Functional Reconstruction of the Oral Cavity with Radial Forearm Free Flap

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= ABSTRACT =

Background and Objectives : The radial forearm free flap is a useful reconstructive method of surgical defects after oral and oropharyngeal tumor resection. We evaluated the swallowing and speech outcomes of radial forearm free flap reconstruction for oral and oropharyngeal cancers.

Materials and Methods : We retrospectively reviewed clinical data of 84 patients who underwent reconstructive surgery for oral or oropharyngeal cancer using radial forearm free flap from August 1994 to January 2007. Modified barium swallowing (MBS) was done in 100 patients and speech-language assessment was done in 23 patients by a speech-language pathologist. Results were analyzed according to the swallowing functions and the speech-language assessments.

Results : According to the results of MBS which was done postoperatively, aspiration occurred in three patients and velopharyngeal insufficiency occurred in four patients who had been reconstructed with multilobed free flap due to large mucosal defects. There was one patient who exhibited severe articulation impairment out of 23 patients. However, 19 patients out of 23 patients showed excellent intelligibility in speech.

Conclusion : We concluded that the radial forearm free flap technique is an excellent reconstructive method for the restoration of palatal and pharyngeal function in oral and oropharyngeal cancer patients.

KEY WORDS : Radial forearm free flap · Oral cavity · Swallowing · Speech.

Introduction

In surgical treatment of oral and oropharyngeal cancer, it is important not only to remove the tumor completely, but also to reconstruct the resected area appropriately to maintain the function of oral and oropharynx. After the resection of tumor, the extensive defect brings soft palate malfunction which can cause velopharyngeal insufficiency or hypernasality, and problems in deglutition, swallowing and the protection of the airway. Free flap is often used for the reconstruction of oral and oropharynx after the surgical treatment of oral and oropharyngeal cancers. Among those types of free flaps, radial forearm free flap is outstanding functionally or cosmetically, the survival rate of the grafted tissues is high[1], and it is very easy to harvest anatomically compared to the other flaps, such as pectoralis major flap or anterolateral thigh flap.

We evaluated the swallowing and speech function of patients who underwent reconstruction with radial forearm free flap after the surgical resection of the oral or oropharyngeal cancer.

Materials and Methods

Information was collected retrospectively from medical records of 84 patients who underwent surgical resection of the oral or oropharyngeal cancer and reconstruction with radial forearm free flap at the department of Otolayngology, Kangnam St. Mary's Hospital in the Catholic University of Korea from August, 1994 to Jan, 2007. Among 100 patients, there were 84 men and 16 women, and the average age was 53.1 years old. For the primary sites, there were 31 oral tongue, 6 base of tongue, 37 tonsil, 9 floor of mouth, 7 soft palate and so on. According to TNM classification (AJCC, 2002), the distribution of the cases were 16 cases of T4, 21 cases of T3, 57 cases of T2 and 6 cases of T1. Pathologically, there were 90 cases of squamous cell carcinoma which took the most of the part, 6 cases of adenoid cystic cancer, 2 cases of adenocarcinoma, 1 cases of pleomorphic adenoma, 1 cases of Ewing sarcoma (Table 1).

The reconstruction of the defect with radial forearm free flap was done simultaneously with the extensive surgical resection of tumor, and the various designs of flap were determined according to the defect size and shape. The design

Table 1. Profiles of oral and oropharyngeal cancer patients according to site of origin, pathology and T stage

Site of origin	Pathology	T stage
Oral tongue (33 cases, 39.2%) Tonsil (19 cases, 22.6%) Floor of mouth (9 cases, 10.7%) Soft palate (8 cases, 9.5%) Base of tongue (7 cases, 8.3%) Retromolar trigone (4 cases, 4.7%) Buccal mucosa (3 cases, 3.5%) Hard palate (1 case, 1.1%)	Squamous cell carcinoma (69 cases, 82.1%) Adenoid cystic carcinoma (6 cases, 7.1%) Adenocarcinoma (3 cases, 3.5%) Carcinoma ex pleomorphic adenoma (2 cases, 2.3%) Mucoepidermoid cardinoma (2 cases, 2.3%) Leiomyosarcoma (1 case, 1.1%) Lymphoma (1 case, 1.1%)	T1 (12 cases, 14.2%) T2 (37 cases, 44.1%) T3 (15 cases, 17.8%) T4 (20 cases, 23.9%)
Total : 84 cases		

