to 83 years with a mean age of 65.6. Male to female ratio was 2.22:1. All tumors were advanced stage T3 or T4 tumors. Patient follow-up ranged from 12 months to 7.5 years with a mean of 3.4 years.

Surgical Pathology

Neoplasm pathology included squamous cell carcinoma (n = 90), mucoepidermoid carcinoma (n = 3), and adenoid cystic carcinoma (n = 1). In all cases, tumor extirpation required removal of the entire tongue, including both oral cavity and oropharyngeal components. In 6 patients, a small segment of the supraglottis was also resected, while the majority of patients had supraglottis preserved. All patients achieved negative surgical margins confirmed on final pathology.

Flap Selection

Reconstructive methods employed included pedicled pectoralis major myocutaneous flap (n = 35), rectus abdominis myocutaneous free flap (n = 32), radial forearm fasciocutaneous free flap (n = 21), parascapular fasciocutaneous free flap (n = 3), and latissimus dorsi myocutaneous free flap (n = 3). Fifty-eight (61.7%) patients received preoperative radiation therapy (average dose 65 Gy). Thirty-eight of those patients received neo-adjuvant chemotherapy (Eribitux = 18, platinum based = 20). All patients treated with primary surgery underwent postoperative radiation therapy. All patients received tracheostomy and gastrostomy tube at or prior to the time of surgical resection.

Myocutaneous Pedicled Pectoralis Major Flap

Of the 35 patients treated with pectoralis major myocutaneous (PMM) flap reconstruction, 5 patients (14.2%) required prolonged tracheostomy tube while 24 (68.6%) required a prolonged gastrostomy tube. Four of the 24 patients were able to eat for pleasure but unable to meet required caloric intake. All 5 patients requiring prolonged tracheostomy, as well as 18 of the 24 prolonged gastrostomy tube patients, had received preoperative radiation therapy. Of the 11 (31.4%) patients demonstrating gastrostomy tube independence after PMM flap, 10 patients were treated with primary surgery followed by postoperative radiation therapy. Four patients (11.4%) in this group developed postoperative pneumonia that resolved with medical management.

Myocutaneous Vertical Rectus Free Flap

Of the 32 patients treated with rectus myocutaneous free flap (VRAM), 6 (18.7%) required prolonged tracheostomy tube while 23 (71.8%) required a prolonged gastrostomy tube. Three of the 23 patients were able to eat for pleasure but unable to maintain caloric requirements. Four of the 6 patients (66.7%) with prolonged tracheostomy tube and 17 of the 23 (73.9%) patients with prolonged gastrostomy tube patients had received preoperative radiation therapy. Three patients in the VRAM flap group (9.3%) developed postoperative pneumonia responsive to medical management.

Fasciocutaneous Radial Forearm Free Flap

Twenty-one patients were reconstructed with radial forearm free flaps (RFFF) with only 2 patients (9.5%) requiring prolonged tracheostomy. Fifteen patients (71.4%) required prolonged gastrostomy tubes with 5 patients eating occasionally for pleasure only. Both prolonged tracheostomy patients and 11 of the 15 (73.3%) prolonged gastrostomy patients had received preoperative radiation. There were 4 (19%) cases of pneumonia in the RFFF reconstruction group, who all responded to medical management.

Fasciocutaneous Parascapular and Latissimus Dorsi Myocutaneous Free Flap

Of the 3 patients reconstructed with parascapular free flap, only 1 (33.3%) required prolonged tracheostomy while all 3

Table 1. Gastrostomy tube dependence 1 year following surgery.

Gastrostomy Tube Dependence (%)	All Patients (n = 94)	Salvage (n = 58)	Primary (n = 36)
All flaps	71.30	87.90	44.40
By flap:			
PMM	68.50	95	37
VRAM	71.90	89	46
RFFF	71.40	79	57
Parascapular	100	100	n/a
Latissimus	66	66	n/a

Abbreviations: PMM, pectoralis major myocutaneous; VRAM, rectus myocutaneous free flap; RFFF, radial forearm free flaps.

