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Comprehensive Analysis of Functional Outcomes and Survival After Microvascular Reconstruction of Glossectomy Defects

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ABSTRACT

Background. Few studies on tongue reconstruction provide a comprehensive, multidisciplinary analysis examining defect size, flap selection, function, and long-term survival. This report presents the largest study in the literature evaluating free flap reconstruction after glossectomy.

Methods. A retrospective review of patients undergoing free flap glossectomy reconstruction from 2000 to 2012 was performed.

Results. In this review, 268 patients were identified. Resections involving the tongue only included 59 partial glossectomies, 86 hemiglossectomies, 28 subtotal glossectomies, and 24 total glossectomies. Glossectomies performed with mandibulectomies were analyzed independently for speech and swallowing function (32 partial glossectomies, 18 hemiglossectomies, 8 subtotal glossectomies, and 13 total glossectomies with mandibulectomy). A total of 299 free flaps were performed, with 30 patients receiving two free flaps. Multivariate analysis demonstrating smoking ($p = 0.018$), composite resections ($p < 0.001$), and larger resections (total and subtotal glossectomies; $p < 0.001$) were associated with significantly worse speech results. Advanced age ($p = 0.002$), radiation ($p = 0.003$), and larger or composite resections had significantly worse swallowing function ($p < 0.001$). Patients with a persistent tracheostomy had significantly worse speech and swallowing function ($p < 0.001$), whereas innervated flaps were associated with superior speech ($p = 0.049$) and better swallowing function ($p = 0.004$). The surgical complication rate was 23.5 %, with only one total flap loss. Tumor stage ($p = 0.003$), positive margins ($p < 0.001$), lymphovascular invasion ($p = 0.023$), and chemotherapy ($p < 0.001$) were associated with significantly worse overall survival. The median overall survival time was 50.5 months (range 39–79 months).

Conclusions. Although comorbidities and the extent of resection impair both speech and swallowing, reconstruction, particularly with innervated free flaps, still affords the majority of patients' reasonable function.

Resection of the tongue for malignancy is a debilitating operation that can dramatically impair speech and swallowing function.[1,2] More recent experience suggests that functional outcomes have improved, especially with continued refinement of microvascular free flap tongue reconstruction.[3–5] However, literature correlating outcomes that control for both the range of potential glossectomy defects and the specific flap used for reconstruction are relatively sparse.

We hypothesized that the extent of glossectomy and reconstructive flap choice have an impact on long-term functional outcomes. Therefore, we evaluated speech and swallowing after microvascular free flap tongue reconstruction based on the location and extent of the glossectomy defect. We also aimed to identify factors that may impair or improve function to provide an algorithm for reconstruction. Finally, we evaluated patient survival because a poor oncologic prognosis often is used as an argument against performing complex reconstructions in head and neck cancer patients, particularly those with extensive disease.

METHODS

Patients

All patients undergoing microvascular free flap reconstruction after glossectomy between January 2000 and December 2012 were retrospectively reviewed after

Institutional Review Board approval. The authors (E.I.C., P.Y., R.J.S., and M.M.H.) performed 268 of these reconstructions, with precise documentation of the defect, and used a similar method of reconstruction. Staging was determined on the basis of dictated tumor-node-metastasis (TNM) staging and included for analysis. Innervation of flaps was completed with coapting of the remaining stump of the lingual nerve to a cutaneous sensory nerve of the flap whenever a stump was available. A subset of patients was evaluated with Semmes–Weinstein filament testing to confirm return of sensation in innervated flaps. Patients who had glossectomies performed in conjunction with a laryngectomy were excluded from the study because speech and swallowing outcomes were not comparable with those of patients who had an intact larynx.

Defect Assessment

Partial glossectomy defects were defined based on quadrants (types 1–4) encompassing at least 25 % but less than 50 % of the oral and/or base of tongue volume. A fifth subset of partial glossectomy defects (type 5) involved resection of the ventral surface. Hemiglossectomy defects (type 6) encompassed at least 50 % but less than 75 % of the oral and base of the tongue. Subtotal glossectomy defects (type 7) included the entire oral tongue and at least half of the base of the tongue (i.e., more than 75 % of the tongue). Total glossectomy defects (type 8) encompassed the entire oral and base of the tongue (Fig. 1). Patients undergoing a mandibulectomy concurrent with the glossectomy were noted and analyzed independently.

