

The comparison of the functional outcomes between primary closure and reconstruction with free flap after resection of T1 stage tongue cancer: A prospective study

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Research

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Abstract

Background: Reconstruction with free flap after the resection of tongue cancer is commonly used by craniofacial surgeons. However, it is unknown whether the reconstruction with free flap is better than the primary closure for the T1 stage tongue cancer. The objective of this prospective study is to compare the functional outcomes between these two methods.

Methods: In this prospective study, 30 patients who were diagnosed as T1 stage tongue cancer (on anterior two-third of the tongue) were randomly divided into two groups. The first group underwent the primary closure after the resection (15 patients) and the second group were reconstructed with the anterolateral perforator flap (15 patients). All patients underwent postoperative functional evaluation using specific questionnaires and a screening test with special emphasis on speech, swallowing, and tongue mobility at 1, 3, 6 and 12 months.

Results: Functional outcomes, including tongue mobility, speech, and swallowing, were all better in primary closure than anterolateral thigh flap group. At 1-month post-op, the speech understandability of the patients who received a primary closure were statistically better than those who received ALT flap ($p = 0.01$), while at 1-year post-op, there was no significant difference on speech understandability between two groups ($p = 0.16$). Statistically significant differences were found between the two groups in the swallowing capacity at all four different time periods ($p < 0.05$). For the primary closure group, tongue mobility was statistically better at all four different time periods than in ALT flap group ($p < 0.05$).

Conclusion: For the tongue cancer patients (T1), reconstruction with primary closure, rather than with flap, can reserve more functions including tongue mobility, speech and swallowing outcomes, and therefore might be the appropriate reconstruction method after partial glossectomy.

Background

Tongue cancer is the most common intraoral site cancer[1], in most of the countries with reports of incidence of 3.0 per 100,000 individuals[2][3]. But only a few numbers of studies have analyzed a larger series of tongue cancer[4]. In all SEER combined stages, the overall 5-year survival rate of tongue cancer is around 66% reported by the American Cancer Society[5]. Tongue cancers are differentiated by their size or location in the mouth and the tongue. Cancer that develops in the front two-thirds of the tongue is known as oral tongue cancer and cancer that develops in the posterior third or in the tongue base is categorized as oropharyngeal cancer (a type of head and neck cancer)[6]. Most of them occur in the anterior two-thirds of the lateral border of the tongue, followed by a body of the tongue, the tongue base and the tip of the tongue[7].

Tongue reconstruction after surgical resection plays a significant role in resuming the function of speech, articulation, and swallowing. The degree of the function restoration is not only affected by the site and size of the tumor, but also by the reconstruction methods. Owing to advancements in microsurgical techniques[8], anterolateral thigh (ALT) perforator flap is widely used for the reconstruction now-days.

However, the defect after the resection of T1 stage tongue cancer can be primarily sutured without flap. It is unknown whether ALT free flap is suitable for the reconstruction after the resection of T1 stage tongue cancer or not. The aim of study is to determine the most optimal reconstruction method for T1 tongue cancer by evaluating postoperative function based on its reconstructive options. The results of the study help the surgeon to design an optimal reconstruction method for achieving good functional outcomes.

Methods

Patients

This prospective study included 30 patients who underwent surgery of T1 stage [6] tongue carcinoma in the anterior two-thirds of the tongue treated between October 2018 to January 2020 in the Department of Oral and Maxillofacial Surgery, Xiangya Hospital of Central South University. The patients were randomly divided into two groups, and underwent simultaneous partial glossectomy and intraoral defects reconstruction with either primary closure (Group 1, n = 15) or ALT flap (Group 2, n = 15) as shown in Fig. 1. The inclusion criteria included: (1) Radio-logically and pathologically proven malignant T1 cancer i.e. the cancer is 2 cm or less at its greatest dimension, and has invaded nearby tissues to a depth of 5 mm or less; this is called depth of invasion [6], limited to the anterior two-thirds of tongue. The exclusion criteria were as follows: (1) Tumors involving the posterior third (i.e. the base of the tongue) were excluded from the study; (2) Pre-op treatment: Previous surgery of oral tongue or oropharynx cancer; (3) Pre-op treatment: Previous head and neck, chemotherapy or radiotherapy. This study was approved by the Medical Ethics Committee of the Xiangya Hospital, Central South University.

