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Factors affecting volume change of myocutaneous flaps in oral cancer

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Abstract. After oral cancer resection with flap reconstruction, the volume of the flap decreases over time. The purpose of this study was to estimate the volume change in myocutaneous flaps and to identify the clinical factors associated with this volume decrease. Postoperative computed tomography scans and magnetic resonance images of 30 patients, obtained at 1, 6, and 12 months after oral cancer resection with myocutaneous flap reconstruction, were reviewed retrospectively. Changes in the volume of the flaps over time were assessed. The residual flap ratio was calculated using the flap volume at 1 month after reconstruction as the denominator. The residual ratios in relation to clinical factors were compared at 6 and 12 months using the Student *t*-test. Overall, the flap residual ratio was 78.1% (range 64.1–93.9%) at 6 months and 71.4% (range 48.8–87.2%) at 12 months. Hypertension, diabetes mellitus, and postoperative radiotherapy were significantly associated with volume changes at 6 months, and postoperative infection and decreased serum albumin levels were associated with volume changes at both 6 months ($P = 0.015$ and $P = 0.001$, respectively) and 12 months ($P = 0.026$ and $P = 0.017$, respectively). Flap reconstruction must be performed with postoperative flap atrophy in mind in order to preserve optimum speech and swallowing function.

Keywords: oral cancer; reconstruction; myocutaneous flap; volume change; latissimus dorsi myocutaneous flap; pectoralis major myocutaneous flap; rectus abdominis myocutaneous flap; residual ratio.

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Tissue defects after the resection of oral cancer have a major effect on speech and swallowing and on cosmetic appearance, all of which contribute greatly to postoperative quality of life.[1–7] Currently, free flaps and pedicle flaps are used widely for reconstruction after the resection of oral cancer, and reconstructive procedures appropriate for each case can be selected. Myocutaneous flaps including the rectus abdominis myocutaneous (RAM) flap, pectoralis major myocutaneous (PMMC) flap, and latissimus dorsi myocutaneous (LDM) flap are frequently used for the restoration of large tissue defects.[7]

A flap of optimal volume is very important for swallowing function and speech intelligibility. Flap volume is known to decrease gradually over time due to muscle atrophy, infection, radiation, and the patient's nutritional status.[8–11] Therefore, it is important to select the type and volume of myocutaneous flap for reconstruction under the assumption of an eventual volume decrease. Although studies have compared different types of flaps, such as the RAM flap, forearm flap, and anterolateral thigh (ALT) flap, none of these studies appears to have investigated three myocutaneous flaps alone.

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A retrospective study was performed to investigate the long-term volume changes in myocutaneous flaps after oral cancer resection with flap reconstruction and to determine the clinical factors with the greatest effect on the volume decrease.

Materials and methods

Patient characteristics

The cases of 30 patients treated for oral cancer with resection and myocutaneous flap reconstruction in the department of oral and maxillofacial surgery of a university hospital in Kumamoto between 2004 and 2013 were reviewed retrospectively. Twenty-one of the patients were men and nine were women. Their mean age was 64.1 years (range 28–83 years). Cases of local and regional recurrence were excluded. The primary site was the tongue in 11 patients, the lower gingiva in 10, the upper gingiva in two, the buccal mucosa in three, the oral floor in three, and the hard palate in one. The histopathological diagnosis was squamous cell carcinoma in 28 cases and adenoid cystic carcinoma in two. A RAM flap was used in 10 patients, a PMMC flap in 10, and a LDM flap in 10. Clinical characteristics including the tumour and node classifications and the pathological stage are summarized in Table 1. In all cases, the same operator at the same hospital performed the tumour resection, neck dissection, and myocutaneous flap reconstruction.

Table 1. Patient characteristics.

Characteristic	*n* or mean (range)
Sex	
Male	21
Female	9
Age, years	64.1 (28–83)
Flap type	
Rectus abdominis myocutaneous flap	10
Pectoralis major myocutaneous flap	10
Latissimus dorsi myocutaneous flap	10
Primary site	
Tongue	11
Lower gingiva	10
Upper gingiva	2
Buccal mucosa	3
Oral floor	3
Hard palate	1
T classification	
T2	1
T3	8
T4	21
N classification	
N0	5
N1	5
N2b	18
N2c	2
Pathological stage	
III	2
IVA	28

T, tumour; N, node.

