Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology 27 (2015) 608–613

Contents lists available at ScienceDirect

Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology

journal homepage: www.elsevier.com/locate/jomsmp

Original Research

Morphological changes of upper airway and dysphasia problems in oral cancer patients with oropharyngeal reconstruction surgery

Hiroto Itoh [a,*], Akitoshi Katsumata [c], Kei Kashimura [a], Yukihiro Iida [c], Tadahide Noguchi [a], Shunji Sarukawa [b], Yoshinori Jinbu [a], Mikio Kusama [a]

[a] Department of Dentistry, Oral and Maxillofacial Surgery, Jichi Medical University, Tochigi, Japan
[b] Department of Plastic Surgery, Jichi Medical University, Tochigi, Japan
[c] Department of Oral Radiology, Asahi University, School of Dentistry, Gifu, Japan

ARTICLE INFO

Article history:
Received 10 December 2013
Received in revised form 6 August 2014
Accepted 24 September 2014
Available online 6 November 2014

Keywords:
Morphological changes
Upper airway
Computed tomography (CT)
Videofluorographic swallowing study (VFSS)
Oral cancer

ABSTRACT

Objective: Swallowing statuses in patients with advanced cancers that require reconstruction have not been studied well. The relationship between topography of the reconstructed upper airway and swallowing status was evaluated.
Material and methods: Subjects comprised 19 cases of tongue cancer and 10 cases of mandibular cancer who underwent resection of the primary lesion and reconstructive surgery with the vascularized free flap. CT image data preoperatively and postoperatively were utilized to evaluate morphological airway changes. Videofluorographic swallowing study (VFSS) was performed postoperatively. Aspiration and laryngeal penetration were noted and compared with morphological airway changes.
Results: Regarding postoperative airway morphology, no significant differences in postoperative airway changes were apparent between tongue and mandibular cancers. In postoperative VFSS, aspiration and/or laryngeal penetration was seen in 32% of the tongue cancer cases and 20% of the mandibular cancer cases.
Conclusion: Cases with aspiration and/or laryngeal penetration revealed less reduction of postoperative cross-sectional area compared to other cases.

1. Introduction

The main functions of the oropharyngeal cavity are speech, mastication, and swallowing. With the progress of surgical treatment for oral cancer, various grafting surgeries have been applied for massive tissue defects [1]. Although grafting surgeries have been performed to reconstruct the oral cavity and upper airway, patients may experience eating and swallowing disability along with aspiration [2–7].

The videofluorographic swallow study (VFSS) is the gold standard modality for diagnosing swallowing disorders. VFSS offers superior ability to diagnose the presence of aspiration [8]. In our clinical experience, VFSS after oropharyngeal reconstruction surgery can reveal more complicated findings than dysphagia due to other diseases. Some patients complain of postoperative difficulty in swallowing even when no functional abnormality is apparent on VFSS. In other cases, although some abnormalities are seen on VFSS, subjective dysphagic symptoms are absent. Fluoroscopic imaging, including VFSS, shows 2-dimensional transparent images from a single direction. VFSS is appropriate for observing dynamic swallowing, but is not suitable for quantitatively evaluating the morphology of deformed oral and pharyngeal cavities following surgery.

Computed tomography (CT) and magnetic resonance imaging (MRI) showing precise cross-sectional images of the body are necessary for the diagnosis, treatment planning and follow-up of head and neck malignancies. In comparison with MRI, CT offers advantages in distinguishing airway from surrounding tissue due to air revealing a particular CT value of −1000 HU (Hounsfield units) [9]. Three-dimensional (3D) reconstruction of CT data has been used to depict and evaluate various anatomical structures, such as the skeletal hard tissues, muscles, facial appearance and airways [10–15].

☆ Asian AOMS: Asian Association of Oral and Maxillofacial Surgeons; ASOMP: Asian Society of Oral and Maxillofacial Pathology; JSOP: Japanese Society of Oral Pathology; JSOMS: Japanese Society of Oral and Maxillofacial Surgeons; JSOM: Japanese Society of Oral Medicine; JAMI: Japanese Academy of Maxillofacial Implants.

* Corresponding author at: Department of Oral and Maxillofacial Surgery, Jichi Medical University, 3311-1 Yakushiji Shimotsuke-City, Tochigi 329-0498, Japan. Tel.: +81 285 58 7390; fax: +81 0285 44 8669.
E-mail address: hirotos@jichi.ac.jp (H. Itoh).

http://dx.doi.org/10.1016/j.ajoms.2014.09.012
2212-5558/

Among various oral cancers, tongue cancer and mandibular cancer are relatively frequent. In addition, the concept for surgical approaches differs between these two lesion types [16]. We studied the relationship between morphological changes of the upper airway following reconstruction surgery and swallowing status using 3D-CT imaging and VFSS.

2. Materials and methods

Subjects comprised 19 patients with tongue cancer and 10 patients with mandibular cancer who had undergone resection of the primary lesion and reconstructive surgery with a vascularized free flap. Surgical methods for resection included 2 cases of partial glossectomy, 5 cases of hemiglossectomy of the moving part of the tongue (not including the tongue root), 7 cases of subtotal excision of the moving part of the tongue (not including the tongue root), 5 cases of hemiglossectomy (includes the tongue root) and 10 cases of segmental mandibular resection. The extent of resection in the ten mandibular gingival cancer cases was as follows: from the right lower canine to the right retromolar gingiva of the mandible in 2 cases; from the right mandibular central incisor to the right retromolar gingiva of the mandible in 2 cases; from the right mandibular first molar to the right mandibular first premolar in 1 case; and from the right mandibular lateral incisor to the anterior margin of the right mandibular ramus in 5 cases.