All patients underwent postoperative functional evaluation at 1, 3, 6, and 12 months. The data was analyzed by an independent sample t-test using SPSS V.25.0. Software (SPSS, Inc., Chicago, IL), and results with a two-tailed p-value < 0.05 were considered to be statistically significant.

Functional Parameters

Postoperative evaluation of speech was evaluated using the scale 0 to 3 according to the method described by Taguchi[9] in which the patient's speech was rated on a scale of (0 = speech clearly understood; 1 = speech occasionally misunderstood; 2 = speech occasionally understood; 3 = speech cannot be understood at all) according to its understandability during the conversation. Information regarding patient diet that they can swallow postoperatively was evaluated using scale (0 = can swallow normal food; 1 = can swallow soft food; 2 = can swallow liquids only; 3 = cannot swallow) according to the UW-QoL questionnaires[10] at four different time periods. Tongue mobility was assessed using the modification of the Korean Speech Mechanism Screening Test[11], which is defined to evaluate the structure and function of the tongue. We used the 'motion of tongue' section of the Korean Speech Mechanism Screening Test, for evaluation of tongue mobility. We evaluated the three different important tongue movements. Each movement was evaluated with a score of 2 = no movement; 1 = limited

movement; 0 = normal movement. The tongue mobility was defined as the sum of the 3 movement scores: 1. Protrusion: Bring the tongue out of your mouth as far as you can. Protrusive movement is the most important movement. 2. Elevation: Put the tongue tip up to the hard palate. 3. Lateralization: Move the tongue to the right and left corners of the mouth.

Results

Clinical pathologic results of patients and treatment methods

The research group as illustrated in Table 1 had 26 male patients (86.7%) and 4 female patients (13.3%), and the age of patients ranged from 24 to 69 years with a mean age of 50.27 years. All cases were T1 squamous cell carcinoma of the oral tongue (an anterior-two third of the tongue) on final histology. The left side (63.3%) was more affected than the right side (36.7%). No bone involvement was diagnosed. The base of the tongue was preserved in all cases. Supra omohyoid neck dissection was performed in 17 (56.7%) patients and modified radical neck dissection in 13 (43.3%) patients. All the patients had at least one intact hypoglossal nerve, lingual nerve, lingual artery, and vessels. Tongue cancer defects were surgically reconstructed with primary closure in 15 patients (50%), and ALT perforator flap in 15 (50%) patients. The flap sizes in the ALT perforator flap group ranged from 32cm² (8cm × 4cm) to 60cm² (10cm × 6cm), with the average flap measuring was 43cm² (8.6 cm × 5cm). All patients were followed up for at least 12 months after the surgery.

Functional Outcomes

Speech Understandability

The speech understandability was measured at four different periods. The results of evaluation of speech understandability is shown in Table 2.

The test variable was speech understandability at four different periods and the grouping variable were surgical reconstruction with two types (primary closure and ALT perforator flap). Independent (unpaired) - sample t-test was conducted to evaluate whether speech understandability differed for patients who received a primary closure and patients who received ALT flap. At the 1st-month postoperative, the primary closure group were statistically significant on speech understandability than the ALT perforator flap group ($p = 0.01$). On the final (1-year) postoperative there was not significantly different on speech understandability between the two groups ($p = 0.16$) (Table 2).

Table 1 Clinical pathologic results of patients and treatment methods

Clinical Characteristics	No. Of Cases		
	All (n=30)	Primary closure group (n=15)	ALT flap group (n=15)
Gender (M/F)	26/4	12/3	14/1
Age (years; mean age)	50.27 years	51.8 years	48.7 years
Side (R/L)	11/19	5/10	6/9
Neck Dissection (SOHND/ MRND)	17/13	14/1	3/12
Flap size , cm ² (mean)			43cm ² (8.6cm × 5cm)

Table 2 Compared speech understandability in patients after primary closure or with perforator ALT flap reconstruction

