Clinical Assessment of Chewing Function of Obturator Prosthesis Wearers by Objective Measurement of Masticatory Performance and Maximum Occlusal Force

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Purpose: Eating, which includes chewing and swallowing, is an oral function that influences quality of life. Though the swallowing ability of maxillectomy patients was reported in our previous study, the chewing function has not been fully reported to date. Thus, the purpose of this study was to evaluate the chewing function of obturator prosthesis wearers by measurement of masticatory performance and occlusal force. The relationship of these 2 measurements was also investigated. ***Materials and Methods:*** Twenty maxillofacial obturator prosthesis wearers undergoing periodic checkup at the maxillofacial rehabilitation clinic in Kyushu University Hospital were recruited for this study. Additionally, 20 young, healthy individuals were recruited as controls. Data on masticatory performance, which was measured by a sieve method using hydrocolloid material, and maximum occlusal force, which was measured by the Dental Prescale System (Fuji Film), were obtained for each participant. ***Results:*** The mean of masticatory performance was 2.6 (SD 1.2) on a 1.40-mm mesh. There was no significant difference in masticatory performance between the patient group and the controls. The mean maximum occlusal force of the patient group was 625.9 N (SD 299.1 N), which was significantly lower than that of the control group. There was no significant correlation between masticatory performance and maximum occlusal force for the patient group in this study ($P = .3726$). ***Conclusion:*** Masticatory performance of obturator prosthesis wearers with dentate or partially edentulous maxillae was not different from that of young, healthy individuals, though maximum occlusal force of these patients was lower than that of controls. *Int J Prosthodont 2006;19:253–257.*

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Three primary objectives in the comprehensive rehabilitation of maxillectomy patients are to restore the functions of mastication, deglutition, and speech.[1] Especially during eating, the complex actions of chewing, forming boluses, and swallowing can influence quality of life.[2] The swallowing ability of maxillectomy patients was reported in our previous study.[3]

There are numerous reports regarding objective assessments of chewing function. Masticatory performance and occlusal force especially have been recognized as quantitative assessment modalities and have been widely accepted in prosthetic dentistry. However, there are few reports about maxillofacial rehabilitation[4–7]; thus the purpose of this study was to clinically evaluate the chewing function of obturator

Table 1 Distribution of Aramany's Classification in the Patient Group (n = 20)

Classification	% of Patients
Class I	55.0
Class II	35.0
Class III	0.0
Class IV	0.0
Class V	0.0
Class VI	10.0

Table 2 Distribution of Eichner Index in the Patient Group (n = 20)

Classification	% of Patients
Class A	0.0
Class B	95.0
B1	5.0
B2	60.0
B3	10.0
B4	20.0
Class C	5.0
C1	5.0
C2	0.0
C3	0.0

prosthesis wearers by measurements of masticatory performance and occlusal force. The relationship between these 2 measurements was also investigated.

Materials and Methods

Subjects

Twenty maxillofacial obturator prosthesis wearers who had partially edentulous or dentate maxillae were recruited for this study. They were consecutively enrolled among all the maxillectomy patients for whom an obturator prosthesis was made in Kyushu University Hospital between April 2002 and June 2005. For partially edentulous subjects, a prosthesis covered the missing teeth regions and provided artificial teeth to restore full-arch occlusal contacts. Twenty young, healthy individuals were recruited from the faculty and staff of Kyushu University and acted as controls. Each subject was informed about the aim and procedures of this study, and consent to participate was obtained before the procedure.

Masticatory Performance

Masticatory performance was measured by an originally modified sieve method using hydrocolloid material.[8] The tear strength of the material was 0.92 N/mm under 23˚C and 50% humidity, as reported in a previous study.[8]

Masticatory performance with an obturator prosthesis was measured for the patient group. The subjects were asked to chew a piece of hydrocolloid impression material (column shaped, 12 mm in diameter, 12 mm in height, and 1.5 g in weight) freely for 10 and 20 strokes. After the completion of each chewing session, all the particles were collected into a cup and poured onto 1.70- and 1.40-mm mesh sieves. The number of particles on the 1.40-mm mesh sieve was counted, and masticatory performance was calculated by the following formula:

$$\text{Masticatory performance} = \frac{(B - A)}{10}$$

where A = number of particles obtained after 10 strokes and B = number of particles obtained after 20 strokes.

