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Swallowing Function before and after Subtotal Glossectomy and Reconstruction with a Rectus Abdominis Musculocutaneous Flap: A Case Report

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Abstract

Purpose: Swallowing function was in a patient with tongue cancer that was evaluated with video fluorography before and after subtotal glossectomy and reconstruction with a rectus abdominis muscuocutaneous flap. **Materials and Methods:** A 41-year-old man underwent subtotal glossectomy and retained the unilateral posterior mylohyoid and unilateral stylohyoid muscles. The structure of the flap was evaluated postoperatively. To assess swallowing function, video fluorography was performed before surgery, 1 month after surgery and 1 year after surgery. Testing involved 1) ability to hold 10 mL of liquid in the oral cavity, 2) epiglottis turnover, 3) the presence of aspiration, 4) hyoid bone movement, and 5) maximum width of the esophageal entrance. **Results:** The flap was protuberant postoperatively. The patient was able to hold the test diet in the oral cavity before and after surgery. Epiglottis turnover was good before surgery but insufficient after surgery. Aspiration during swallowing was not observed before or after surgery. At rest, the hyoid bone sagged postoperatively, in comparison with preoperatively. Hyoid bone movement and width of the esophageal entrance decreased after surgery; however, they demonstrated gradual recovery. **Conclusions:** For good postoperative swallowing function after subtotal glossectomy, it is necessary to perform reconstruction with protuberant flap and to retain the suprahyoid

muscles as much as possible.

Keywords

Subtotal Glossectomy, Rectus Abdominis Musculocutaneous Flap, Swallowing Function, Hyoid Bone Movement, Width of the Esophageal Entrance

1. Introduction

It is important for reconstructive surgeons to evaluate swallowing function in patients with tongue cancer who have undergone glossectomy and flap reconstruction. We were interested in a reconstructive method that would preserve swallowing function in patients who had undergone more than hemiglossectomy [1] [2] [3]. We previously reported on postoperative swallowing function in patients who had undergone subtotal glossectomy and reconstruction with a rectus abdominis musculocutaneous flap [4]. We suggested that for good postoperative swallowing and hyoid bone movement after subtotal glossectomy, it is necessary to perform reconstruction with a flap that has sufficient volume and to retain the bilateral stylohyoid muscles [4]. However, we had never evaluated preoperative and postoperative serial swallowing function in patients who underwent subtotal glossectomy and reconstruction with a rectus abdominis musculocutaneous flap. Therefore, our aim was to evaluate preoperative and postoperative swallowing function in a patient after such reconstruction. In this study, swallowing function was evaluated with video fluorography in a patient with tongue cancer before and after subtotal glossectomy and reconstruction with a rectus abdominis musculocutaneous flap.

2. Patients and Methods

2.1. Patient

The patient was a 41-year-old man with a diagnosis of squamous cell carcinoma of the tongue on the left side ($T_4N_0M_0$). The patient underwent subtotal glossectomy and reconstruction with a rectus abdominis musculocutaneous flap at Kindai University Hospital, Osaka in 2008. Table 1 lists the details of the surgical procedure. With regard to preservation of the suprahyoid muscles, the patient retained the unilateral posterior mylohyoid and unilateral stylohyoid muscles (Table 1). Hyoid bone suspension was not performed (Table 1). Postoperatively,

Table 1. Characteristics of a patient who underwent subtotal glossectomy and reconstruction with rectus abdominis musculocutaneous flap.

Age	Gender	Neck dissection	Conserved tongue area	Conserved suprahyoid muscles	Hyoid bone suspension
41	Male	Bilateral conservative	Unilateral basal tongue (right side)	Unilateral mylohyoid (Posterior) Unilateral stylohyoid	None

the patient did not receive chemotherapy or radiation therapy.