		Early (1 st -month) post-op	3 rd month post-op	6 th month post-op	Final (1-year) post-op
Primary closure Group	N	15	15	15	15
	Mean	0.40	0.07	0.07	0.00
	Standard deviation	0.507	0.25	0.25	0.00
ALT flap Group	N	15	15	15	15
	Mean	1.27	0.67	0.40	0.13
	Standard deviation	0.70	0.72	0.63	0.35
<i>p</i> -value		0.01*	0.07	0.075	0.16
Total	N	30	30	30	30
	Mean	0.83	0.37	0.23	0.07
	Standard deviation	0.74	0.61	0.50	0.25

**p* value < 0.05

Swallowing Capacity

Information regarding patient diet what they can swallow were scored according to the UW- QOL questionnaires. Table 3 provides the results of evaluation of swallowing capacity at all four different time periods. Comparing the results of two groups, statistically significant differences were found between the both groups in the swallowing capacity at all four different time periods, p value < 0.05 as shown in Table 3.

Table 3 Compared swallowing capacity in patients after primary closure or with perforator ALT flap reconstruction.

			Early (1 st -month) post-op	3 rd month post-op	6 th month post-op	Final (1-year) post-op
Primary closure Group	N		15	15	15	15
	Mean		0.87	0.20	0.07	0.00
	SD		0.516	0.561	0.258	0.000
ALT flap Group	N		15	15	15	15
	Mean		1.93	1.20	0.80	0.27
	SD		0.258	0.862	0.862	0.458
<i>p</i>-value			0.000 ^{***}	0.001 ^{**}	0.006 ^{**}	0.04 [*]
Total	N		30	30	30	30
	Mean		1.40	0.70	0.43	0.13
	SD		0.675	0.877	0.728	0.346

SD means Standard deviation, * p value < 0.05 ; ** p value < 0.01 ; *** p value < 0.001

Tongue mobility

Tongue mobility was evaluated at all four different time periods because it can generate strong impairments in speech, swallowing and mastication, which induce a noticeable decrease of the quality of life of the patients. The results of evaluation of tongue mobility is shown in Table 4. For the primary closure group, tongue mobility was statistically better in all four different time periods than in the ALT perforator flap group, p value < 0.05 (Table 4). Figure 2 provides the tongue movement after 1-year postoperative; protrusive movement (Fig 2a) and tongue elevation (Fig 2b).

Table 4 Compared tongue mobility in patients after primary closure or with perforator ALT flap reconstruction.

		Early post-op	(1-month)	3 rd month post- op	6 th month post- op	Final post-op	(1-year)
Primary closure Group	N	15		15	15	15	
	Mean	1.07		0.67	0.00	0.00	
	SD	0.258		0.488	0.000	0.000	
ALT flap Group	N	15		15	15	15	
	Mean	1.80		1.53	1.27	0.87	
	SD	0.414		0.516	0.458	0.352	
p-value		0.000 ^{***}		0.000 ^{***}	0.000 ^{***}	0.000 ^{***}	
Total	N	30		30	30	30	
	Mean	1.43		1.10	0.63	0.43	
	SD	0.504		0.662	0.718	0.504	

SD means Standard deviation, * p value < 0.05 ; *** p value < 0.001

Time effects

Speech Intelligibility

Comparing the results of two groups at all four different time periods, speech understandability was better in a primary closure group than in the ALT perforator flap group. In early (1st-month) period, speech

was clearly understood in 60% patients reconstructed with primary closure while in patients who were reconstructed with ALT flap only 6.7% had clearly understandable speech. On final (1-year) postoperative evaluation, all patient's speech was clearly understood in the primary closure group and in the ALT flap group only 86.7% patient's speech was clearly understood.

Swallowing Capacity

All patients were able to swallow normal food before surgery, but the presence of odynophagia were a common complaint[12]. Three of the 15 patients (20%) who were evaluated were able to swallow normal food in the primary closure group, but in the ALT flap group, no patient was able to swallow normal food at early (1st-month) postoperative. All 15 patients (100%) were able to swallow normal food in the primary closure group while eleven of the 15 patients (73.3%) was able to swallow normal food in the ALT flap group at the final (1-year) postoperative.