The contents of this study were reviewed and approved by Jichi Medical University Hospital, Ethical Review Board for Clinical Study A (April 20, 2012, No. A11-73). Table 1 provides a summary of the cases.

All 29 patients underwent neck dissection, including 3 cases of total neck dissection, 1 case of functional dissection, and 25 cases of supraomohyoid neck dissection. Regarding the oropharyngeal reconstruction, muscle flap harvest sites in tongue cancer cases included the lateral thigh in 16 cases and rectus abdominis in 3. Four cases of mandible cancer were treated using iliac flaps and 6 cases were treated using fibular flaps.

Volumetric CT data from preoperative examination and from 1 month postoperatively were utilized to evaluate morphological airway changes. CT was performed with the patient supine using a multislice helical CT apparatus (Aquilion CX; Toshiba, Tokyo, Japan). Imaging parameters were: X-ray tube voltage, 120 kV; tube current, 200 mA; slice pitch, 2 mm; matrix size, 512 × 512; and field of view, 250 mm. Three cross-sectional reference planes were defined for the upper airway as follows. Plane A was a cross-section parallel to the line connecting the posterior nasal spine and the tip of the dens axis. Plane B was a cross-section parallel to the occlusion plane. Plane C was set parallel to the inferior border of the second cervical vertebra. Fig. 1 shows a schematic of the cross-sectional planes. Using the multi-planar reconstruction (MPR) technique in OsiriX 5.0 imaging software (www.osirix-viewer.com), cross-sectional images in the above planes were rendered. A window width setting of 3000 HU and a window level of 500 HU were used to observe the pharyngeal airway. Cross-sectional area of the airway was measured and the postoperative reduction rate in cross-sectional area was calculated as:

$$\text{Postoperative reduction rate} = \frac{D_0 - D_1}{D_0} \times 100$$

where D_0 is the preoperative cross-sectional area and D_1 is the postoperative cross-sectional area.

Fig. 2 shows the procedure to define objective cross-sectional planes and to measure cross-sectional area of the upper airway.

VFSS was performed 1 month postoperatively. A general-purpose X-ray fluoroscope system (SONIALVISION safire; Shimadzu, Kyoto, Japan) was used for fluoroscopic imaging. The X-ray tube voltage was set at 80–90 kV and tube current was set at 2 mA. Examinations were performed in the natural feeding posture of sitting upright. The angle between the trunk of the body and the seat of the chair was approximately 90°. Images from the lateral and frontal views were acquired without fixation of the patient's head.

Barium sulfate contrast media (30%) with thickened (gelatinous) material was used as the test food. Patients swallowed autonomously, and the course of the simulated food was imaged from eating to complete passage through the esophagus phase. Aspiration and laryngeal penetration were noted and compared with morphological airway changes.

For statistical analyses, the non-parametric Mann–Whitney *U* test was used to compare the reduction ratio of cross-sectional airway between groups with and without aspiration/larynx invasion.

Tests were performed using PASW Statistics version 17.0 statistical software (SPSS Inc, an IBM Company, Chicago, USA). Differences associated with values of $p < 0.05$ were considered significant.

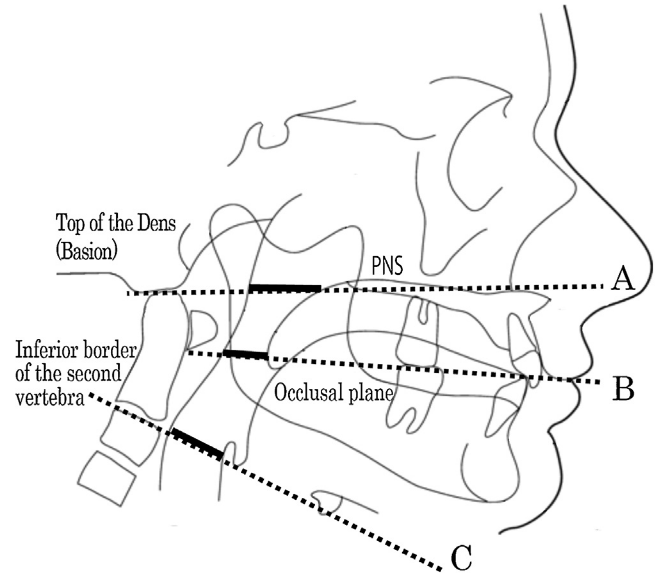

Fig. 1. Reference points for cross-sections A, B, and C. (A) Parallel to the line connecting the posterior nasal spine (PNS) and the tip of the dens axis (basion). (B) Parallel to the occlusion plane. (C) Parallel to the inferior border of the second vertebra.

Table 1
Outline of the 29 cases of oral cancer.

	Tongue cancer	Mandible cancer
Number of patients (male/female)	19 (14/5)	10 (7/3)
Age (mean ± SD)	62.1 ± 12.5	68.8 ± 7.0
Surgical technique	PG = 2, HM = 5, SE = 7, HE = 5	SM = 10
Neck dissection technique	TND = 3, FND = 1, SOHND = 15	SOHND = 10
Flap harvest sites	Thigh = 16; rectus abdominis = 3	Fibula = 6; ilium = 4

PG, partial glossectomy; HM, hemiglossectomy of the moving part of the tongue (not including the tongue root); SE, subtotal excision of the tongue (not including the tongue root); HE, hemiglossectomy (including the tongue root); SM, segmental mandibular resection; TND, total neck dissection (lymph nodes dissection: Level I–V, other structures excised: sternocleidomastoid muscle, internal jugular vein, spinal accessory nerve, submandibular salivary gland); FND, functional neck dissection; SOHND, supra-omohyoideus neck dissection; SD, standard deviation.

3. Results

From CT measurements, cross-sectional area of the airway was reduced in 23 of the 29 cases (79%) and was enlarged in