

Research Paper
Reconstructive Surgery

Assessing stomatognathic performance after mandibulectomy according to the method of mandibular reconstruction

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Abstract. The aim of this study was to investigate stomatognathic performance after mandibulectomy. Twenty-six subjects were classified into two groups: the mandibular continuity (MC) group were reconstructed and kept in MC, while the mandibular non-continuity (MNC) group lost MC. Stomatognathic performance was evaluated using the Oral Health Impact Profile in Japanese (OHIP-J), a colour-changing chewing gum, a gummy jelly, Sato's questionnaire, electromyography (EMG) of the masticatory muscles, and mandibular movement. The OHIP-J and modified Sato's questionnaire revealed that the physical and eating disability of the MNC group was significantly more severe than that of the MC group ($P < 0.05$). The mean EMG activity of the anterior temporalis muscle in the relaxed state was significantly higher in the MNC group than in the MC group ($P < 0.05$). The mean masticating/relaxing ratio of EMG activities for the masseter muscle was lower in the MNC group than in the MC group ($P < 0.05$). The maximum mouth opening range of the MNC group was greater than that of the MC group ($P < 0.05$). Accordingly, the MC group had good results for physical and eating ability. The MNC group suffered from muscle fatigue but had the advantage of a greater maximum mouth opening range.

Key words: stomatognathic performance; mandibular reconstruction; mandibulectomy; mandibular movement; masticatory muscles; masticatory performance.

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Surgical resection of the mandible often results in various stomatognathic dysfunctions. In particular, when a segmental or hemi-mandibulectomy is performed, jaw

movements, chewing functions, and dental articulation are compromised because the remaining mandible loses bilateral fulcrums of the temporomandibular joint

and tends to rotate or deviate from a normal jaw position.^{1,2} These stomatognathic dysfunctions have been evaluated previously using various methods. Endo

examined electromyographic activities of the masticatory muscles in mandibulectomy patients, and Marunick et al. investigated occlusal force using a gnathodynamometer.^{3–6}

Masticatory performance is one of the essential stomatognathic functions, and has been defined as a measure of food comminution in the glossary of prosthodontic terms of the academy of prosthodontics.⁷ Manly and Braley developed a sieving test to evaluate food comminution ability.⁸ Natural foods, such as peanuts, almonds, and raw carrots, are used as test items for the sieving test.⁹ If these natural foods are packed in a finger cot, they can be manipulated even by a compromised patient.¹⁰ However, natural foods lack universality in size and hardness. Therefore artificial foods have been developed. Gummy jelly, an artificial food, has been used as a test item; the comminuted surface area is calculated according to the dissolved glucose concentration measured using a blood glucose level monitor.¹¹ This method makes it possible to assess the masticatory performance without delay in the clinical setting.

Comminuted food particles are finally diluted and broken down by saliva, formed into a bolus, and swallowed. Before bolus formation, food particles are mixed with saliva and kneaded by the teeth, as well as by the tongue and cheeks. The ability to mix and knead a food bolus has been evaluated using chewing gum or paraffin wax.¹² Recently a new colour-changing chewing gum, which changes in colour gradually from yellowish-green to red according to the amount of mastication, has been developed.¹³ This chewing gum does not adhere to denture materials, and we have demonstrated in a previous study that the colour-changing gum is a useful test material for obturator prosthesis wearers after maxillectomy.¹⁴

As a traditional questionnaire to evaluate masticatory performance in Japan, Sato's questionnaire has been used widely.¹⁵ This questionnaire asks patients whether they can masticate 20 different examples out of 100 test foods, including native Japanese foods. These 100 test foods are divided into five categories based on the chewing index, which indicates the level of food hardness and elasticity. Koyama et al. examined masticatory function after maxillectomy using Sato's questionnaire.¹⁶

Stomatognathic dysfunction influences oral health-related quality of life (OHRQoL). The Oral Health Impact Profile (OHIP) was developed in Australia as a measure of OHRQoL.