Tongue mobility

All 15 patients (100%) had normal tongue movements in a primary closure group while two of the 15 patients (13.3%) had normal tongue movements in the ALT flap group at final (1-year) postoperative. No, any patient had normal tongue movements in both groups, at early (1st-month) postoperative. Comparing the results of two groups, the tongue movements were better in a primary closure group than the ALT flap group.

Discussion

The primary treatment modality of tongue cancer is surgery[9] and the principal goal of tongue reconstruction after surgery is to re-establish speech and swallowing functions[13]. The main functions of the tongue are speech and swallowing. The form and the mobility of the tongue are important for efficient speech, swallowing, and mastication[14]. In our present study, thirty patients who underwent surgery for T1 stage tongue cancer (on anterior -two third of the tongue) and reconstructed with primary closure (15 patients) and anterolateral perforator flap (15 patients) were included in the study. All patients underwent postoperative functional evaluation using specific questionnaires and a screening test with special emphasis on domains such as speech, swallowing and tongue mobility at 1, 3, 6 and 12 months. Functional outcomes, including tongue mobility, speech and swallowing, were all better in primary closure than the anterolateral thigh flap group. At 1-month post-op, a primary closure group was scored significantly better (i.e. lower) on speech understandability than ALT flap group ($p = 0.01$), while at 1-year post-op, there was no significantly different on speech understandability between two groups, ($p = 0.16$). Statistically significant differences were found between the two groups in the swallowing capacity at all four different time periods ($p < 0.05$). For the primary closure group, tongue mobility was statistically better in all four different time periods than in ALT flap group ($p < 0.05$).

Insufficient remaining muscle structure, loss of bulk, harm to the hypoglossal nerve, and postoperative fibrosis can cause functional impairments after tongue cancer resection. Hence restoration of natural tongue bulk, shape, mobility, are the main principles of tongue reconstruction to preserve tongue mobility and restore speech, swallowing and mastication. To achieve these goals, choosing the most appropriate reconstruction technique is important. Selection of techniques for tongue reconstruction, including primary closure, skin graft, and free or loco-regional flap reconstruction, depends on the size, location of cancer and extent of resection. Small defects require epithelial reconstruction such as healing by primary closure or secondary intention[15], but they are not able to restore the volume of the tongue. Therefore, if there is a large defect after tongue resection, volumetric reconstruction with a microvascular free flap reconstruction or loco-regional pedicle flap reconstruction[16] is necessary to restore the tongue volume.

Regarding tongue reconstruction after partial glossectomy, previous studies have reported only functional outcomes of one reconstructive method and conflicting results about the optimal reconstructive method. A long-term follow-up study of 63 patients with partial glossectomy of the tongue appeared good speech and swallowing function without flap reconstruction[17]. A prospective multicenter study also reported that the postoperative speech and swallowing function were better following a primary closure compared to a free flap reconstruction for a partial glossectomy[18]. The study by Yong Bae Ji and Yong Hee Cho has reported tongue mobility, swallowing and speech intelligibility were all better in the primary closure group for partial glossectomy patients[11].

In the present study, speech understandability, swallowing capacity and tongue mobility was all better in the primary closure group compared to those with ALT flap group. These results suggest that tongue defects reconstructed with the flap may interfere with the mobility and flexibility of the remaining normal tongue, which limits speech and swallowing function for partial glossectomy patients. Although the flap provides bulk and volume, it can actually hinder the functional outcomes by restricting the mobility of the remaining normal tongue in partial glossectomy cases. The excellent tongue mobility allows good speech, swallowing and mastication. Our results agree with other previous studies indicating that a reconstructed flap of the tongue may interfere with the flexibility and mobility of the residual tongue, which limits speech and swallowing function for partial glossectomy patients. It is clear that the quality of speech and swallowing outcomes after partial glossectomy is more a function of tongue mobility than volume[19].

In the previous studies, only speech and swallowing outcomes were evaluated after surgery but we evaluated the tongue mobility along with speech and swallowing outcomes at four different time periods for partial glossectomy patients. This is an important difference because the form and mobility of the tongue are important for efficient speech, swallowing and mastication. The excellent tongue mobility allows better speech, swallowing and mastication in partial glossectomy patients. Therefore, evaluating the speech and swallowing outcomes following oral tongue cancer resection is more accurate with an evaluation of tongue movements, as in this study.