Thus, masticatory performance is represented by the increase in number of particles after one stroke. The measurements were done 3 times for each participant and the means were submitted to data analysis.

Maximum Occlusal Force

Maximum occlusal force was measured with pressure-sensitive film, Dental Prescale 50H, R-type (Fuji Film),[9] and analyzed by an original analyzing system (Occluzer, Fuji Film). The measurement was performed with obturator prostheses for the patient group. The measurements were done 3 times for each participant and the means were submitted to data analysis.

Data Analysis

Masticatory performance and maximum occlusal force of the patient group were compared to those of controls by Student *t* test (unpaired). In the patient group, the correlation between masticatory performance and maximum occlusal force was analyzed by Pearson correlation coefficient. The level of significance was set at .05. All statistical analyses were performed with Stat View 5.0 for Macintosh.

Results

Subject Profiles

Twenty maxillofacial obturator prosthesis wearers, 10 men and 10 women with a mean age of 60.8 years (SD 10.4), were recruited. All of them exhibited partially edentulous maxillae. The patient profiles, in accordance with Aramany's classification[10] and Eichner's classification,[11,12] are shown in Tables 1 and 2.

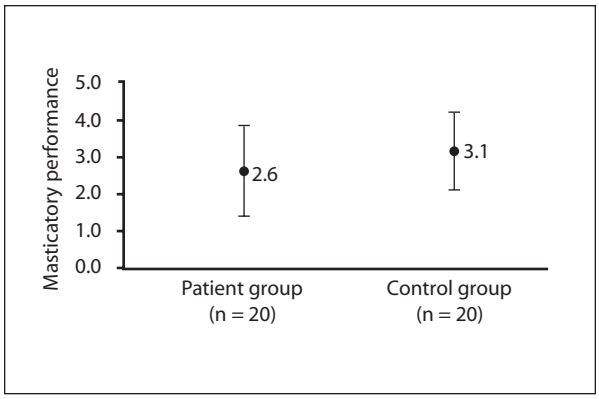

Fig 1 Distribution of masticatory performance ($P = .1529$).

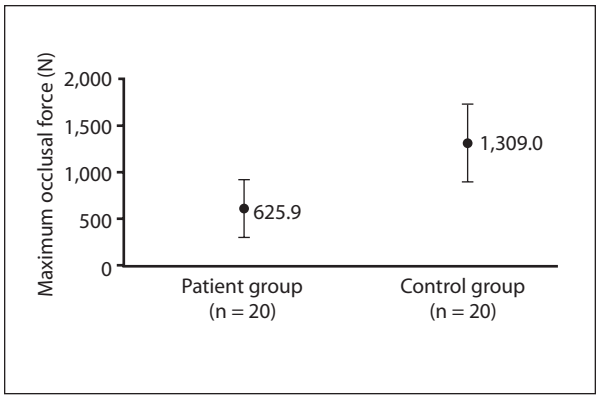

Fig 2 Distribution of maximum occlusal force ($P < .0001$).

The partially edentulous maxillectomy dental arch was evaluated with Aramany's classification as follows: Class I exhibits midline resection; Class II, unilateral resection; Class III, central resection; Class IV, bilateral anterior-posterior resection; Class V; posterior resection; Class VI, anterior resection.

The status of occlusal support of the subjects was evaluated with the Eichner index[11,12] and defined by the molar and premolar contacts of residual teeth as follows: class A exhibits contacts in 4 support zones; class B exhibits 1 to 3 support zones or contact in the anterior area only: B1 three, B2 two, B3 one, and B4 contact in the anterior area only; class C has no support zones at all, although a few teeth may still remain: C1 residual teeth in both jaws, C2 in one jaw, and C3 completely edentulous.