Functional Assessment

Speech and swallowing function were evaluated based on previously described systems.[3,6–8] Briefly, postoperative speech and swallowing functions were assessed by a certified speech-language pathologist. Speech intelligibility was defined as the percentage of words understandable to the speech therapist, who assigned a percentage score as the patient read a standardized passage.[6–8] The following numeric scale was used: 4 (>80 % intelligible) 3 (50–80 % intelligible), 2 ($\leq$50 % intelligible), 1 (unintelligible), and 0 (inability to speak).

All the patients underwent a modified barium swallow in the swallow therapy department, which determined patients able to tolerate an oral diet without risk of aspiration. All the patients were typically started with thick liquids and then advanced to a soft/pureed diet and ultimately to a regular diet if possible under the supervision of the
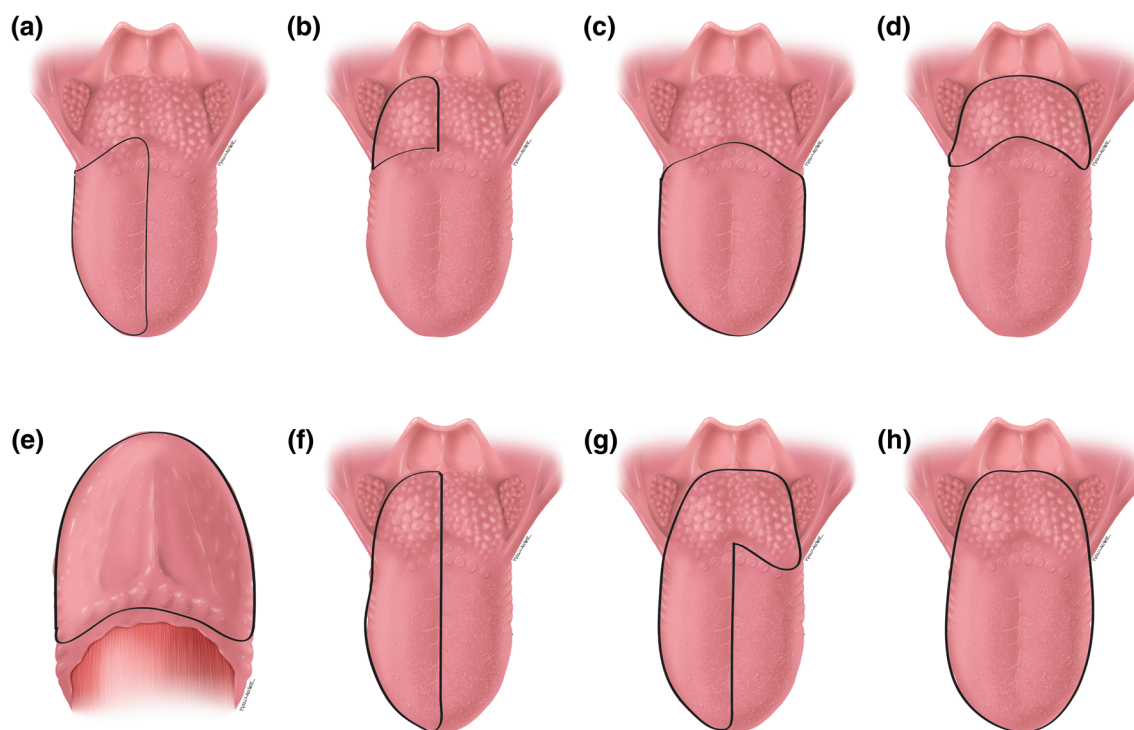

FIG. 1 Pictorial representation of defects to define the extent of tongue resected. **a** Partial glossectomy involving half the oral tongue (type 1). **b** Partial glossectomy involving half the base of the tongue (type 2). **c** Partial glossectomy involving the oral tongue with preservation of base of the tongue (type 3). **d** Partial glossectomy defect involving the base of the tongue with preservation of the oral tongue (type 4). **e** Partial glossectomy involving the ventral tongue (type 5). **f** Hemiglossectomy (type 6). **g** Subtotal glossectomy (type 7). **h** Total glossectomy (type 8)

therapist. Swallowing function was therefore estimated based on the type of diet tolerated, as previously described: 4 (regular, unrestricted) diet, 3 (soft diet), 2 (pureed or liquid diet), 1 (oral diet requiring tube feed supplementation), and 0 (tube-feed dependency).[6–8]