2.2. Evaluation of Swallowing Function

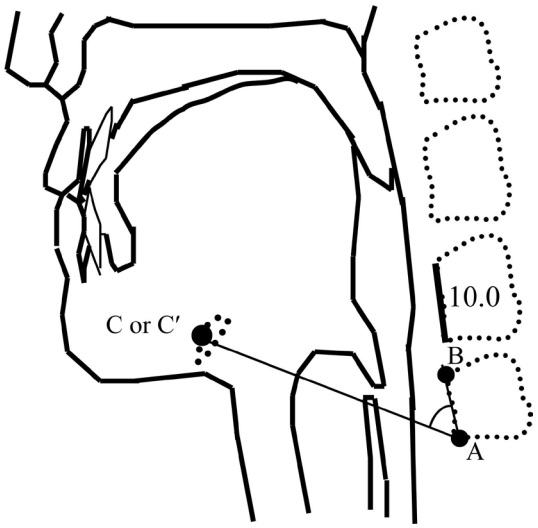
1) Postoperative flap structure

We evaluated the structure of the flap both 1 month and 1 year after surgery. The flap could be classified as protuberant, semiprotuberant, flat, or depressed [5].

2) Video fluorography

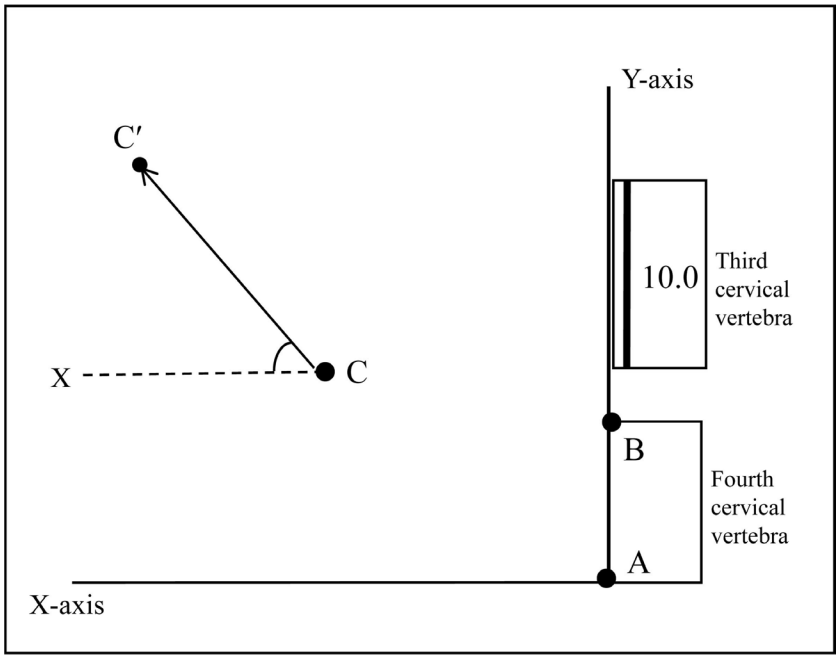
Swallowing function was evaluated with video fluorography before surgery, 1 month after surgery, and 1 year after surgery. In the test, the following items were evaluated with a 10 mL of liquid: a) holding the liquid in the oral cavity, b) epiglottis turnover, c) aspiration, d) hyoid bone movement, and e) maximum width of the esophageal entrance.

To examine the extent of hyoid bone movement (**Figure 1**, and **Figure 2**) and the maximal widening of the esophageal entrance (**Figure 3**), the method of Matsunaga *et al.* [4] [6] was used. Points A and B represented the lower and upper borders of the fourth cervical vertebra, respectively. Points C and C′represented the hyoid bone at rest and at the highest elevation, respectively. Then the distance from point A to point C (line AC) and the distance from point A to point C′ (line AC′) were measured (relative to the height of the third cervical vertebra, which on a lateral image was set as 10.0). Angles BAC and BAC′ represented the angles when the hyoid bone angle was at rest and at the highest elevation, respectively (**Figure 1**). **Figure 2** shows the method of assessing the extent of hyoid bone movement. The Y-axis was parallel to the line from point A