Measurements

The patients underwent a routine computed tomography (CT) examination at 1, 5–7, and 11–13 months (1, 6, and 12 months) to monitor for the recurrence of oral cancer. Magnetic resonance imaging (MRI) was performed as needed. The CT scans were performed using an Aquilion ONE scanner (Toshiba Medical Systems, Tochigi, Japan) and the MRI using an Achieva 3T scanner (Philips, Amsterdam, Netherlands) with a slice interval of <3 mm. The areas of the RAM, PMMC, and LDM flaps were calculated on each axial CT slice and the flap volume was then measured by integration using Quest/ViewC software (Yokogawa Medical Solutions Corporation, Tokyo) at the three time points. For greater accuracy, detailed information was gathered from the operator on the extent of resection, and the CT values of the boundary line were used. Furthermore, the MRI data were referred to. The area of measurement was above the body of the hyoid bone, and the residual volume ratios at 6 and 12 months were calculated using the 1-month value as the denominator. Three double-blind measurements were performed for each CT image by three experienced clinicians and the average value was used in the analysis.

Clinical factors

The associations of clinical factors with the volume change were also examined, including sex, age, flap type, hypertension, diabetes mellitus, smoking habit, body mass index (BMI), serum albumin level, history of postoperative infection, and postoperative radiotherapy. The serum albumin level was classified into two groups depending on whether it increased or decreased compared with the preoperative value. A postoperative infection was considered to be present in cases where a purulent discharge from the transplanted flap persisted for longer than 1 month.

Statistical analysis

All statistical analyses were performed using JMP 9 statistical software (SAS Institute Inc., Cary, NC, USA). Residual ratios at 6 and 12 months according to the clinical factors were compared using the Student *t*-test. A *P*-value of <0.05 indicated statistical significance.

Results

The mean reconstruction volume for the 30 cases was 60.1 cm^3 (range 18.9–136.3 cm^3). The overall residual ratio was 78.1% (range 64.1–93.9%) at 6 months and 71.4% (range 48.8–87.2%) at 12 months (Fig. 1).

The correlations between the volume change of the flaps and clinical factors are shown in Table 2. The residual ratio at 6 months was significantly lower in patients with hypertension (81.7% vs. 75.3%, $P = 0.016$), diabetes mellitus (88.9% vs. 76.9%, $P = 0.006$), and a history of postoperative radiotherapy (68.8% vs. 79.1%, $P = 0.019$), and the residual ratio was also significantly lower in patients with a history of postoperative infection than in those without at both 6 months (70.9% vs. 79.5%, $P = 0.015$) and 12 months (58.8% vs. 73.9%, $P = 0.001$) (Fig. 2). For patients with increased vs. decreased serum albumin levels, the residual ratio at 6 months was 82.0% vs. 75.6% ($P = 0.026$) and at 12 months was 77.4% vs. 67.8% ($P = 0.017$) (Fig. 3). Thus, a

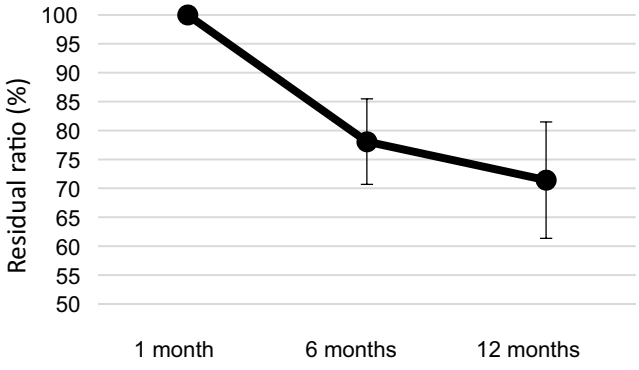

Fig. 1. Overall residual ratio. The overall residual ratio was 78.1% at 6 months ($n = 30$) and 71.4% at 12 months ($n = 30$). Error bars represent the standard deviation.