Table 2. Profiles of oral and oropharyngeal cancer patients : Primary site, flap design, aspiration, velopharyngeal insufficiency, residue at the swallowing end

Case	Primary site (T tage)	Flap designs	Aspiration	VPI	Residues
1	Tonsil (T2)	Unilobed	N	N	N
2	Tonsil (T2)	Unilobed	N	N	N
3	Tonsil (T2)	Tetralobed	N	Y	20−40%
4	Tonsil (T2)	Unilobed	N	N	N
5	Tonsil (T2)	Tetralobed, Double folding	N	N	N
6	Tonsil (T4)	Tetralobed	N	N	N
7	Tonsil (T4)	Tetralobed, Double folding	N	Y	20−40%
8	Tonsil (T4)	Tetralobed, Double folding, *S*	Y	Y	10%
9	RMT (T2)	Pentalobed	N	N	N
10	Tongue (T4)	Trilobed, S	N	Y	50%
11	Tongue (T4)	Bilobed, S	N	N	20−30%
12	Soft palate (T4)	Tetralobed	N	N	N
13	Tongue (T2)	Unilobed	N	N	N
14	Tongue (T2)	Tetralobed	N	N	N
15	Tonsil (T2)	Tetralobed	Y	N	N
16	Tonsil (T4)	Trilobed	N	Minimal	50%
17	Tongue (T2)	Bilobed	N	N	N
18	Tongue (T2)	Bilobed	N	N	Minimal
19	Tongue (T2)	Bilobed	N	Minimal	N
20	Tonsil (T2)	Unilobed	N	N	N
21	Tongue (T2)	Bilobed	N	N	N
22	Tongue (T2)	Bilobed	N	N	N
23	Tonsil (T3)	Bilobed	Y	N	20−30%
24	Tongue (T3)	Bilobed	N	N	20−30%
25	Tonsil (T3)	Tetralobed	N	N	20−30%
26	Tongue (T3)	Bilobed	N	N	N
27	Tonsil (T2)	Bilobed	N	N	N
28	Tonsil (T2)	Bilobed	N	N	Minimal
29	Tongue (T2)	Unilobed	N	N	N
30	Soft palate (T2)	Bilobed	N	N	N
31	Tonsil (T3)	Trilobed	N	N	Minimal
32	Tongue (T4)	Bilobed	N	N	20−40%
33	Tonsil (T2)	Bilobed	N	N	Minimal
34	Soft palate (T4)	Tetralobed	N	N	Minimal

* : sensate flap. N : no, Y : yes

Table 3. Summary of speech analysis

Cases	Primary site	Flap designs	Organ movements	GRBAS	Precise consonants (%)	Speech intelligibility	Nasalance
1	Tongue (T2)	Bilobed	Slightly restricted tongue lateralization to Rt. side Slightly restricted tongue elevation	0	67	9	++
2	Tongue (T2)	Bilobed	Tongue elevation (−), protrusion (−) Restricted lateralization to ipsilateral side	0	46	8	+
3	Tongue (T2)	Bilobed	Slight tongue tremor	0	67	7	+
4	Tongue (T2)	Bilobed	Restricted tongue elevation, protrusion, lateralization	1	76	9	0
5	Tongue (T2)	Bilobed	Slightly restricted tongue elevation	0	97	9	0
6	Tongue (T3)	Bilobed	Slightly restricted tongue elevation	2	76	7	+
7	Tongue (T3)	Bilobed, S	Restricted tongue deviation, lateralization, protrusion	1	67	7	+
8	Tonsil (T2)	Unilobed	Restricted tongue lateralization to contralateral side	2	100	10	+
9	Tonsil (T2)	Tetralobed, PL, DF	Slightly slow tongue movement	2	100	8	++
10	Tonsil (T3)	Tetralobed, PL, DF	Normal	2	100	10	+
11	Tonsil (T4)	Tetralobed	Normal	0	100	9	0
12	Tonsil (T4)	Tetralobed	Restricted tongue movement to upper, lower, ipsilateral side	0	95	9	0

PL : palmaris longus tendon, DF : double folding flaps

of the free flap was diverse from unilobed to multilobed. The flap was sometimes used as double folded and even the dynamic flap reconstruction with palmaris longus muscle tendon was performed.