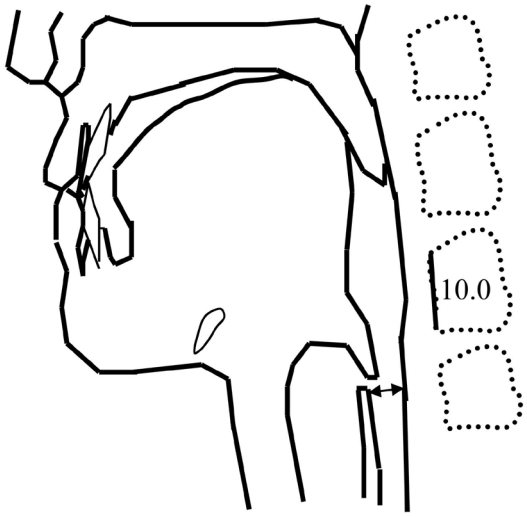
A: Lower edge position in fourth cervical vertebra; B: Upper edge position in fourth cervical vertebra; C: Hyoid bone position at rest; C': Hyoid bone position at highest elevation; AC: Distance of point C from point A (the longitudinal length of the three cervical vertebra on lateral images was established as 10.0); AC': Distance of point C' from point A (the longitudinal length of the three cervical vertebra on lateral images was established as 10.0); Angle BAC (˚): The angle of hyoid bone at rest; Angle BAC' (˚): The angle of hyoid bone at highest elevation.

Figure 1. Position of hyoid bone (Matsunaga K *et al.*, 2004, 2017).



X-axis: Perpendicular line of line BA; Y-axis: Line that links point BA; C:Hyoid bone point at rest; C': Hyoid bone point at highest elevation; CC': Distance of hyoid bone movement (the longitudinal length of the three cervical vertebra on lateral images was established as 10.0); Angle C'CX (˚): Angle of hyoid bone movement (CX: Parallel line of the X-axis).

Figure 2. Assessment of the hyoid bone movement (Matsunaga K *et al.*, 2017).



Double arrow: Degree of maximal widening of the esophageal entrance during swallowing (the longitudinal length of the three cervical vertebra on lateral images was established as 10.0).

Figure 3. Degree of maximal widening of the esophageal entrance (Matsunaga K *et al.*, 2004, 2008, 2017).

to point B (line AB), and the X-axis was perpendicular to line AB (**Figure 2**). Line CC' represented the distance between the position of the hyoid bone at rest and its position at the highest elevation in relation to the height of the third cervical vertebra set, as 10.0 (**Figure 2**). Angle C'CX was the angle of hyoid bone movement (Line CX was a line parallel to the X-axis) (**Figure 2**).

Figure 3 shows the method of assessing the maximum width of the esophageal entrance [4] [6] [7]. The maximum width of the esophageal entrance was measured during swallowing in relation to the height of the third cervical vertebra (Figure 3).

3. Results

1) Postoperative flap structure

Figure 4 shows the intraoral appearance 1 year after surgery. The flap had a protuberant structure postoperatively.

2) Video fluorography

Table 2 shows the results of testing for ability to diet hold the liquid in the oral cavity, for epiglottis turnover, and for the presence of aspiration.

1) Holding the liquid in the oral cavity

Both before and after surgery, the patient was able to hold the liquid in the oral cavity, and flow of the liquid into the pharynx was not observed (Table 2).

2) Epiglottis turnover

Epiglottis turnover was good before surgery, however, postoperative epiglottis turnovers were insufficient (Table 2 and Figure 5).

3) Aspiration

Aspiration during swallowing was not observed before or after surgery (Table 2 and Figure 5 and Figure 6).

(4)Hyoid bone movement

The position of the hyoid bone at rest before surgery was different from that after surgery (Table 3 and Figure 6). The preoperative and postoperative positions of the hyoid bone at the highest elevation, however, were different (Table 3, Figure 5). The distances of hyoid bone movement before surgery, 1 month after

Figure 4. Flap structure 1 year postoperatively The flap had a protuberant structure.

Table 2. Findings on video fluorography.