The control group comprised 10 men and 10 women, with a mean age of 28.0 years (SD 3.7). Four individuals had previous orthodontic treatment, including 3 individuals with all 4 first premolars extracted. Two other individuals had a congenital incisal tooth loss but no space was observed. All individuals exhibited class A in Eichner's classification.[11]

Masticatory Performance

Figure 1 shows the distribution of masticatory performance. The mean masticatory performance of the patient group was 2.6 (SD 1.2) and that of the control group was 3.1 (SD 1.0). There was no statistically significant deference between the 2 groups (*t* test, $P = .1529$).

Maximum Occlusal Force

Figure 2 shows the distribution of maximum occlusal force. The mean maximum occlusal force of the patient group was 625.9 N (SD 299.1 N) and that of the control group was 1309.0 N (SD 405.0 N). There was a statistically significant deference between the 2 groups (*t* test, $P < .0001$).

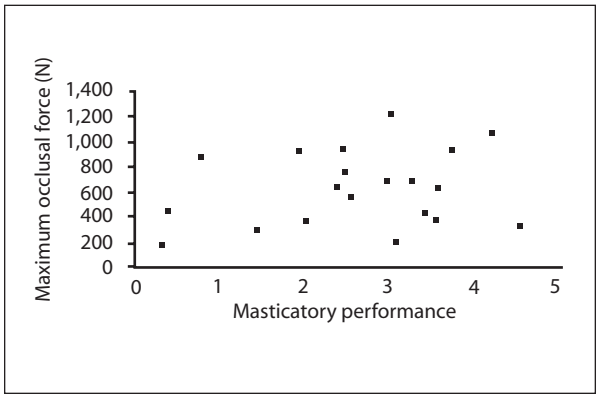

Fig 3 Relationship between masticatory performance and maximum occlusal force (n = 20) ($P = .3726$).

Correlation Between Masticatory Performance and Maximum Occlusal Force in Patient Group

The relationship between masticatory performance and maximum occlusal force for the patient group is shown in Fig 3. There was no statistically significant relationship between masticatory performance and maximum occlusal force ($P = .3726$).

Discussion

One aim of maxillofacial rehabilitation is to improve the oral functions that were deteriorated by maxillofacial defects.[1] Especially patients who have undergone maxillectomy have relatively severe disabilities in oral functions such as chewing, swallowing, and speech. Therefore it is necessary to carry out rehabilitation with an obturator prosthesis and/or surgical reconstruction after the resection procedure.

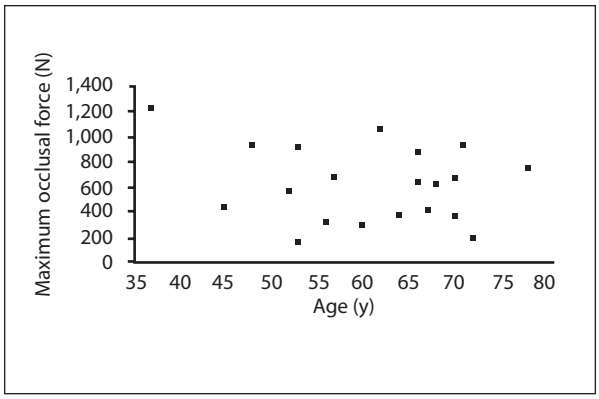

Fig 4 Relationship between age and maximum occlusal force (n = 20) (*P* = .3364).

Because eating is one of the most important oral functions and influences overall satisfaction with daily life,[2] many methods of objective evaluation of chewing ability have been introduced in the prosthodontic field. However, there are only a few studies that report on the masticatory function of maxillofacial rehabilitation patients.[4–7]

An originally modified sieve method for determining masticatory performance with hydrocolloid impression material was used in this study. This method is reproducible and simple enough for application in routine situations.[8]

The masticatory performance of the patient group was not different from that of the control group in the present study (*P* = .1529). This implied that a patient with an obturator prosthesis could crush the test material at the same degree as controls. According to the patients' profiles, 90% of their defects belonged to Class I or II in Aramany's classification[10] and 75% of the patients exhibited B1, B2, or B3 in Eichner's classification.[11] Most patients had residual occlusal supports in premolar and/or molar regions in the non-defect side. It was also reported in a previous study[13] that the rate of coincidence between the non-defect side and preferred-chewing side was 92.9%. Since the subjects were instructed to chew the test material freely in this study, it was assumed that the patients chewed at the premolar and/or molar regions in the non-defect side. For these reasons, the masticatory performance of maxillectomy patients with obturator prostheses could be as good as healthy individuals when they chewed food in the non-defect side in which posterior occlusal supports existed.