Statistical Analysis

Uni- and multi-variate logistic regression models were used to test the association between complication rate and various patient characteristics. The Wilcoxon rank-sum and Kruskal–Wallis tests were used to compare speech and swallow scores among glossectomy defect groups, respectively. Scores are reported as mean ± standard deviation. Analysis of variance (ANOVA) was used to evaluate the effect of patient and surgical variables on functional scores. A stepwise model selection method was used to construct the most parsimonious model. The Kaplan–Meier method was used to estimate the 5-year overall survival rate, and a long-rank test was used to compare survival between defect types. All the tests were two-tailed, with p values lower than 0.05 considered significant. Analyses were performed using SAS 9.2 (SAS Institute Inc., Cary, NC, USA).

RESULTS

Patients

The study population consisted of 176 men (65.7 %) and 92 women (34.3 %) with a mean age of 55.2 years (range 19–83 years) (Table 1). Tumor stages were distributed as follows: T1 (15 patients, 5.6 %), T2 (56 patients, 20.9 %), T3 (80 patients, 29.9 %), and T4 (75 patients, 28 %). Using the TNM system, 11 patients were classified as stage 1, 30 patients as stage 2, 69 patients as stage 3, and 118 patients as stage 4. An additional 35 patients (13.8 %) had recurrent or second primary tongue cancers, and the staging was not documented for 5 patients.

Overall, 299 flaps were performed for the 268 patients, with 30 patients receiving two free flaps (Table 2). One patient underwent free flap reconstruction after a partial glossectomy and experienced recurrent disease requiring a second free flap. Overall, innervation was confirmed in 39 patients using the Semmes–Weinstein filament test, including 9 patients with partial glossectomies, 12 with hemiglossectomies, 10 with subtotal glossectomies, and 8 with total glossectomy defects.

Composite Mandibulectomy Resection and Glossectomy

A total of 29 patients underwent a simultaneous fibula osteocutaneous (FOC) free flap and a soft tissue free flap for

TABLE 1 Patient characteristics ($n = 268$ patients)

Characteristic	No. of patients n (%)
Age ≥60 years	109 (40.7)
Prior surgery (glossectomy)	8 (3.0)
Average BMI: kg/m^2 (range)	23.9 (14–62)
Radiation therapy	
Preoperative	70 (26.1)
Postoperative	161 (60.1)
Pre and postoperative	11 (4.1)
Tobacco use	194 (72.4)
Alcohol abuse	96 (35.8)
Medical comorbidities	
Hypertension	126 (47.0)
Coronary artery disease	28 (10.4)
Diabetes	29 (10.8)
Hypothyroidism	38 (14.2)
Peripheral vascular disease	19 (7.1)
Chronic obstructive pulmonary disease	13 (4.9)
Obesity	28 (10.4)

BMI body mass index

reconstruction of a composite mandible and tongue defect. One patient with peripheral vascular disease underwent a deep circumflex iliac artery (DCIA) osteocutaneous flap with an anterolateral thigh (ALT) for reconstruction of a segmental mandible defect and hemiglossectomy. Composite mandibulectomy resections with a partial or hemiglossectomy defect were reconstructed with a free FOC flap for the mandibular defect, whereas the tongue was reconstructed with a forearm free flap, ALT flap, or the skin paddle of the FOC free flap. In the setting of larger tongue resections, an ALT myocutaneous free flap ($n = 12$) or RAM free flap ($n = 1$) was used for the tongue, whereas the fibula was used to reconstruct the mandible. Two patients underwent an FOC free flap that included a significant portion of the soleus muscle to reconstruct the mandible and glossectomy defect. Overall, 44 patients underwent a bony reconstruction for a composite mandibulectomy and glossectomy defect, whereas 27 patients received a soft tissue reconstruction for a mandibulectomy and glossectomy defect due to sacrifice of the condyle.