Period	Ability to hold the test food in the oral cavity	Epiglottis turnover	Aspiration
Preoperative	Good	Good	None
Postoperative, 1 month	Good	Insufficient	None
Postoperative, 1 year	Good	Insufficient	None

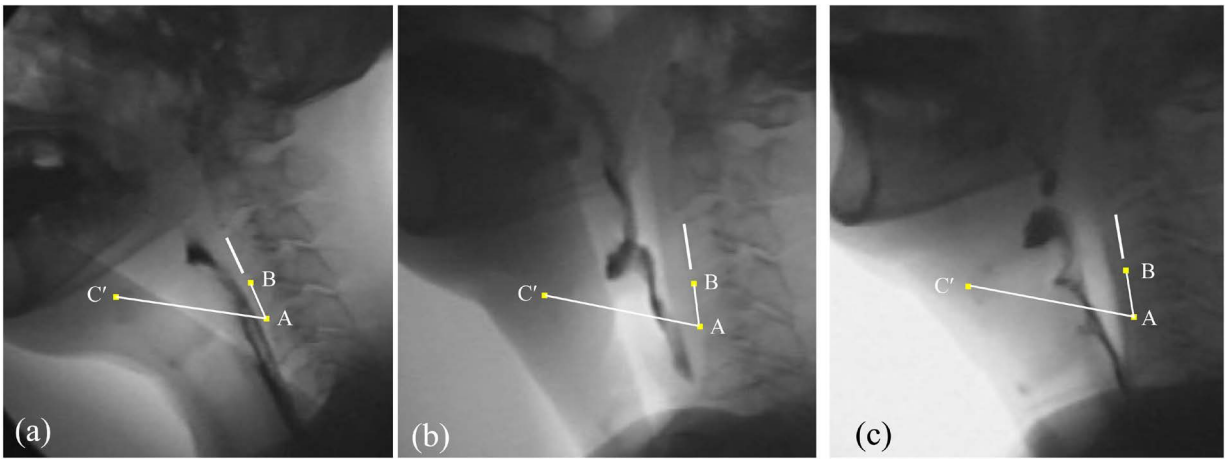


Figure 5. Hyoid bone position at highest elevation. (a) Preoperative view; (b) Postoperative view, 1 month; (c) Postoperative view, 1 year.

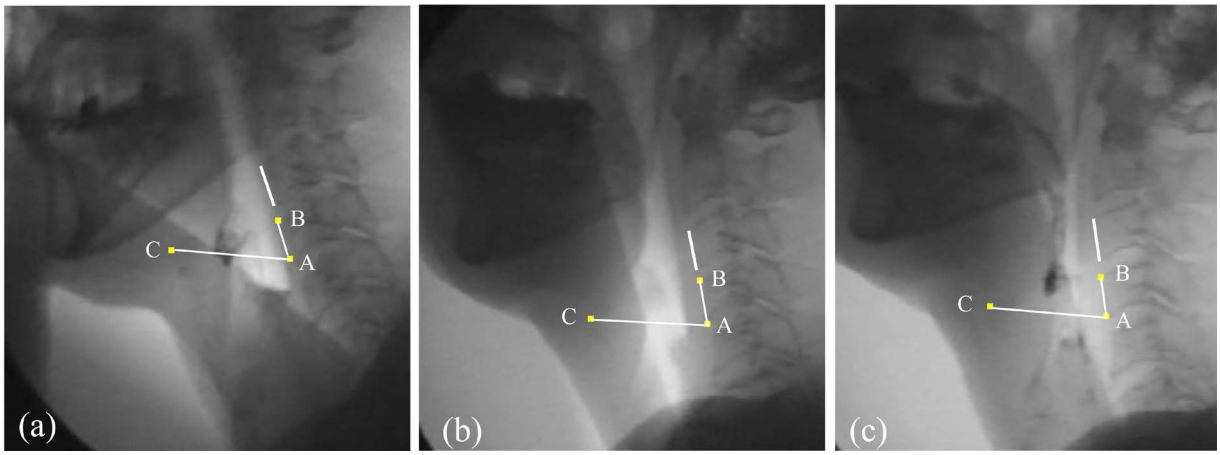


Figure 6. Hyoid bone position at rest. (a) Preoperative view; (b) Postoperative view, 1 month; (c) Postoperative view, 1 year.