Occlusal force is a common parameter to estimate one aspect of masticatory function. With regard to the maximum occlusal force in maxillofacial defect patients, Wedel et al[7] used an originally developed system to evaluate the occlusal force of patients with congenital and acquired maxillofacial defects. They reported that the maximum occlusal force, measured at each subject's best biting location, was 120 N for those with some remaining teeth. Unfortunately, their results cannot be directly compared to our study because of the difference in measuring maximum occlusal force.

There are also a few reports on occlusal force in which the same system as this study was used. In one study,[9] the mean maximum occlusal force from 50 complete denture wearers after appropriate adjustments was 276.6 N (SD 143.0 N); and in another,[15] the median maximum occlusal force in healthy elderly individuals was 408.0 N for men and 243.5 N for women. The maximum occlusal force obtained in this study was larger than the results of these studies.

It was thought that age and condition of occlusal support were the major factors that could influence maximum occlusal force. Wedel et al[7] mentioned that the causes of extremely low maximum occlusal force in their study were the high prevalence of removable prostheses and the older age of their subjects. Likewise, Maeda et al[14] also mentioned the negative correlation between age and maximum occlusal force. Figure 4 shows the relationship between age and maximum occlusal force in this study. They showed no statistically significant relationship between in this study (*P* = .3364).

The average age of patients in this study was 60.8 years, which is older than the control group and younger than those in previous studies (mean age 70.3 and 70.4 years in Suzuki et al[9]; age range 65 to 74 years in Miura et al[15]). Also, the number of existing teeth and occlusal supports was larger than in a previous report.[15] Therefore, the maximum occlusal force in this study was larger than those in previous studies but lower than controls.

Previous studies also reported substantial variations in individual maximum occlusal force.[7,9,15] Individual variations in maximum occlusal force were also evident in this study (range: 171.8 to 1,219.3 N). This was again considered to be a result of the variations in age and the status of residual occlusal supports.

However, there was no significant negative correlation between age and maximum occlusal force in this study (*P* = .3364, Pearson correlation coefficient). It was considered that maximum occlusal force was influenced more by the status of residual occlusal supports than by age for patients in this study.

There was no significant positive correlation between masticatory performance and maximum occlusal force for the maxillectomy patients with obtura-

tor prostheses in this study. As previously mentioned, maximum occlusal force was influenced by the number of existing teeth and especially by the number of occlusal supports. It has also been reported that masticatory performance could be influenced by the occlusal contact area, especially the occlusal supports in premolar and molar regions.[16] The lack of a significant positive relationship between these 2 measurements could be explained partly by the fact that maximum occlusal force was not required for the subjects to chew the hydrocolloid material used in the present study.

Despite this study's limitations, it is interesting that there was no difference between the masticatory performances of maxillofacial obturator prosthesis wearers who had partially edentulous or dentate maxillae versus young, healthy individuals. The results may indirectly imply that the use of maxillofacial obturator prostheses improved the masticatory functions of maxillectomy patients.

Conclusions

The chewing function of maxillectomy patients with dentate or partially edentulous maxillae while wearing an obturator prosthesis was objectively evaluated by measurement of masticatory performance and maximum occlusal force. The results demonstrate:

1. Masticatory performance was not different from that of young, healthy individuals.
2. Maximum occlusal force was lower than that of young, healthy individuals.

It was suggested that the chewing function of maxillectomy patients with an obturator prosthesis could be influenced by the status of residual occlusal supports.

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