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Functional outcome after partial glossectomy with reconstruction using radial forearm free flap

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ABSTRACT

Objective: The purpose of this study was to investigate the relationship between the radial forearm free flap (RFFF) volume changes and speech and swallowing outcomes.
Methods: The study included 18 subjects with squamous cell carcinoma of the oral tongue.
Results: Average percentage changes in flap volume between 3 and 12 months was 19.2%. Postoperative free flap volume changes were significantly and negatively correlated with the word and sentence intelligibility ($Y = -0.338X + 43.641$, $r^2 = 0.383$, $p = 0.006$ and $Y = -0.246X + 34.322$, $r^2 = 0.321$, $p = 0.014$, respectively). A significant positive correlation was also found between word and sentence intelligibility and floor of mouth resected, postoperative irradiation. Postoperative flap volume changes between 3 and 12 months were correlated with reduced posterior bolus movement by tongue ($p = 0.002$), reduced tongue base to posterior pharyngeal wall contact ($p = 0.002$), reduced laryngeal elevation ($p = 0.005$), increased aspiration ($p = 0.005$), delayed oral ($p = 0.010$) and pharyngeal transit time ($p = 0.011$). Floor of mouth resected, tongue base resected, and postoperative irradiation also influenced the swallowing outcomes.
Conclusions: This study shows that postoperative flap volume changes are significantly related to speech and swallowing outcomes in patients undergoing partial glossectomy reconstructed with RFFF.

1. Introduction

Restoration of function following glossectomy is one of the great remaining challenges for head and neck reconstructive surgeons. The extent of surgical resection, particularly, the amount of oral tongue and tongue base resected, has been implicated as the primary correlate of swallowing impairment in postsurgical oral and oropharyngeal cancer patients [1–4]. Some studies have suggested that swallowing function depends on the method of reconstruction rather than on the degree of resection [5–7]. The principal goal of tongue reconstruction is to re-establish the functions of speech, mastication, and swallowing, and thus, microvascular tissue transfer has been regularly employed since the 1990s. The advantages of microvascular reconstruction of the tongue are; freedom of flap placement without tethering, the possibility of bone reconstruction, and the possibility to model and design the desired form [8]. It is now recognized that immediate reconstruction at the time of tumor resection optimizes functional results [9]. Furthermore, because the volume of the reconstructed tongue affects functional outcomes, such as, swallowing function and speech intelligibility, changes observed in the neotongue after a long-term follow-up require investigation [1,10,11]. As we previously reported, overcorrection with a 40% greater radial forearm free flap (RFFF) volume is recommended for the reconstruction of tumor-related defects in the head and neck [12].

RFFF is the most commonly used sensate flap in the head and neck. The thin, pliable nature of the fasciocutaneous flaps is ideally suited for head and neck reconstructions, especially when the defect involves multiple sites, such as the pharyngeal wall, soft palate, and tongue base. In our experience, reconstruction with the RFFF is a safe and effective method associated with the restoration of the functional outcome among patients undergoing partial glossectomy.

The purpose of this study was to estimate postoperative RFFF volume changes and evaluate the relationship between free flap volume changes and speech and swallowing functions in patients after partial glossectomy.

2. Materials and methods

2.1. Patient population

The clinical and pathological data of 40 consecutive patients diagnosed with tongue cancer that underwent partial glossectomy

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followed by RFFF reconstruction at the Department of Otolaryngology – HNS, the Catholic University of Korea, Seoul, from May 2003 to July 2008, were reviewed. Enrolment criteria included the availability of a CT scan at 3–4 and 11–13 months postoperatively. Twenty-two patients were excluded because of a history of tumor recurrence after treatment or the absence of follow up CT scans. The study population therefore consisted of 18 patients. All free flap reconstructions were performed by the same surgeon (the last author). Speech and swallowing analyses were completed on average 21.6 months after the operation (range: 12–65 months). The Institutional Review Board of the Seoul St. Mary's Hospital (Seoul) approved this retrospective review of medical records.

2.2. CT image acquisition

Routine neck CT scans were performed using a SOMATOM Volume ZoomTM (Siemens, Forchheim, Germany) in spiral mode. Technical factors were; 120 kV, 240 mA, 3 mm slice thickness, and 1 s scanning time. The field of view used was 215 × 215 mm, and this resulted in a 512 × 512 matrix.

Imaging data were stored in a DICOM (Digital Imaging and Communication in Medicine) file, imported to a personal computer, and then using 3D-DOCTOR software (Able Software Corp, 5 Appletree Lane, Lexington, MA), we reconstructed 3-D images in accordance with anatomic boundaries (Fig. 1). The window widths and centers were varied, depending on the type of tissue being examined.