Table 3. Data for calculation of hyoid bone position.

Period	Position of hyoid bone at rest		The position of the hyoid bone at highest elevation	
	AC	Angle BAC (˚)	AC’	Angle BAC’ (˚)
Preoperative	28.4	69.2	39.4	59.2
Postoperative, 1 month	29.3	77.0	34.9	71.5
Postoperative, 1 year	28.4	77.5	36.2	70.4

AC: Distance of point C from point A (the longitudinal length of the three cervical vertebra on lateral images was established as 10.0); AC′: Distance of point C′ from point A (the longitudinal length of the three cervical vertebra on lateral images was established as 10.0); Angle BAC (˚): The angle of hyoid bone at rest; Angle BAC′ (˚): The angle of hyoid bone at highest elevation.

surgery and 1 year after surgery were 12.3, 6.7, and 8.6, respectively (Table 4). The angles of hyoid bone movement in anterior and upward directions before surgery, 1 month after surgery and 1 year after surgery were 53.8, 50.0 and 46.1 degree, respectively (Table 4). After surgery, the hyoid bone at rest sagged, in comparison with its preoperative position at rest (Figure 7). The hyoid bone

Table 4. The extent of hyoid bone movement.

Period	CC'	Angle C'CX(˚)
Preoperative	12.3	53.8
Postoperative, 1 month	6.7	50.0
Postoperative, 1 year	8.6	46.1

CC': Distance of hyoid bone movement; Angle C'CX: The angle of hyoid bone movement.

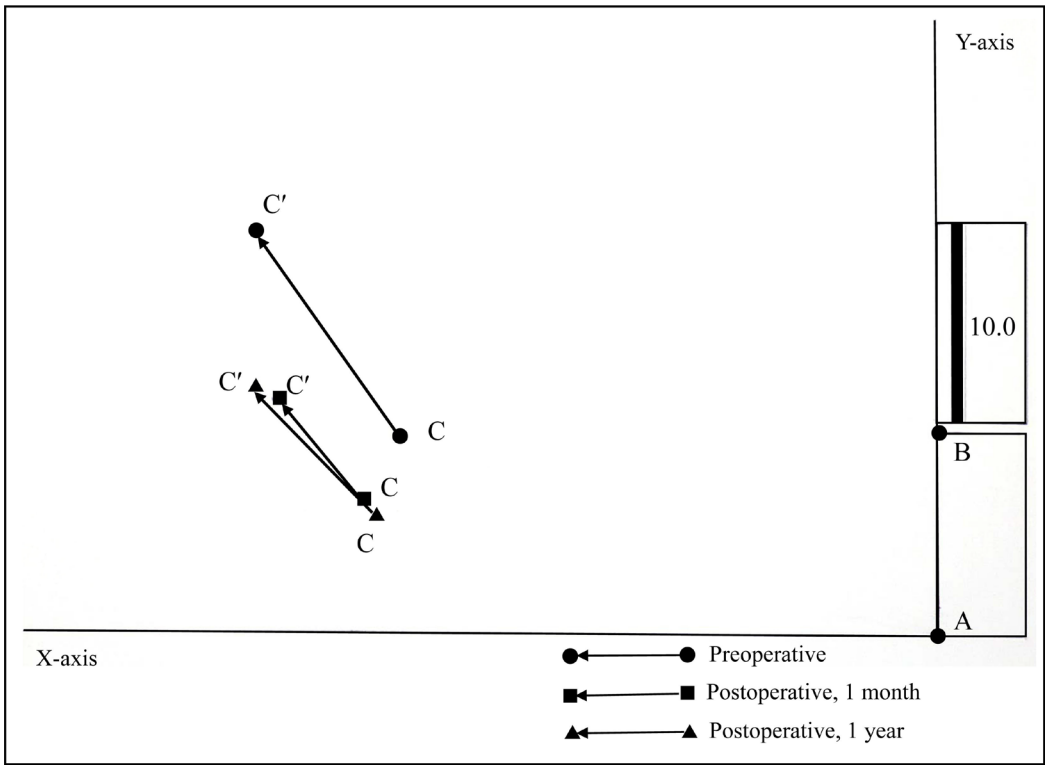


Figure 7. The extent of hyoid bone movement.