Speech

Multivariate analysis for factors that have an impact on speech function demonstrated that smoking (nonsmokers 3.52 vs. smokers 3.16; $p = 0.018$) significantly impaired speech function. A trend toward worse function was observed with radiation ($p = 0.064$), advanced age (>60 years) ($p = 0.056$), and alcohol use ($p = 0.062$). However, improved speech was demonstrated by the

TABLE 2 Flap selection based on glossectomy defect ($n = 268$ patients)

Glossectomy defect					
Free flap	Partial	Hemi-	Subtotal	Total	All patients n (%)
Without mandibulectomy					
ALT	19	40	24	15	98 (36.6)
RFF	25	31	–	1	57 (21.3)
UAP	13	12	1	–	26 (9.7)
RAM	–	–	1	5	6 (2.2)
Lateral arm	1	3	1	–	5 (1.9)
Gracilis	–	–	1	3	4 (1.5)
ALT and RFF	1	–	–	–	1 (0.37)
With mandibulectomy					
ALT	15	3	1	2	21 (8.4)
RFF and PMMC	–	–	–	1	1 (0.37)
Lateral arm	1	–	–	–	1 (0.37)
RAM	1	1	–	2	4 (1.5)
FOC	10	2	2	–	14 (5.2)
FOC and RFF	1	1	–	–	2 (0.75)
FOC and ALT	4	9	5	7	25 (9.3)
FOC and RAM	–	–	–	1	1 (0.37)
FOC and freestyle	1	–	–	–	1 (0.37)
DCIA and ALT	–	1	–	–	1 (0.37)

ALT anterolateral thigh, *RFF* radial forearm fasciocutaneous, *UAP* ulnar artery perforator, *RAM* rectus abdominis myocutaneous, *PMMC* pectoralis major myocutaneous, *TUG* transverse upper gracilis myocutaneous *FOC* fibula osteocutaneous, *DCIA* deep circumflex iliac osteocutaneous

patients who received innervated flaps (innervated, 3.51) compared with those who received noninnervated flaps (noninnervated, 3.18) ($p = 0.049$).

Analysis of different partial glossectomy defects (types 1–5) did not demonstrate any significant differences in speech function between the different partial glossectomy subtypes ($p = 0.67$). For analysis, partial glossectomy types 1–5 were grouped together to compare hemiglossectomy, subtotal glossectomy, and total glossectomy defects. Patients undergoing any partial glossectomy (types 1–5, 3.59) or hemiglossectomy (type 6, 3.74) had significantly superior speech function compared with patients who underwent a subtotal glossectomy (type 7, 3.14) or total glossectomy (type 8, 2.42) ($p < 0.001$). Finally, the presence of a tracheostomy (3.48 vs. 1.57; $p < 0.001$) or a mandibulectomy (3.45 vs. 2.81) was associated with significantly worse speech function ($p < 0.001$).

Subgroup Analysis of Speech

Subgroup analysis of patients who had received innervated flaps or had undergone reconstruction of a composite mandibulectomy and glossectomy reconstruction demonstrated the innervation had a significant impact on hemiglossectomy reconstruction only (3.89 vs. 3.42; $p = 0.011$). However, all the innervated flaps showed superior speech function compared with noninnervated flaps, but the results were not statistically significant (Table 3). Only those patients who underwent a combined hemiglossectomy with mandible resection demonstrated significantly impaired speech compared with those who had isolated hemiglossectomy (3.74 vs. 2.78; $p < 0.001$). Although the remaining types of glossectomy defects all showed worse function with a composite resection, the difference was not statistically significant (Table 4). Comparison of bony reconstruction with soft tissue flap reconstruction did not demonstrate any significant different in speech function ($p = 0.69$).

Swallowing

Multivariate analysis of swallowing showed that the significant risk factors for worse swallowing function were age of 60 years or older (1.67 vs. 2.30; $p = 0.002$) and radiation (1.95 vs. 2.86; $p = 0.003$). Similarly, patients who received innervated flaps had superior swallowing outcomes compared with patients who received noninnervated flaps (2.52 vs. 1.85, respectively; $p = 0.004$).