2.3. Flap volume measurements

The maximum diameter of each reconstructed tongue on CT images was determined using the software and a mouse controlled cursor. In each case, the flap borders of the reconstructed tongue were traced manually on the screen using a mouse-controlled cursor on an axial image. The software then generated a 3D model and directly calculated reconstructed tongue volume.

2.4. Speech intelligibility assessment

A speech-language pathologist assessed the word and sentence intelligibility using the Korean Urimal Test of Articulation and Phonology® published by the Korean Academy of Speech-Language Pathology and Audiology. The Korean Urimal Test of Articulation and Phonology® measured the percentage of consonants correct. It was designed on the basis of the Peabody Picture Vocabulary Test – Revised and standardized on Korean. Twenty-two picture cards were used to elicit 43 Korean consonants in word initial syllable, word medial syllable, word final syllable position (Table 1).

2.5. Swallowing assessment

Videofluoroscopic images were recorded and analyzed with a KayPentax Digital Swallowing Workstation (model 7200; Kay Pentax, Lincoln Park, NJ). The recordings were completed by a radiologist in the Radiology Department at our hospital. Three consistencies of food were given to each patient: water mixed with liquid barium (Polibar Plus liquid, barium sulfate suspension; Therapex) in a 3:1 ratio presented in a cup; approximately 10 mL of pudding mixed with paste barium (Esobar, barium sulfate cream; Therapex) in a 3:1 ratio presented in a spoon; and one quarter of a digestive cookie coated with barium paste. Two trials of each consistency were consumed while videofluoroscopic recording took place. All patients consumed as many of the 3 consistencies of food as possible, with some consistencies excluded for certain patients because of anatomic constraints

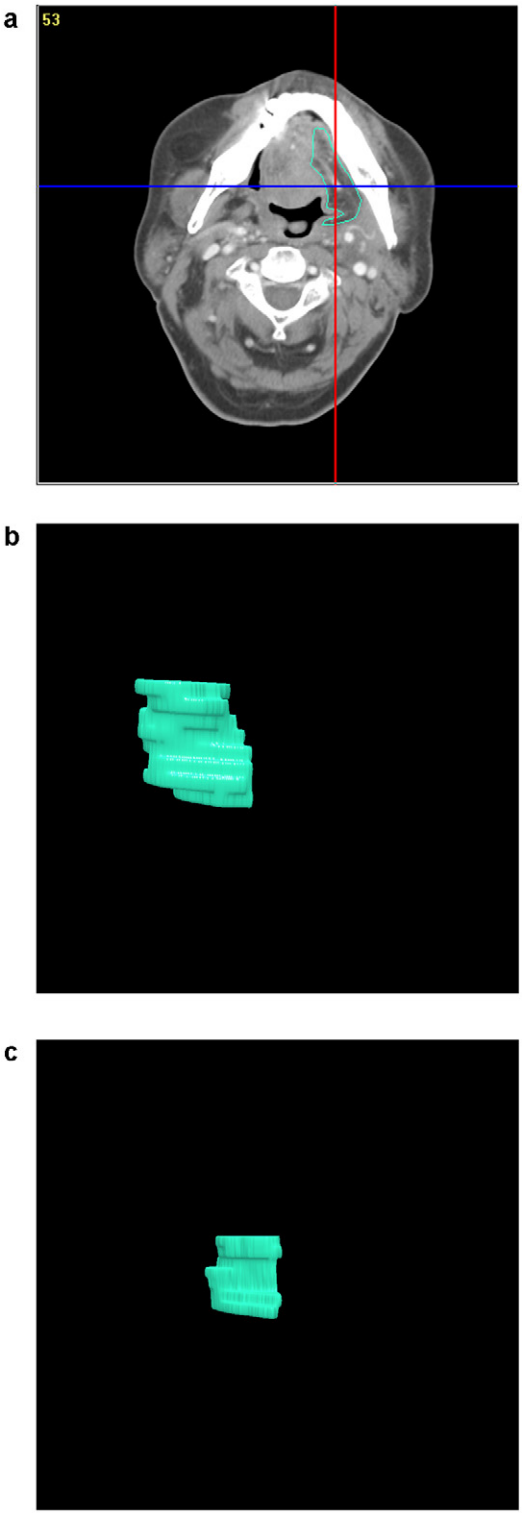

Fig. 1. CT sections of a tongue reconstructed using a radial forearm free flap and 3-D reconstructed radial forearm free flap images; A: axial image, B: reconstructed image at 3 months post-glossectomy, and C: reconstructed image at 12 months.

(i.e., absence of dentition) or clinician perceived clinical risk to the patient.

Posterior bolus movement by tongue, inflow of barium into the pharynx before swallowing, tongue base to posterior pharyngeal wall contact, pharyngeal wall contraction, laryngeal elevation, stasis in the epiglottic vallecula, stasis in the oral cavity after swallowing, and laryngeal aspiration, were evaluated. Swallowing