demonstrated less movement after surgery than before surgery (**Figure 7**). However, the hyoid bone movement increased 1 year after surgery (**Figure 7**).

5) Maximum widths of the esophageal entrance

The maximum width of the esophageal entrance before surgery, and 1 month after surgery and 1 year after surgery were 9.9, 6.3 and 7.8, respectively (**Figure 8**). Postoperative maximum widths of the esophageal entrance were smaller than the preoperative widths. However, maximum width of the esophageal entrance 1 year after surgery increased somewhat (**Figure 8**).

Swallowing function in the patient remained good 3 years postoperatively. Moreover, till the time of drafting, the patient the patient has survived without recurrence or metastasis.

4. Discussion

It is important to improve postoperative swallowing function after glossectomy and reconstruction of the tongue [1] [2] [3]. We previously investigated swallowing

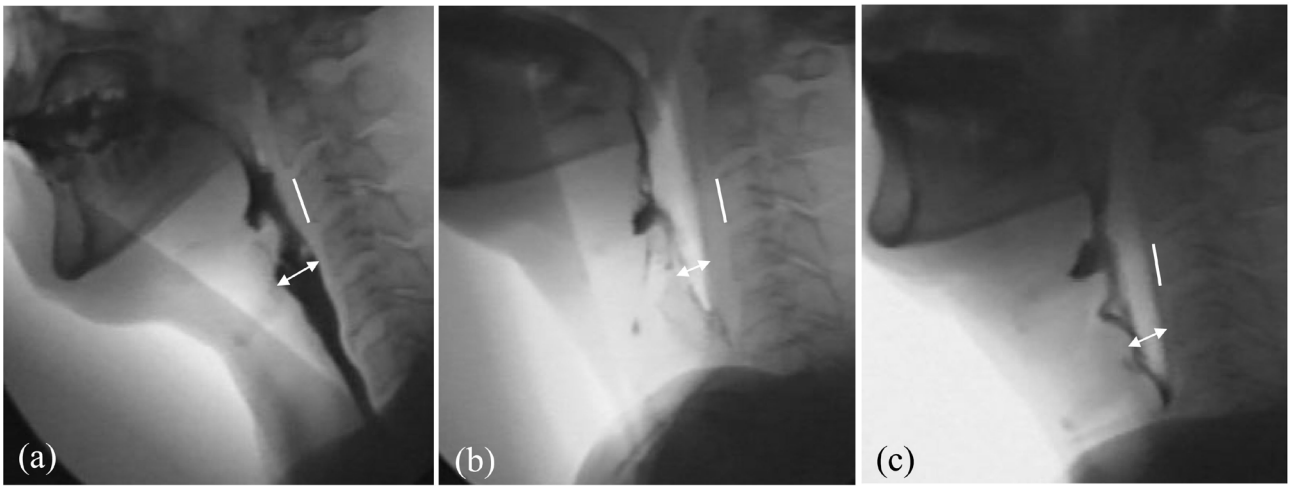


Figure 8. Maximal widening of the esophageal entrance. (a) Preoperative: 9.9 (Double arrow); (b) Postoperative, 1 month: 6.3 (Double arrow); (c) Postoperative, 1 year: 7.8 (Double arrow).

function in patients who had undergone subtotal glossectomy and reconstruction with a rectus abdominis musculocutaneous flap 3 years postoperatively [4]. However, we had never evaluated preoperative and postoperative swallowing function, serial change in hyoid bone movement, and width of the esophageal entrance in patients who underwent subtotal glossectomy and reconstruction with a rectus abdominis musculocutaneous flap. In this study, we undertook this evaluation.