TABLE 3 Speech function comparing sensate and nonsensate flaps (n = 268 patients)

Bold value indicates statistical significance at p < 0.05

Defect type	Innervated (n = 79)	Noninnervated (n = 189)	p value
Partial (1–5)	3.59 ± 1.00 (n = 17)	3.44 ± 1.14 (n = 74)	0.584
Hemi- (6)	3.89 ± 0.53 (n = 35)	3.42 ± 1.16 (n = 69)	**0.011**
Subtotal (7)	3.20 ± 1.37 (n = 15)	2.71 ± 1.55 (n = 21)	0.287
Total (8)	2.67 ± 1.44 (n = 12)	2.20 ± 1.76 (n = 25)	0.481

TABLE 4 Speech function comparing glossectomy alone with glossectomy and concurrent mandibulectomy (n = 268 patients)

Bold value indicates statistical significance at p < 0.05

Defect type	Glossectomy alone (n = 197)	Glossectomy with mandibulectomy (n = 71)	p value
Partial (1–5)	3.59 ± 1.01 (n = 59)	3.25 ± 1.27 (n = 32)	0.154
Hemi- (6)	3.74 ± 0.75 (n = 86)	2.78 ± 1.59 (n = 18)	**<0.001**
Subtotal (7)	3.14 ± 1.33 (n = 28)	2.13 ± 1.81 (n = 8)	0.145
Total (8)	2.42 ± 1.74 (n = 24)	2.23 ± 1.54 (n = 13)	0.717

TABLE 5 Swallowing function comparing sensate and nonsensate flaps (n = 268 patients)

Bold values indicate statistical significance at p < 0.05

Defect type	Innervated (n = 79)	Noninnervated (n = 189)	p value
Partial (1–5)	2.71 ± 1.49 (n = 17)	2.19 ± 1.63 (n = 74)	0.293
Hemi- (6)	3.14 ± 1.09 (n = 35)	2.13 ± 1.70 (n = 69)	**0.009**
Subtotal (7)	2.33 ± 1.59 (n = 15)	0.91 ± 1.27 (n = 21)	**0.007**
Total (8)	0.92 ± 1.53 (n = 12)	0.67 ± 1.30 (n = 25)	0.647

TABLE 6 Swallowing function comparing glossectomy alone with glossectomy and concurrent mandibulectomy (n = 268 patients)

Bold values indicate statistical significance at p < 0.05

Defect type	Glossectomy alone (n = 197)	Glossectomy with mandibulectomy (n = 71)	p value
Partial (1–5)	2.61 ± 1.52 (n = 59)	1.76 ± 1.64 (n = 32)	**0.016**
Hemi- (6)	2.74 ± 1.46 (n = 86)	1.17 ± 1.58 (n = 18)	**<0.001**
Subtotal (7)	1.72 ± 1.58 (n = 28)	0.63 ± 1.19 (n = 8)	**0.049**
Total (8)	1.00 ± 1.50 (n = 24)	0.54 ± 1.33 (n = 13)	0.237

Patients who underwent more extensive resections (total glossectomy, 0.83; subtotal glossectomy, 1.49) had significantly worse function than those who received only a partial glossectomy or hemiglossectomy (2.47; $p < 0.001$). Comparison of the swallowing functions associated with partial glossectomy defects also did not demonstrate any significant differences between the different partial glossectomy subtypes ($p = 0.18$). Additionally, a combined mandibulectomy and glossectomy demonstrated significantly worse function than a glossectomy alone (1.26 vs. 2.23; $p < 0.001$). The presence of a tracheostomy significantly impaired swallowing function (0.36 vs. 2.25; $p < 0.001$).

Subgroup Analysis of Swallowing Function

Analysis of innervation as an independent variable for swallowing function demonstrated that innervation provided significantly superior swallowing for hemiglossectomy ($p = 0.009$) and subtotal glossectomy ($p = 0.007$) defects,

but the difference was not significant in partial or total glossectomy reconstruction (Table 5) Significantly worse outcomes were demonstrated by patients undergoing partial glossectomy ($p = 0.016$), hemiglossectomy ($p < 0.001$), or subtotal glossectomy in conjunction with mandibulectomy ($p = 0.049$) than those who had isolated glossectomies. Although the swallowing function for a combined mandibulectomy and total glossectomy was worse, the difference was not significant (0.54 vs. 1.00; $p = 0.237$, Table 6). Analysis of a bony reconstruction for a composite defect versus a soft tissue flap demonstrated no significant impact on overall swallowing function ($p = 0.45$).

