



Progressive functional improvement in hemiglossectomy defects reconstructed with radial forearm free flap at 6-months

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A B S T R A C T

Objective: The purposes of the study was to evaluate for the functional improvement of outcomes of patients undergoing surgical management for tongue cancer at varying periods after surgery.

Design: Case series with intervention.

Participants: Thirty consecutive patients, from 2011 to 2015, with carcinoma of the tongue undergoing surgical resection and reconstruction with a radial forearm free flap.

Main measures: The Speech Intelligibility Test (SIT) is used for objective evaluation of speech function. The 7-point ordinal scale Functional Oral Intake Score (FOIS) was used to estimate the swallowing function.

Results: The patients included were 25 men and 5 women with a mean age of 50.4 years (range – 27–65). All tumors were squamous cell carcinomas and all patients underwent a hemiglossectomy. There were two complete flap failures, with a resultant flap success rate of 93.3%. The initial mean speech intelligibility scores at 1-month increased from 72.3 ± 0.2 to 77.7 ± 8.9 at 6-months after surgery ($p = 0.05$). Similarly, the mean score of swallowing function improved from 6.1 at 1-month to 6.8 at 6-months after surgery ($p = 0.05$).

Conclusion: Reconstruction of hemiglossectomy defects with a radial forearm free flap offers functional benefits in speech and deglutition that demonstrate progressive improvement when 1- and 6-month post-surgical assessments are compared.

1. Introduction

Carcinoma of the oral tongue is the most common presentation of squamous carcinoma in the oral cavity and resection is the cornerstone of treatment. Rehabilitation of the speech and swallowing capacity of these patients be an emotionally and technically challenging endeavor [1].

A partial glossectomy may still permit reasonably effective post-operative function without the need for free tissues or pedicled flap reconstruction. However, surgical resection of larger oral tongue tumors can result in a significant functional impairment. Resection of approximately one half of the tongue results in a loss of the tongue bulk and can result in scar contracture that profoundly affects mobility of the remaining tongue. Lingual contact with the palate, teeth, and lip is subsequently decreased and results in impaired capacity for articulation. Posterior propulsion of a food bolus and liquids is also likely to be affected. The use of thin pliable fasciocutaneous free flaps such as a radial forearm or anterolateral thigh free flap can provide intraoral bulk

and while preserving existing mobility of the remaining native tongue [2–4].

2. Patients and methods

From 2011 to 2015, at the Ho Chi Minh City Oncology Hospital in Vietnam, 30 consecutive patients with squamous cell carcinoma of the tongue requiring hemiglossectomy underwent resection and reconstruction with radial forearm free flaps. There were 25 men and 5 women with a mean age of 50.4 years (range 27–65.).

The Speech Intelligibility Test (SIT) was used for objective evaluation of speech function. In our study, this test was conducted in Vietnamese (Table 1) at 1 and 6 months after reconstruction. Each patient was instructed to pronounce 100 syllables and their pronunciation was recorded. Three untrained volunteers, with no knowledge of the patients, and normal hearing reviewed the audio files and wrote down the syllables they heard. This resulted in a score that reflected the percentage of the correct syllables discerned.

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Table 1
Grouping of glossal sounds [5,6].

Portion of palato – lingual contact		Syllables in Vietnamese		No. of syllables
Blade	Plosive	Initial consonant	t, t ^h , t̄, d	22
		Vowel nucleus	(i, ie, e, ε, u, uɣ, ɣ, ɣ̄, a, ä)	
		Final consonant	n, t, ɲ, k	
	Nasal	Initial consonant	n	5
		Vowel nucleus	(i, ie, e, ε, u, uɣ, ɣ, ɣ̄, a, ä)	
		Final consonant	n, t, ɲ, k	
	Fricative	Initial consonant	s, ʃ, z, z̄, f	31
		Vowel nucleus	(i, ie, e, ε, u, uɣ, ɣ, ɣ̄, a, ä)	
		Final consonant	n, t, ɲ, k	
	Liquid	Initial consonant	l	9
		Vowel nucleus	(i, ie, e, ε, u, uɣ, ɣ, ɣ̄, a, ä)	
		Final consonant	n, t, ɲ, k	
Mid	Nasal	Initial consonant	ɲ	9
		Vowel nucleus	(i, ie, e, ε, u, uɣ, ɣ, ɣ̄, a, ä)	
		Final consonant	n, t, ɲ, k	
	Plosive	Initial consonant	c	15
		Vowel nucleus	(i, ie, e, ε, u, uɣ, ɣ, ɣ̄, a, ä)	
		Final consonant	n, t, ɲ, k	
Rear	Plosive	Initial consonant	k, ɲ	4
		Vowel nucleus	(i, ie, e, ε, u, uɣ, ɣ, ɣ̄, a, ä)	
		Final consonant	n, t, ɲ, k	
	Fricative	Initial consonant	x, ɣ	5
		Vowel nucleus	(i, ie, e, ε, u, uɣ, ɣ, ɣ̄, a, ä)	
		Final consonant	n, t, ɲ, k	

Table 2
Functional Oral Intake Score items [7].

Level	Description
1	Nothing by mouth
2	Tube dependent with minimal attempts of food or liquid
3	Tube dependent with consistent oral intake of food or liquid
4	Total oral diet of a single consistency
5	Total oral diet with multiple consistencies but requiring special preparation or compensations
6	Total oral diet with multiple consistencies without special preparation but with specific food limitations
7	Total oral diet with no restrictions

The 7-point ordinal scale Functional Oral Intake Score (FOIS) (Table 2) was used to estimate the swallowing function. Each patient was scored at 1-month and 6-months after surgery.