In the reconstruction of the oral tongue for partial glossectomy patients, the factors **affecting functional outcomes** were: 1) Tumor size. Patients with large tumors had a significantly greater decline in speech understandability and tongue movements[20]. 2) Preservation of tongue tip. Patients with the preservation of the tongue tip showed better functional outcomes than those with resection of the tip. 3) Method of reconstruction[21]. Some studies reported better functional outcomes in patients with free flap reconstruction compared to those with primary closure following the glossectomy of the oral tongue. In our present study, comparing the results of two methods, functional outcomes were better in patients with primary closure than in patients with ALT perforator flap reconstruction for partial glossectomy patients. 4) Tongue mobility. Although the flap provides bulk and volume, it can actually hinder the functional outcomes by restricting the mobility of the remaining normal tongue in partial glossectomy cases. The excellent tongue mobility allows good speech, swallowing and mastication. A reconstructed flap of the tongue may interfere with the flexibility and mobility of the residual tongue, which limits speech and swallowing function for partial glossectomy patients.

The present study does have some limitations. We did not perform QoL and functional evaluation before the treatment and this may represent a substantial bias of the present study. The number of studies patients in each group is less, limiting the statistical strength. Further investigations with a huge number of cases is vital to verify the results of this study.

Conclusion

In conclusion, postoperative functional outcomes, including tongue mobility, speech and swallowing after partial glossectomy is better when epithelial reconstruction with primary closure was used. Although the postoperative function is influenced by multiple factors, it is clear that quality of speech and swallowing outcomes after partial glossectomy is more a function of tongue mobility than volume. For the tongue cancer patients (T1), reconstruction with primary closure, rather than with the flap, can reserve more functions including tongue mobility, speech and swallowing outcomes, and therefore might be the appropriate reconstruction method after partial glossectomy. To establish the optimal reconstruction method for patients undergoing partial glossectomy, however, further prospective studies and quality of life appraisals including more numbers of patients are vital.

Abbreviations

TNM:	Tumor, Nodes, and Metastases
ALT:	Anterolateral Thigh
UW-QOL:	The University of Washington Quality of Life Questionnaire

Declarations

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Not applicable

Authors' contribution:

Guided the study: FG. Wrote the manuscript: AKP, XSW. Collected and analyzed the data: AKP, XSW, HL, RY, YX. All authors read and approved the final manuscript.

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Availability of data and materials

The data sets used and/or analyzed in this study are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

Ethical approval for this study was obtained from the Medical Ethics Committee of Xiangya Hospital, Central South University.

Consent for publication

All the patients gave their written informed consent to participate in this study. The consent for the publication of identifying images was obtained from the patient.

Competing interest

The authors declare they have no competing interest.