The OHIP comprises 49 items grouped into seven subscales, namely, 'functional limitation' (9 items), 'physical pain' (9 items), 'psychological discomfort' (5 items), 'physical disability' (9 items), 'psychological disability' (6 items), 'social disability' (5 items), and 'handicap' (6 items). The original OHIP was written in English, but several versions have been developed in other languages, including one in Japanese. It has been demonstrated that OHRQoL in patients with oral cancer can be measured successfully using the OHIP.¹⁷

It is generally accepted that a segmental mandibulectomy or hemi-mandibulectomy reduces stomatognathic performance significantly, however it is uncertain whether mandibular continuity after bony reconstruction contributes absolutely to an improvement in stomatognathic function.¹² In this study, the stomatognathic performance of mandibulectomy patients was investigated to clarify the distinction between subjects with and without bony reconstruction. For this purpose, mandibulectomy subjects were classified into two groups – a mandibular continuity group, in which reconstruction was done with both hard and soft tissue (MC group), and a mandibular non-continuity group, in which reconstruction was done using only soft tissue (MNC group). The OHIP-J, a colour-changing chewing gum, a gummy jelly, and Sato's questionnaire were employed to measure stomatognathic performance, and electromyographic activities of the masticatory muscles and a range of mandibular movements were also surveyed using the Win Jaw System (Zebris Medical Systems, Tübingen, Germany). Following this, a comparative study between the MC group and the MNC group was performed.

Materials and methods

Subjects

A total of 26 patients attending Kobe University Hospital, who signed the consent document for this study, were recruited. The subjects underwent a mandibulectomy in the study hospital between January 1982 and May 2010. This study was approved by the medical ethics committee of the university (No. 1094, 2011). Fifteen of the subjects were male and 11 were female; their median age was 63.5 years, with a range of 11–89 years at the time of surgery. All of the patients had attended the hospital for the removal of a mandibular disease (1 benign, 25 malignant). The clinical characteristics of the

patients are summarized in Table 1. Defects of the mandibulectomy were classified according to the CAT classification¹⁸ (Fig. 1).

The subjects were classified into two groups based on the method of reconstruction. The mandibular continuity group patients were reconstructed using both hard and soft tissue (MC group); the mandibular non-continuity group patients were reconstructed using only a musculocutaneous flap (MNC group). In the MC group, nine cases were reconstructed using an osteocutaneous fibula flap, three cases were reconstructed using a combination of a reconstruction plate and a musculocutaneous flap, and one case was reconstructed using an osteocutaneous scapula flap. In the MNC group, seven cases were reconstructed with only a rectus abdominis flap, four cases were reconstructed with a pectoralis major musculocutaneous flap, one case was reconstructed with a latissimus dorsi musculocutaneous flap, and one case was reconstructed using a forearm flap. These reconstructive operations were performed simultaneously with the mandibulectomy. Therefore, no patient undergoing reconstruction with a musculocutaneous flap at the same time as the mandibulectomy underwent rebuilding with a reconstruction plate as a secondary operation.

After surgery, radiation therapy was performed in three patients in the MC group and in seven patients in the MNC group. The following occlusal supports by natural teeth were used (Eichner's classification): in the MC group, B1 was used in six cases, B2 in four cases, B3 in two cases, and C2 in one case; in the MNC group, B1 was used in nine cases, B2 in one case, B4 in one case, and C3 in two cases. Finally, seven cases in the MC group and five cases in the MNC group required a removable denture.

All of the data described below (Fig. 2) were obtained more than 3 months after the completion of oral rehabilitation. The mean period from mandibulectomy to the time of assessment was 24.9 months (range 3.0–148.0 months) in the MC group and 52.1 months (range 7.0–246.0 months) in the MNC group.

OHRQoL measured by OHIP-49

For each of the 49 OHIP questions, the subjects were asked how frequently they experienced the target condition. A rating scale was used for the responses: 0, never; 1, hardly ever; 2, occasionally; 3, fairly often; 4, very often. OHIP-49 is divided into seven categories, and the score range is 0–36 for 'functional limitation'

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