Table 2. Tracheostomy dependence at 1 year from time of surgery.

Tracheostomy Dependence	All Patients (n = 94)	Salvage (n = 58)	Primary (n = 36)
All flaps	15.90	22.40	5.50
By flap:			
PMM	14.20	26	0
VRAM	18.80	21	15
RFFF	10	14	0
Parascapular	33	33	0
Latissimus	33	33	0

Abbreviations: PMM, pectoralis major myocutaneous; VRAM, rectus myocutaneous free flap; RFFF, radial forearm free flaps.

(100%) patients required prolonged gastrostomy tube. None of the 3 patients were able to tolerate oral intake even for pleasure and all were subjected to preoperative radiation. Of the 3 patients reconstructed with latissimus dorsi myocutaneous free flap, 1 (33.3%) required prolonged tracheostomy, and 2 (66.7%) patients required prolonged gastrostomy without any tolerance for oral intake. All had received preoperative radiation. There were no cases of pneumonia, seroma, or infection in the parascapular and latissimus groups.

Gastrostomy Tube Dependence

Oral intake sufficient to maintain caloric requirement without gastric tube was possible in 27 of 94 patients (29%). While the overall majority of patients required prolonged gastrostomy tube, this was not the case when excluding those with preoperative radiation (**Table 1**). Rates of gastric tube independence for primary surgery followed by postoperative radiation versus primary radiation followed by surgical salvage were 56% and 11%, respectively. The majority of patients treated with primary surgery and postoperative radiation were able to achieve gastric tube independence and maintain adequate per oral intake. When comparing flap selection and overall gastric tube dependence rate, we found no significant difference between groups ($P = .906$).

Tracheostomy Dependence

Tracheostomy was continued primarily for patients found to be at high aspiration risk. Tracheostomy decannulation was

possible in 79 of 94 (84%) patients. Patients treated with primary radiation followed by salvage surgery were found to have a greater trend toward having prolonged tracheostomy dependency (see **Table 2**). In the 6 patients who underwent partial supraglottic laryngectomy, all but 1 patient had permanent tracheostomy and all were gastric tube dependent at the time of publication. However, this subgroup was able to achieve good speech intelligibility with adequate management of pharyngeal secretions as determined by FEES. No patients required conversion to total laryngectomy. Again, when comparing flap selection to overall tracheostomy dependence, we found no significant difference between groups ($P = .521$).

Discussion

Defects resulting from total glossectomy are associated with significant morbidity. While aesthetic outcomes are important, functionality of the reconstruction deserves the highest priority in terms of flap selection with the aim of achieving eventual tracheostomy and gastric tube independence and optimizing speech.

Laryngeal Preservation

Although conventional teaching advocates universal concurrent total laryngectomy in total glossectomy patients due to the concern of significant chronic aspiration, our institution's approach has shied away from this approach to minimize morbidity. The results of our study reveal a relatively low incidence of postoperative pneumonia (11.8%), and

they were all successfully managed medically. Although there was a higher incidence of postoperative pneumonia associated with RFFF reconstruction than other types of flap reconstruction, a causal relation cannot be determined due to the nature of the study design. In the setting of a relatively low pneumonia incidence seen in our patient population, it appears that universal total laryngectomy in the setting of total glossectomy is not always necessary.

We have found that our patients have a subjectively higher quality of life with preservation of their larynx. Although we do not have objective data at this time, we believe the benefit of minimizing morbidity of total laryngectomy is obvious. The challenges of vocal rehabilitation with the use of prosthesis or electrolarynx are quite significant and should be avoided when possible. Despite undergoing total laryngectomy, some total glossectomy patients will continue to have oropharyngeal impairment and demonstrate increased transit time that may still lead to gastric tube dependency.^{5,6} Further objective investigation of quality of life in these patients is warranted.