4.1. Association between Flap Structure and Swallowing Function

After subtotal glossectomy, it is important to reconstruct the large defect with an appropriate flap to improve or maintain postoperative swallowing function. We previously reported that for good postoperative swallowing after subtotal glossectomy, it is necessary to perform reconstruction with a flap that has sufficient volume [4]. Kimata *et al.* [5] suggested that protuberant and semiprotuberant flaps demonstrated better postoperative swallowing function than did flat or depressed flaps; therefore, the large tongue defect should be reconstructed with the wider and thicker flaps. Chang *et al.* [8] suggested that defects after subtotal or total glossectomy should be reconstructed with a thicker and bulkier flap to optimize postoperative speech and swallowing function. The patient in this study, who had undergone reconstruction of a flap with sufficient volume, demonstrated good ability to hold liquid in the oral cavity after surgery, and flow of liquid into the pharynx was not observed after surgery. These findings demonstrate the necessity of reconstruction of a protuberant flap for good postoperative swallowing after subtotal glossectomy. Some authors [8] [9] have suggested that functional reconstruction of a flap with both sensory and motor innervation can result in better postoperative swallowing outcomes after subtotal glossectomy. In the future, we hope to examine functional reconstruction of tongue defect with innervated flaps.

4.2. Association between Hyoid Bone Movement and Swallowing Function

With regard to the association between resection of the suprahyoid muscles and hyoid bone movement during swallowing, Fujimoto *et al.* [10] suggested that the hyoid bone movement deceased significantly after resection of the suprahyoid muscles. We reported that after bilateral resection of the anterior and posterior bellies of the digastric, mylohyoid, geniohyoid, and hyoglossus muscles, the forward and upward movement of the hyoid bone was impeded [11]. However, the degree of the hyoid bone movement during swallowing had not been quantitatively evaluated. Therefore, we evaluated postoperative swallowing function in patents who underwent subtotal glossectomy and reconstruction with a rectus abdominis musculocutaneous flap [7]. We found that in patients who have undergone subtotal glossectomy and bilateral neck dissection-, the extent of hyoid bone muvement was definitely smaller than that in patients after only unilateral neck dissection [4] [6]. However, we had not quantitatively evaluated changes in hyoid bone movement before and after surgery. In this study, we evaluated change in hyoid bone movement and width of the esophageal entrance in a patient who underwent subtotal glossectomy and bilateral neck dissection. The positions of the hyoid bone at rest were lower after surgery than before surgery because almost all of the bilateral suprahyoid muscles had been resected without hyoid bone suspension. Furthermore, hyoid bone movement and width of the esophageal entrance decreased after surgery; however, they demonstrated gradual recovery, which may have been a result of strengthening of the retained suprahyoid muscles and compensatory reinforcement of the infrahyoid muscles.

The limitation of this study is that it is a case report; more cases like this should be studied. Furthermore, a comparative study analyzing swallowing function based on hyoid bone suspension in patients who have undergone subtotal glossectomy is needed.

5. Conclusion

In a patient with tongue cancer who underwent subtotal glossectomy and reconstruction with a rectus abdominis musculocutaneous flap, swallowing function evaluated with video fluorography before and after the surgery, our findings showed that for good postoperative swallowing function and hyoid bone movement after subtotal glossectomy, reconstruction should entail the creation of a protuberant flap, and the suprahyoid muscles should be retained as much as possible.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Yokoo, S., Komori, T., Umeda, M., Takenono, I., Hashikawa, K., Hanagaki, H. and Tahara, S. (2001) Functional Reconstruction of Mobile Tongue and Suprahyoid Muscles after Resection of Cancer of the Tongue. *British Journal of Oral and Maxillofacial Surgery*, **39**, 252-255. https://doi.org/10.1054/bjom.2001.0636