From the total of 84 patients, 84 patients underwent MBS (Modified Barium Swallowing) after the surgery. Velopharyngeal insufficiency, aspiration, residue after swallowing were analyzed according to the primary site and T classification (Table 2).

Postoperative speech evaluations for 23 patients were performed by the speech therapist from the speech-language rehabilitation clinic in our hospital. Consonant articulation, speech intelligibility[2], hoarseness evaluation and speech resonance test were done. Consonant articulation was analyzed in percentage (%) according to the awareness of speech therapist. Speech intelligibility was measured according to Hirose scale as the total of 10 points with the maximum of 5 points for the full understanding of the family and 5 points for the understanding of speech therapist.

Hoarseness was graded from grade 0 to 3 for the overall hoarseness among GRBAS scale and the higher the number, the higher the hoarseness. For the hypernasality test, the resonance degree was measured by speech therapist subjectively.

Results

84 patients underwent MBS in an average of 19.7 days after the surgery and out of these patients, most of the primary sites were tongue and tonsil. The analyzed results showed that 46 patients out of 84 patients (54.7%) had mild aspiration, 4 patients had velopharyngeal insufficiency (4.7%) and 24 patients had residue after swallowing (28.5%) (Table 2).

When the MBS results were analyzed with T classification, the number of patients with velopharyngeal insufficiency or residue after swallowing was higher with increasing T stage .

Speech evaluation by the speech therapist was done in an average of 27.7 months after the surgery with 5 tongue cancer and 14 tonsil cancer patients. Hoarseness was normal or mildly flawed in most of the patients. 23 out of 12 patients showed 85% accuracy of consonants articulation. For the speech intelligibility, 4 out of 23 patients showed moderate intelligibility and 19 showed excellent intelligibility. In the hypernasality evaluation, 3 patients showed moderate degree hypernasality (Table 3).

With the comparative analysis of speech evaluation between tongue cancer group and tonsil cancer group, 4 patients from tonsil cancer group showed 100% accuracy. For the speech intelligibility, there were more patients with excellent intelligibility from tonsil cancer group than tongue cancer group, showing that relatively the accuracy of articulation was better in tonsil cancer group than tongue cancer group. There were no definite differences in speech resonance test between two groups .

Discussion

Oral tongue, base of tongue, and soft palate play roles in swallowing, articulation and airway protection. When the primary site of oral or oropharyngeal cancer is resected widely, the removal of these specialized structures brings inevitable functional loss. Therefore, structural and functional reconstruction of defect area in addition to curative tumor resection takes an important part in improving the quality of life. With the recent development in microvascular surgery, the free flap is widely used in head and neck area and especially the radial forearm free flap is popularly used. Although there are some reports that lateral thigh flap is better than radial forearm free flap to maintain the volume of defect area while total glossectomy or extensive resection of oropharyngea[2], the radial forearm free flap is most widely used for oral and oropharyngeal reconstruction because it is thin, it has less hair, a thick diameter of blood vessel used and less anatomical diversity, it is possible to use as complex flaps including nerve and palmaris logus tendon and it is suitable for morphological and functional design for wide range of complex defects inside the oral and oropharyx[3-5].

The intraoral reconstruction using pectoralis major flap is lacking the flexibility, is difficult to suture and it has an impairment for pronunciation and swallowing function so that it is not much of use recently compared to the past. Wan-Fu et al reported that when they compared pectoralis major flap with radial forearm free flap for 60 cases of tongue cancer patients who underwent the reconstructive surgery, postoperative radial forearm free flap had better results for articulation intelligibility than pectoralis major flap and in case of swallowing function there were no differences between two groups[6].

There were several reports for assessment of swallowing and speech-language ability after reconstructing the soft palate by using radial forearm free flap. Sinha et al reported that it was possible to maintain the swallowing function for 14 patients (87.5%) within 6 weeks after the soft palate reconstruction with 16 cases of radial forearm free flap, and the articulation with clear consonation was possible for 11 patients (68.5%).[7]

Seikaly et al reported that 94% of oropharyngeal reconstruction patients showed the successful swallowing function and only 5% patients showed aspiration[8].