Several studies have shown that laryngeal suspension may help maintain structural integrity and prevent flap prolapse, both of which aid in swallow function preservation.^{4,7,8} Sensation preservation via conservation of the superior laryngeal nerve (SLN) may also decrease incidence of aspiration.^{6,9} We generally perform laryngeal suspension on all cases of total glossectomy with laryngeal preservation (TGLP) and aim to preserve the SLN when oncologically possible.

Flap Selection and Body Habitus

Paramount to total glossectomy reconstruction is adequate tissue bulk of neo-tongue (see **Figure 1**). Sufficient bulk is needed to allow tissue apposition and propulsion of food toward oropharynx during the oral swallowing phase. Existing patient body habitus is a pivotal component in selecting the ideal flap for reconstruction. As such, selection of donor flap is not performed until the glossectomy defect has been created with negative margins. Intraoperatively, the most likely flap donor sites are prepped out in anticipation of its use.

In thin patients, VRAM are typically preferred flaps, however if the size and bulk of pectoralis and VRAM flaps are matched, there does not appear to be a benefit of free flap coverage over pedicled myocutaneous flaps, in our experience. Anterolateral thigh (ALT) free tissue flaps are another viable option for these patients. Contrastingly, obese patients may possess overly abundant adipose tissue in their donor chest or abdomen site. As such, if sufficient subcutaneous soft tissue bulk is present in the versatile RFFF, then this flap may be selected. Careful examination of body habitus and adipofascial bulk present at the flap donor site can help guide clinicians in selecting the ideal flap for total glossectomy defect reconstruction.

Worth noting is the disproportionately high rate of RFFF and pedicled PMM flaps in this study population compared to other institutions. It is our experience that patients

exhibiting sufficient tissue in these particular areas receive appropriate reconstruction and function. The emphasis of appropriate PMM flap selection is based on the adipose component, as the muscle component is expected to atrophy. We typically do not perform ALT flaps due to surgeon preference, although ALT can be an excellent choice in select patients for reconstruction of glossectomy defects given the abundant subcutaneous tissue and minimal donor site morbidity.^{10,11}

Tissue Bulk and Flap Inset

The impact of tongue bulk on swallowing function is well documented in literature.³⁻⁵ The positioning of flap inset is also crucial in total glossectomy reconstruction. Engel et al underscored the importance of a strategic approach to improving functional outcomes in glossectomy patients. In their study only a small portion of the patients had total glossectomy defects, but nonetheless the significance of flap selection is stressed.¹² Various methods have been described for increasing the vertical height during flap inset in order to improve contact with the hard palate. Patients with protuberant or semi-protuberant rectus flaps have been observed with improved propulsion of food bolus toward the posterior oropharynx.⁴ Independent of the type of flap employed, attention should focus on the vertical height with measures taken to re-create normal oral cavity and pharyngeal mechanics. This should be done keeping in mind tissue shrinkage that occurs after flap harvest and prior to inset.¹³

The use of muscle only flaps should be reserved for when tissue innervation is planned. Void of neural input, muscle only flaps will continue to atrophy. Despite initial restoration of volume, the atrophied flap over time often leads to inadequate palatal opposition and swallow dysfunction.³ One must also account for muscle atrophy and radiation-induced fibrosis that can occur in flaps with significant muscle component. Thus, slightly larger size flap harvest is recommended to ensure adequate contact between neo-tongue and surrounding pharyngeal and palatal tissues.

Pedicled Versus Free-Tissue Flaps

Although advances in microsurgery have vastly increased the reconstructive surgeon's armamentarium for oral reconstruction, there is still a role for pedicled flaps. The PMM flap remains a viable option for reconstruction of floor of mouth and tongue defects. It can be especially useful in patients with significant medical risks or lacking ideal donor free flaps. We found no significant difference, when PMM was appropriately selected, between tracheostomy or gastric tube dependence rates compared to free flap groups. Furthermore, we have found the flap to provide a reliable skin paddle when needed, eventual acceptable contour, and acceptable donor site morbidity in men and women.