Complications

Overall, 53 patients (23.6 %) sustained perioperative surgical complications within 30 days after surgery. Among these patients, 45 had complications involving the recipient site, 6 had donor-site complications, and 1 experienced complications at both the recipient and donor

sites. There was one total flap loss secondary to venous congestion of an ALT flap for a subtotal glossectomy defect, which was ultimately reconstructed with a pedicled pectoralis myocutaneous flap. Although the patient had minimal difficulty speaking (score, 3), she required supplemental tube feeding (score, 1).

Univariate logistic regression analysis of the patient characteristics listed in Table 1 did not demonstrate any significant association with the development of complications. None of the patients required a subsequent laryngectomy for chronic aspiration. Overall, 88.4 % of the patients were decannulated. Decannulation was not performed for 26 patients due to recurrent disease ($n = 18$), death before decannulation ($n = 5$), heavy respiratory secretions ($n = 2$), and severe lymphedema precluding decannulation ($n = 1$).

Survival

The mean follow-up time was 29 months (range 1–111 months). At the last follow-up assessment, 133 patients (49.6 %) were alive with no evidence of disease, 91 patients (34 %) had died of disease, 15 patients (5.6 %) were living with disease, and 28 patients (10.4 %) had died of other causes. One patient was lost to follow-up evaluation. The median survival time was 50.5 months [confidence interval (CI), 39–79 months]. No significant differences in survival were observed between the different subsets of partial glossectomy defects (types 1–5) (Fig. 2a). The 5-year survival rate was 48 % (CI, 41–56 %). Given the comparable survival rate for partial glossectomy defects (types 1–5), we grouped all partial glossectomy defects together for comparison with other defects (types 6–8) (Fig. 2b). After grouping of all partial glossectomy defects together, the 5-year survival rates were 57 % for partial glossectomy, 52 % for hemiglossectomy, 49 % for subtotal glossectomy, and 23 % for total glossectomy ($p < 0.001$). Survival based on tumor staging demonstrated worse overall survival for patients with more advanced disease ($p = 0.003$).

Other factors that also had a significant impact on survival were positive margins ($p < 0.001$) and lymphovascular invasion ($p = 0.023$). Neither tumor grade ($p = 0.61$) nor histology ($p = 0.14$) affected overall survival, and although the presence of perineural invasion demonstrated worse survival, the difference did not reach statistical significance ($p = 0.099$). Patients who had chemotherapy also demonstrated worse survival than patients who did not undergo chemotherapy ($p < 0.001$). Patients who underwent a composite resection had significantly worse 5-year survival (31.3 %) than patients who underwent glossectomy alone (54 %) ($p = 0.02$, Fig. 2c).

DISCUSSION

To our knowledge, the current study represents the largest series of microvascular glossectomy reconstructions reported to date. Whereas other studies advocate one type of flap or technique, few address reconstruction based on the specific type of defect. Perhaps most importantly, the current study attempted to differentiate between partial, hemi-, subtotal, and total glossectomies, and also analyzed the effect of combined tongue and mandibular resection on overall function and survival.

Not surprisingly, we found better overall speech and swallowing function for partial glossectomy and hemiglossectomy defects than for subtotal or total glossectomy. Our hypothesis that partial glossectomy defects have an impact on function was proven to be wrong because speech and swallowing function were equivalent among the partial glossectomy subtypes. Overall, defect size rather than location was found to be the more critical factor, but even larger defects could be reconstructed with acceptable postoperative function for many of our patients.[9]

The aforementioned findings may be a reflection of refinements and advances in microvascular reconstructive techniques together with a multidisciplinary approach involving head and neck surgeons, reconstructive surgeons, radiation oncologists, speech and swallow therapists and nutritionists providing appropriate rehabilitation and strong patient motivation. Consequently, we can restore relatively good speech and swallowing not only for smaller defects but also for larger defects. For example, the average speech and swallowing scores for patients with subtotal glossectomy defects were respectively 3.20 and 2.33, indicating that most patients were able to speak with more than 50 % intelligibility and could tolerate a liquid or pureed diet.