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Figures

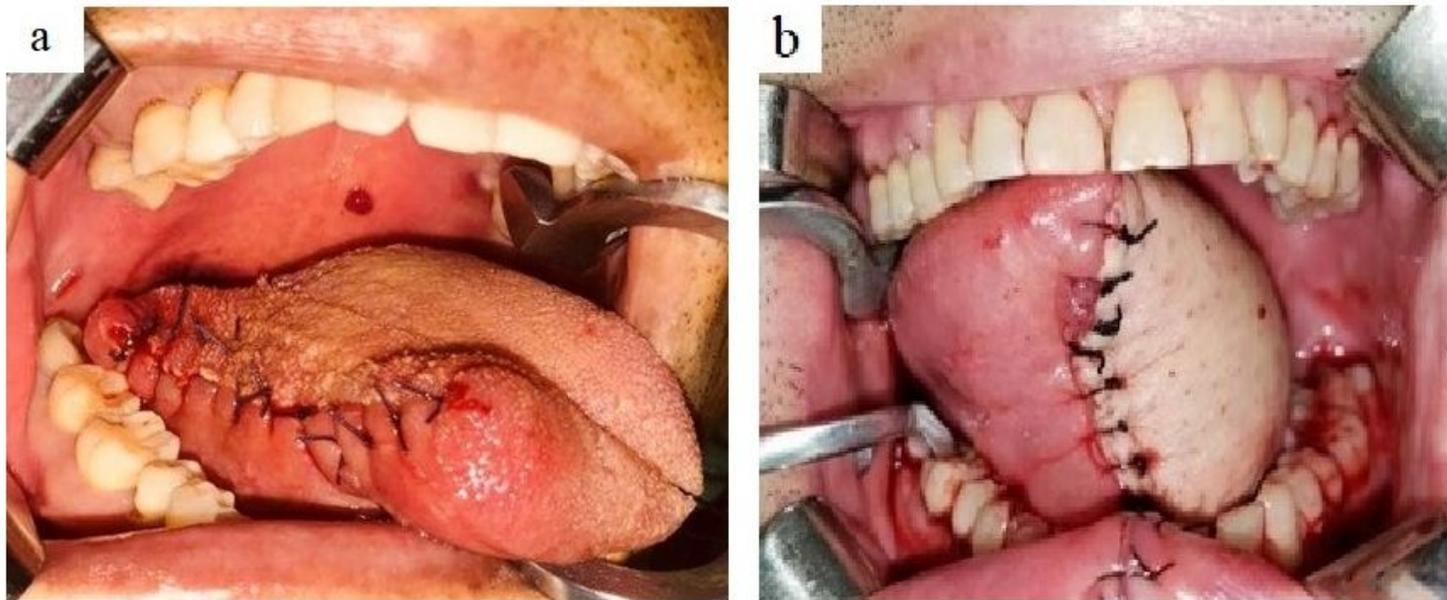


Figure 1

The tongue was reconstructed with primary closure (a) and with ALT flap (b).

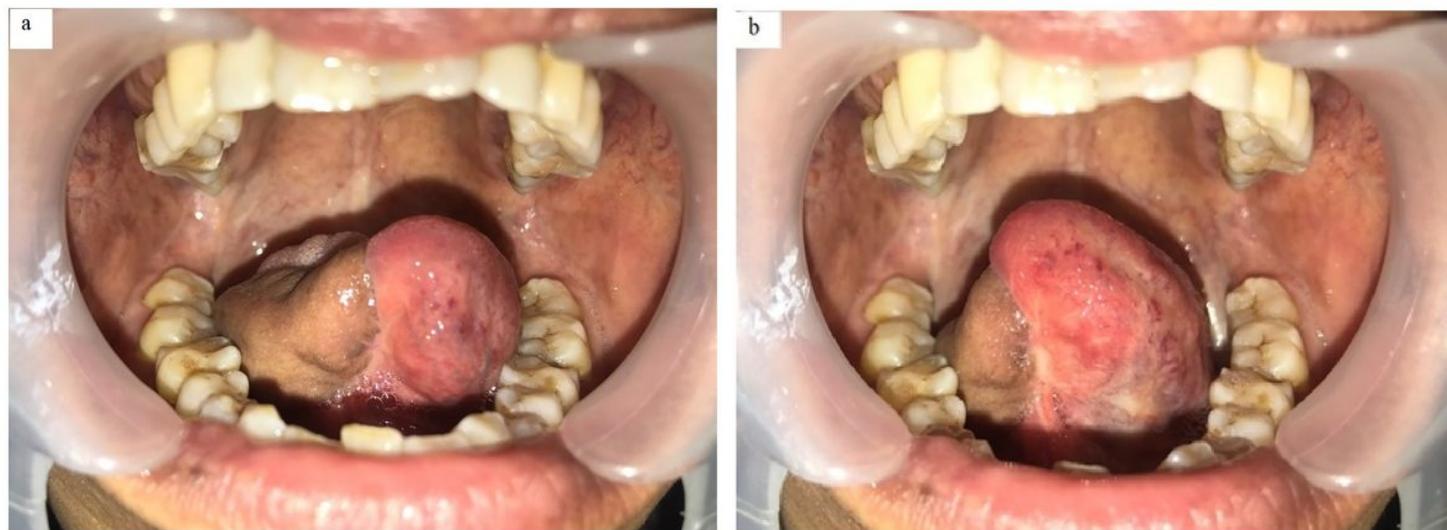


Figure 2

Tongue movement after 1-year post-op, (a) protrusive movement; (b) tongue elevation.