Airway and Aspiration

A common reason for failure of decannulation is persistent significant aspiration in patients undergoing glossectomy. Several studies have shown rates of decannulation to be

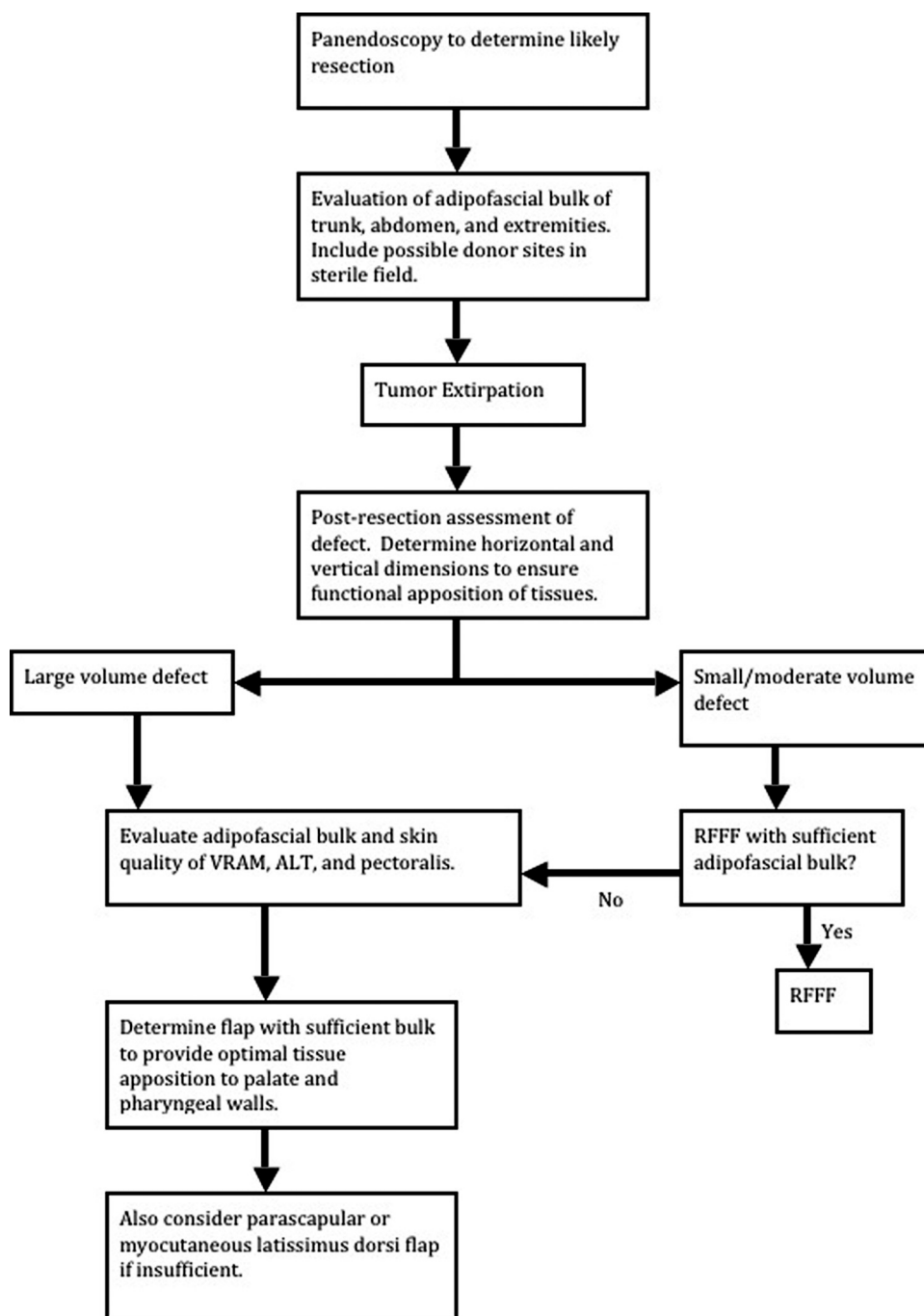


Figure 1. Algorithm for flap selection in total glossectomy with laryngeal preservation defect.