Previous studies also have examined free flap reconstruction of glossectomy defects, but unfortunately, most have reported small numbers of subjects, inconsistent classification of the defect, and a short follow-up period, limiting the strength and utility of those studies.[10–16] In this report, we present our algorithmic approach to tongue reconstruction similar to that in some other studies.[4] In general, partial glossectomy or hemiglossectomy defects were preferentially reconstructed with a thin, pliable flap typically based on the upper extremity (radial forearm, ulnar artery perforator, lateral arm) or an ALT fasciocutaneous perforator flap. An ALT myocutaneous free flap or another bulky flap such as a transverse upper gracilis (TUG) myocutaneous free flap or a rectus abdominus myocutaneous (RAM) free flap was chosen in the setting of a subtotal or total glossectomy defect. The ALT flap was the most commonly used flap due to its versatility because it could be harvested as a thin perforator fasciocutaneous
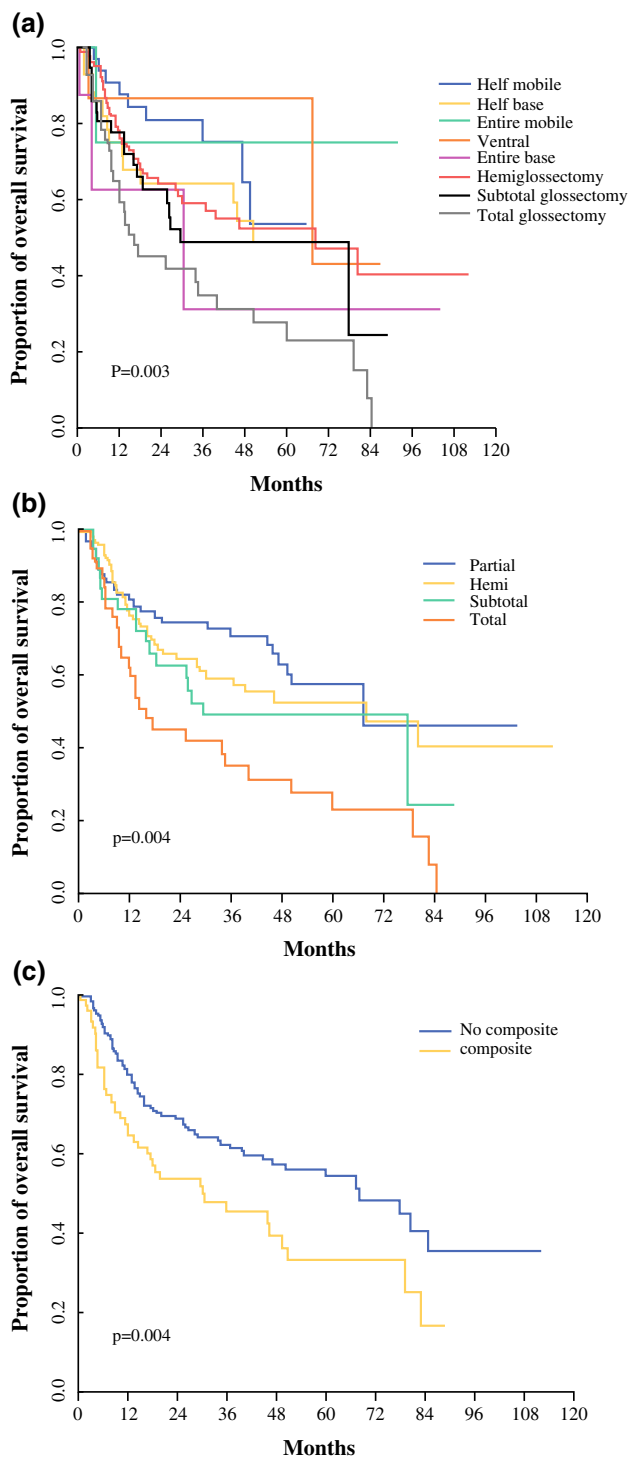
FIG. 2 Kaplan-Meier survival curves for patients with **a** various types of glossectomy, **b** combined partial glossectomy defects compared with hemiglossectomy, subtotal glossectomy, and total glossectomy defects, and **c** glossectomy alone versus glossectomy with composite mandibular resection

free flap for partial glossectomy or hemiglossectomy reconstruction and as a bulky myocutaneous free flap for subtotal or total glossectomy reconstruction.