3. Results

There were two complete flap failures with a resultant success rate of 93.3%. The speech and swallowing function was assessed in 28 patients at 1-month after surgery and for 25 of the patients at 6-months after surgery. Three patients were excluded from re-assessment because of the development of recurrent disease (see Tables 3 and 4).

At 6-months, the speech intelligibility scores (mean ± SD) demonstrated a statistically significant improvement when compared to the 1-month assessment scores rising from 72.3 ± 0.2 to 77.7 ± 8.9.

The mean swallowing function score also demonstrated a statistically significant improvement at 6-month increasing from 6.1 to 6.8.

When the SIT test was performed, the most common type of error was with liquid /l/, fricative /f/, plosives /c/, /t^h/, /t/, and nasal/ɲ/. Additionally, some patients experienced problems in pronouncing the syllable consisting vowel nucleus/ɣ/ and final consonant/t/ (see Fig. 1).

4. Discussion

The importance of the oral cavity component of the tongue in speech articulation, mastication, and the oral phase of deglutition cannot be understated. Patients undergoing partial or hemiglossectomy

Table 3
Speech intelligibility scores of 28 patients.

Case no.	After 1 month	After 6 months	Case no.	After 1 month	After 6 months
1	78	78.7	15	67.3	
2	70.7	77	16	63.3	70.3
3	61	71.3	17	63.3	71
4	76.7	81.3	18	73	72.3
5	87.7	88.7	19	72.3	71
6	70.7	88.3	20	69.7	77.3
7	44.3	48.3	21	85	87.3
8	71.7		22	79.3	88.3
9	88	90.3	23	68	73.3
10	72	72.3	24	73.7	78.7
11	87	88.3	25	70.3	73.3
12	69.7	82.3	26	63.3	75.7
13	69	73.3	27	81.3	78.7
14	67.7		28	79.3	84.3

Table 4
Functional Oral Intake Scores of 28 patients.

Case no.	After 1 month	After 6 months	Case no.	After 1 month	After 6 months
1	6	7	15	5	
2	6	7	16	5	6
3	6	6	17	6	6
4	5	7	18	7	7
5	6	7	19	7	7
6	6	7	20	6	7
7	6	7	21	7	7
8	6		22	6	7
9	6	7	23	6	7
10	6	7	24	6	7
11	7	7	25	6	6
12	7	7	26	6	7
13	7	7	27	6	7
14	6		28	6	6

are expected to have a variable impact on their baseline speech and swallowing function during recovery. Adequate mobility of the remaining oral tongue component is critical in that contact with the



Fig. 1. Patient with the neotongue 6 months after reconstructive surgery.

palate enhances articulation and facilitates the oral phase of swallowing [8].

The tongue plays a central role in articulation by modifying the shape of the oral cavity, causing a change in fundamental resonance characteristics. The complicated arrangements of muscles and the high degree of innervation of this organ facilitate the production of various vowel and consonant sounds that are important for intelligible speech [9].

Michiwaki et al. used intelligibility of Japanese syllables to examine articulatory impairment in patients who underwent surgical reconstruction after glossectomy. The sixty-seven glossal sounds were apportioned into three subgroups: blade, middle and rear sounds produced with the anterior, mid and posterior portions of the tongue, respectively. Blade sounds include plosives, nasals, fricatives, affricatives, and glides. Middle sounds include nasals, fricatives, affricatives, vowels, and semi-vowels. Rear sounds only include plosives [10]. In Michiwaki's study, one patient who had a hemiglossectomy achieved an 82.1% overall score. He had good dentition and had adequate mobility in the reconstructed tongue. However, two other patients with limited dentition and preoperative radiation therapy had scores of approaching 50% [10].

Sun et al. assessed postoperative function in patients that had undergone glossectomy with various reconstructions utilizing scoring by speech-language pathologists. Scores in this population ranged from group of high-functioning patients (90–99.0%) to a group with lower scores (79.5–86.0%) [11].

Chuanjun et al. investigated an articulation intelligibility test with 40 sensitive Chinese sounds which were also apportioned into three similar subgroups [11]. He demonstrated results of 77.0% for blade portion glossal sounds, 76.3% for mid-portion glossal sounds and 84.7% for portion glossal sounds [12].

Song et al. reported a mean speech intelligibility score was 72.5 ± 10.27 in patients with radial forearm free flap reconstruction of the tongue [7]. In this study, the most common pronunciation error was liquid /l/, fricative /f/, plosives /c/, /t^h/, /t/, and nasal /ŋ/. The study also used the 7-point ordinal scale to assess deglutition. Short-term swallowing function scores after surgery were 3.8–4 and subsequently improved to 6.1–6.6 at 1-year [7].

Hsiao et al. reported that the most common type of error was fricative, affricate and plosives [13].

In assessing swallowing capacity, they utilized a drinking test where have patients would consume 175 mL of water and the time to complete the volume and number of swallows required would be recorded. They calculated the average volume/time consumed (mL) by the time taken

and the average volume swallowed in seconds. The results revealed that the functional capacity of the control group and the patients were found to be similar [13].

Dziegielewski concluded that a functional speech assessment score above 80% in post-treatment rehabilitated patients were consistent with near-normal speech functional outcomes [14].

5. Conclusion

Reconstruction of hemiglossectomy defects with radial forearm free flap is an excellent method to restore the functional outcomes in speech and deglutition. The results of the reconstruction continue to mature and improve up to 6-months after surgery. In our case series, the majority of patients went on to have near-normal speech and swallowing outcomes.

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