85% to 100% in patients undergoing TGLP.^{1,4-6,14,15} In the series of 21 patients by Miyamoto, no patients required conversion to total laryngectomy,¹⁶ which is consistent with our results. Our patients underwent decannulation at a similar rate of 84% with successful tracheostomy removal. This finding lends greater support to avoiding universal total laryngectomy in total glossectomy patients and considering laryngeal preservation whenever oncologically possible. Kimata et al reviewed 30 patients with total glossectomy defects and noted 30% proceeded to decannulation with laryngeal preservation. In their study, cerebral dysfunction,

resection of the epiglottis, and postoperative orocutaneous fistulas were associated with failure of laryngeal preservation.¹⁷ In the presented study the majority of epiglottis was preserved when laryngeal preservation was considered. Patients who had concurrent partial supraglottic resection had a relatively high tracheostomy and gastric tube dependence when compared to those without any supraglottic resection, suggesting an increased risk of dysfunction in total glossectomy patients with partial supraglottic resection.

Risk factors for aspiration have been identified as age (>70 years), low BMI (<18.5 kg/m²), and postoperative

radiation therapy.¹⁶ We suspect that low BMI may contribute to increased aspiration secondary to decreased adipofascial bulk, which may compromise optimal oral swallowing phase due to the loss of volume and improper neo-tongue and palate contact. Selecting an adequate flap to maintain sufficient tongue bulk long-term is crucial. Unfortunately, BMI data were not available for all patients in this series; however, future correlation between BMI and flap selection would be worthwhile for future research.

Swallowing dysfunction, gastric tube dependency, and aspiration risks are likely related. Rates of gastrostomy tube dependence range from 14% to 70% in total glossectomy patients with laryngeal preservation.^{1,5,14,15,18,19} Gastric independence was achieved in only 29% of patients although a slightly greater number of patients were able to tolerate per oral intake for pleasure. Interestingly, this study suggests that preoperative radiation therapy patients had a notably higher rate of gastric tube dependency status when compared to primary surgery and postoperative radiation therapy patient group (11% vs 56%). Thoughts behind the discrepancy between salvage versus primary surgery patients include lower functional status at the time of surgery, longer time to initiation of swallowing, and more aggressive tumors with larger defects when comparing the 2 groups. Additionally, it may be related to radiation-induced recipient site dysfunction leading to a higher incidence of minor complications.^{20,21}

Conclusion

Total glossectomy defects remain a challenging reconstruction task for surgeons. TGLP is an option with good functional outcomes in select total glossectomy patients, saving them the additional morbidity of laryngectomy with a relatively low rate of postoperative pneumonia complication. Determining the best method of reconstruction hinges on restoring form and function of neo-tongue. Use of myocutaneous or fasciocutaneous free flaps is an ideal method of choice when applicable and provides long-term tissue bulk required for optimal palatal apposition and swallow function. Pedicled pectoralis myocutaneous flap also is a viable option when selecting the flap for its adipose tissue volume. Selecting an ideal flap for reconstruction of total glossectomy defects should be patient specific and based on matching donor flap bulk. This treatment approach demonstrates high tracheostomy and gastric tube independence.

Author Contributions

Jordan Rihani, data acquisition and manuscript preparation; **Michael R. Lee**, data acquisition and manuscript preparation; **Thomas Lee**, data acquisition and manuscript review; **Yadranko Ducic**, manuscript concept, design, and review.

Disclosures

Competing interests: None.

Sponsorships: None.

Funding source: None.

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