[2] Hsiao, H.T., Leu, Y.S., Chang, S.H. and Lee, J.T. (2003) Swallowing Function in Patients Who Underwent Hemiglossectomy: Comparison of Primary Closure and Free Radial Forearm Flap Reconstruction with Videoflouroscopy. *Annals of Plastic Surgery*, **50**, 450-455. https://doi.org/10.1097/01.SAP.0000044147.09310.E8

[3] Engel, H., Huang, J.J., Lin, C.Y., Lam, W., Kao, H.K., Gazyakan, E. and Cheng, M.H. (2010) A Strategic Approach for Tongue Reconstruction to Achieve Predictable and Improved Functional and Aesthetic Outcomes. *Plastic and Reconstructive Surgery*, **126**, 1967-1977. https://doi.org/10.1097/PRS.0b013e3181f44742

[4] Matsunaga, K., Kusuhara, H., Enomoto, A., Mori, K., Kitano, M., Mukai, T., Shimoide, T., Doi, K., Isogai, N. and Hamada, S. (2017) Swallowing Function in Patients Who Underwent After Subtotal Glossectomy and Reconstruction with a Rectus Abdominis Musculicutaneous Flap. *Acta Medica Kindai University*, **42**, 49-55.

[5] Kimata, Y., Sakuraba, M., Hishinuma, S., Ebihara, S., Hayashi, R., Asakage, T., Nakatsuka, T. and Harii, K. (2003) Analysis of the Relations between the Shape of the Reconstructed Tongue and Postoperative Functions after Subtotal or Total Glossectomy. *Laryngoscope*, **113**, 905-909. https://doi.org/10.1097/00005537-200305000-00024

[6] Matsunaga, K., Oobu, K., Ohishi, M. and Isogai, N. (2004) The Evaluation of Swallowing Function in Unilateral Radical Neck Dissection Cases Using the Picture Analysis Equipment. Analysis about the Position of the Hyoid and Opening of the Esophageal Entrance. *The Journal of Japanese Society of Stomatognathic Function*, **11**, 35-40. https://doi.org/10.7144/sgf.11.35

[7] Matsunaga, K., Mori, K., Asamura, S., Nagata, T. and Isogai, N. (2008) Swallowing Function in Patients Who Underwent Hemiglossectomy and Reconstruction with a Pectralis Major Myocutaneous Flap. *Journal of Japanese College of Surgeons*, **33**, 829-836. https://doi.org/10.4030/jjcs.33.829

[8] Chang, E.I., Yu, P., Skoracki, R.J., Lui, J. and Hanasono, M.M. (2015) Comprehensive Analysis of Functional Outcomes and Survival after Microvascular Reconstruction of Glossectomy Defects. *Annals of Surgical Oncology*, **22**, 3061-3069. https://doi.org/10.1245/s10434-015-4386-6

[9] Ozkan, O., Ozkan, O., Derin, A.T., Bektas, G., Cinpolat, A., Duymaz, A., Mardini, S., Cigna, E. and Chen, H.C. (2015) True Functional Reconstruction of Total or Subtotal Glossectomy Defects Using a Chimeric Anterolateral Thigh Flap with Both Sensorial and Motor Innervation. *Annals of Plastic Surgery*, **74**, 557-564. https://doi.org/10.1097/SAP.0b013e3182a6add7

[10] Fujimoto, Y., Hasegawa, Y., Matsuura, H. and Nakayama, B. (1996) A Quantitative Study of Videoflouorography Using a Personal Computer—Analysis of Postoperative Dysphagia of Oral and Orohpharyngeal Cancer Patients. *Japanese Journal of Head and Neck Cancer*, **22**, 72-77. https://doi.org/10.5981/jjhnc1974.22.72

[11] Matsunaga, K., Oobu, K. and Ohishi, M. (2002) The Clinical Study on Pre and Postoperative Swallowing Function in Tongue Cancer Patients. *The Japanese Journal of Dysphagia Rehabilitation*, **6**, 53-64.