Even though oral and oropharyngeal reconstruction described above can be reconstructed by using various flap techniques, the large defects caused by extensive resection of oropharyngeal and soft palate can have good functional recovery results after the reconstructive surgery by combined use of various flap techniques or by applying the more applied techniques with flap.

To reconstruct the mucous layer of oral and nasal cavity side for oropharyngeal and soft palate, the central part of radial forearm free flap can be used by double folding or by including the palmaris longus tendon to flap and suturing the palmaris longus tendon to the residual muscles of soft palate, the reconstructed soft palate can move dynamically and the functional opening and shutting of soft palate and pharynx may be promoted during swallowing and articulation. In this study, total 13 cases of reconstructive surgery like the above were used and the good functional outcome was shown after the surgery. Lew et al evaluated the degree of nasality after reconstructing the soft palate by double folding the central part of radial forearm free flap which was designed as multilobed, the degree of nasality was 48.4% showing no significant difference compared to 35.4% for normal and the outcome was good for all patients even possible to have a telephone conversation with other people[9].

As the defects of oropharyngeal and soft palate become extensive and are closer to the full defects, it is better to cover the nasal cavity side by using the superiorly based pharyngeal flap. This is because when the atrophy of flap occurs postoperatively, the soft palate reconstructed with radial forearm free flap plays a role as reducer for the velopharyngeal closure insufficiency by being drawn to the posterior pharyngeal wall as well as it provides the epithelial layer to the nasal cavity side[10][11].

In this study, to promote the velopharyngeal closure during swallowing for reconstruction of soft palate, various reconstructive methods (double folding, palmaris longus tendon, superiorly based pharyngeal flap) were used and two cases of mild velopharyngeal insufficiency (VPI) were observed, but it was recovered and a normal oral diet was possible for most of them.

For total glossectomy or subtotal resection patients, the possibility of occurring the VPI or aspiration is relatively low when the defected area didn't invade the soft palate.

According to the report of Weber et al, 100%, and 93% showed the high swallowing success rate for patients who underwent the total glossectomy[12].

The malfunction of swallowing function can be complemented by understanding the occurrences, causes and the degree of aspiration or VPI while swallowing through MBS with the persistent swallowing practice to complement this. In this study, for 46 patients who showed the aspiration during MBS, the normal diet for most of them were possible 1.5-3 months after the surgery through appropriate swallowing practice depending on the causes. Some reported that

the glossectomy with anteroposterior direction rather than lateral direction could cause a bigger impairment for the maintenance of swallowing function and articulation intelligibility for oral and oropharyngeal cancer patients[13]. Also some reports mentioned that radial forearm free flap is more excellent for the swallowing function than the simple suturing of defect area after the tongue resection. This is because it is easier to lift the tongue and link with whole palate when the free flap is used.[14)15)] If the oral and oropharyngeal defects occur, the consonant articulation is more decreased than the vowel for the speech-language functionality. Especially, if there is a velopharyngeal closure, decrease of speech intelligibility due to the hypernasalization is occurred which is particularly because of the articulation difficulty for plosive and fricative sound. In this case, if the articulation intelligibility and consonation test are performed, it is possible to evaluate not only reconstructed oropharyngeal function but also functional conditions of lip and tongue. Therefore, this makes it possible to know which part of intraoral structures is causing the articulation impairment and this will help to establish the direction of postoperative speech rehabilitation. Salibian et al said that the language successful rate was excellent as 80−100% after the reconstruction with the radial forearm free flap[16], and in this study, more than 85% showed consonant articulation and 82% of patients showed more than excellent grade with more than 8 points(maximum of 10 points) for speech discrimination, and thus the maintenance rate of articulation function for radial forearm free flap was very high. McConnel et al also reported that 72% patients showed the excellent speech discrimination three month after the surgery.

Conclusion

After surgical treatment of oral or oropharyngeal cancer, appropriate structural and functional reconstruction of the defect area is important, especially if the defect area includes oral tongue, base of tongue, or soft palate, because it can cause disabilities in swallowing or speech functions.For the past 10 years, radial forearm free flap was used for the reconstruction of the defect area after the surgical treatment of the patients with oral or oropharyngeal cancer and it brought satisfactory results in swallowing and speech functions.

In conclusion, the radial forearm free flap is the most appropriate material that should be considered first for the structural and functional reconstruction of the defect area after the surgical resection of the oral or oropharyngeal cancer.

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