Although our algorithm includes multiple flap choices, the decision to use a particular flap is dependent on a number of factors including surgeon comfort and preference as well as available donor sites, taking into account the patients' body habitus. In general, a thin pliable flap is recommended for smaller defects, whereas thicker, bulkier flaps are needed to replace the volume of larger resections to optimize postoperative speech and swallowing function. For example, more than 10 % of our patients were obese [body mass index (BMI) range 14–62 kg/m^2] which allowed the use of a flap from the upper extremity for reconstruction of larger defects.

Composite glossectomy and mandibular defects were shown to have worse overall functional outcomes and survival. However, comparison of composite resections based on the type of glossectomy only demonstrated a significant difference with hemiglossectomy defects. This may suggest that a partial glossectomy would have reasonable function even in the setting of a composite resection, whereas a subtotal or total glossectomy would be more debilitating regardless whether a mandibulectomy is performed or not.[17–20]

Despite the worse outcomes demonstrated with larger or composite resections, we showed that many patients still are able to achieve reasonably intelligible speech and swallowing even in the setting of a composite resection in which two free flaps are necessary to reconstruct the defect. Furthermore, nearly one fourth to one third of patients undergoing more extensive resections still are alive at 5 years, suggesting that reconstruction for these patients with more advanced disease still is worthwhile in terms of restoring patients' speech and swallowing and optimizing their quality of life. Although a number of pathologic factors such as margin status and lymphovascular invasion were associated with worse survival, they did not have an impact on speech or swallowing function. The finding that chemotherapy was associated with worse survival likely was a reflection of more advanced disease rather than causality. However, these factors should be discussed with patients so they can be counseled appropriately regarding their prognosis.

Reinnervation of the free flaps has been controversial in some studies that have demonstrated promising results with improved sensation and tactile discrimination.[21–23] We have previously demonstrated a functional benefit with reinnervation of our ALT free flaps similar to other studies demonstrating the benefits of innervated flaps.[24,25] Santamaria et al.[26] have further demonstrated that the lingual or inferior alveolar nerve should be the recipient nerve of choice to achieve the optimal reconstruction. Despite conflicting results reported in literature, our series indicated that both speech and swallowing function were significantly improved with innervated flaps, so the use of innervating flaps has become routine in our practice.

Cutaneous sensory nerves are readily available with our most commonly used flaps, including the ALT (lateral femoral cutaneous), RFF (lateral antebrachial cutaneous), UAP (medial antebrachial cutaneous), and lateral arm free flaps (radial sensory branch). In our previous series of 13 patients, we documented return of sensation using the Semmes–Weinstein filament, which translated into superior function after reconstruction. Taken in conjunction with the findings of the current larger study, we recommend performing an innervated flap whenever a stump of the lingual nerve is available because this has a significant beneficial impact on postoperative function. Although our previous study demonstrated that sensation is delayed in patients receiving postoperative radiation, innervation still was found to be an independent factor improving function in multivariate analysis regardless of radiation. Performing a neurorrhaphy is a simple procedure that does not dramatically increase ischemia or operative time but could provide a marked benefit to the patient's ultimate function and quality of life.[27,28]

In this study, postoperative complications developed in nearly one fourth of the patients. However, our series had only one total flap loss reconstructed with a pectoralis myocutaneous flap. Certainly, pedicle flaps also can be used for reconstruction of glossectomy defects, but we tend to reserve pedicle flaps for salvage cases.[28–30] Although our algorithm is specific for free flaps, we fully concede that flap selection should be based on surgeon comfort, expertise, and available equipment and resources. Regardless of the reconstructive method used, postoperative function and quality of life can be improved with appropriate reconstruction. Given the median survival time of more than 4 years, with nearly half of the patients alive at 5 years, we recommend resection and reconstruction even for larger glossectomy defects because many patients are able to achieve reasonable speech and swallowing function.

CONCLUSIONS

Larger tongue defects and composite resections result in a worse functional prognosis, whereas, overall, innervation improved speech and swallowing function. Using thin, pliable flaps for partial glossectomy and hemiglossectomy reconstruction and bulky flaps for subtotal and total glossectomy reconstruction has acceptable risk of complications and affords most patients the potential for intelligible speech and tube-feed-free nutrition with improved quality of life and reasonable long-term survival.

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