Discrepancy Between Satisfaction with Mastication, Food Acceptability, and Masticatory Performance in Older Adults

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Purpose: The purpose of this study was to investigate the relationship between self-assessed satisfaction with mastication and food acceptability and masticatory performance in a large sample of older adults with various occlusal statuses. ***Materials and Methods:*** The subjects were 708 community-dwelling, independently living elderly persons (351 men and 357 women) with a mean age of 66.0 (SD: 4.2) years. Satisfaction with masticatory function and food acceptability (apples, grilled beef, and hard rice crackers) were evaluated using questionnaires. Masticatory performance was determined using test gummy jellies developed for measuring masticatory performance. Subjects were grouped into 3 categories by posterior occlusal contacts according to the Eichner Index. The Kruskal-Wallis test and a multiple logistic regression analysis for dissatisfaction with masticatory function were conducted. ***Results:*** Overall, posterior occlusal contacts, food acceptability, and masticatory performance were associated with satisfaction with masticatory function when evaluated with bivariate analysis. Multiple logistic regression analysis showed that the number of foods that could be eaten without difficulty was the most important explanatory variable for dissatisfaction with masticatory function ($P < .01$). In contrast, objective masticatory performance was not significantly associated with dissatisfaction with masticatory function ($P = .057$) after controlling for posterior occlusal contacts and food acceptance. ***Conclusions:*** The subjective masticatory function was associated not only with objective masticatory performance, but also with an individual's posterior occlusal contacts. *Int J Prosthodont 2007;20:161–167.*

A primary goal of dental treatment is to restore oral function, especially mastication. Masticatory function can be assessed by a mix of masticatory tests, questionnaires, and personal interviews. The masticatory tests allow the assessment of masticatory efficiency or performance with some objectivity, while questionnaires evaluate a person's subjective response about his/her masticatory ability. Masticatory ability is not an objective evaluation, but rather a patient's self-assessment, which depends on a variety of personal and subjective factors[1] and is important in patient-oriented clinical decision-making[2] and treatment planning.[3,4]

Clinically, dental clinicians have evaluated patients' masticatory function mainly by subjective responses, using questions about satisfaction with eating and food choices. Objective measurements are often not used because masticatory tests are complicated and time consuming. However, it is important to know the patient's objective health status to find the cause of his/her symptoms or any unknown problems.

In a small sample of complete-denture wearers,[5, 6] a significant correlation was reported between the individuals' subjective evaluation (via questionnaires regarding the ability to eat foods) and masticatory performance using the sieving method with peanuts. In contrast, other studies[4–6] have reported either no correlation or a weak one between self-assessed masticatory ability and objectively measured masticatory performance. Gunne et al[7] showed no positive corre-

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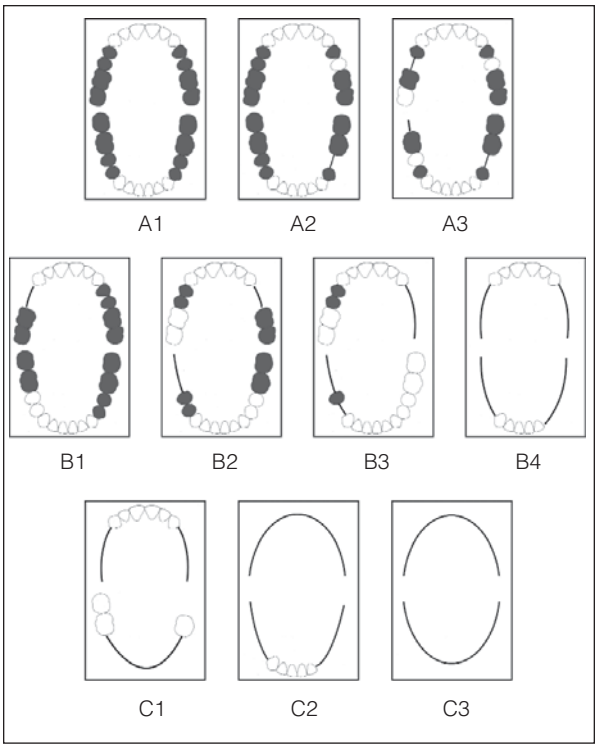

Fig 1 Eichner Index. Class A contains 4 support zones: A1: complete dentition; A2: missing teeth in 1 arch; A3: missing teeth in both arches. Class B contains 1 to 3 support zones or contacts in the anterior area only: B1: 3 support zones; B2: 2 support zones; B3: 1 support zone; B4: contact in the anterior area only. Class C has no support zones at all, although a few teeth may still remain: C1: teeth in both arches; C2: teeth in 1 arch; C3: edentulous.

lation between the subjective responses about mastication and masticatory efficiency in 19 complete-denture wearers. Shinkai et al[8] reported that perceived masticatory ability was not significantly associated with masticatory performance in complete-denture wearers. Van der Bilt et al[9] showed that rehabilitation of post-canine teeth restored some objective masticatory function and led to an increased appreciation of masticatory function, although no correlation was found between the changes in objective and subjective masticatory function.

This study investigated the relationship between self-assessed satisfaction with mastication and food acceptability and masticatory performance in a large sample of older adults with various occlusal statuses. The hypothesis was that subjective masticatory functions are influenced not only by masticatory performance, but also by an individual's occlusal status. Because satisfaction is regarded as multifactorial, multiple regression analysis was used to examine the association between dissatisfaction with masticatory function and food acceptability, masticatory performance, and posterior occlusal contacts.

Materials and Methods

The subjects were participants of the Senior Citizens' College of Osaka prefecture who were living in the prefecture and voluntarily attended lectures once a week in 2002, 2003, and 2004. This college, which enrolls volunteers for a period of 1 year and is supported by the government of Osaka prefecture, is part of the adult education system for those over the age of 60. Consequently, all participants were community-dwelling, independently living elderly people.[10] This course focused not only on health topics, but also on other topics of interest to elderly people, such as finances and culture. At the end of a lecture on oral-health issues, the purpose and procedures of this study were explained to the audience, and volunteers were solicited to return for a dental examination on another day. The final study population comprised 708 subjects (351 men and 357 women) with a mean age of 66.0 (SD: 4.2) years. The participation rate was 41.9% of the total subjects. The mean age and proportion of each gender were quite similar to those who did not volunteer for the dental examination ($n = 982$). Individuals with a partially or fully edentulous arch without a replacement were excluded from the study. As a result, all remaining study participants with loss of teeth used a fixed or removable denture.

The protocol of this study was approved by the ethical review committee of Osaka University Graduate School of Dentistry. All subjects gave written informed consent for their participation.

Posterior Occlusal Contacts

Posterior occlusal contacts were recorded according to the Eichner Index.[11–14] This index is based on the number of occlusal contacts of existing natural teeth or fixed partial dentures between the maxilla and mandible bilaterally in the premolar and molar regions (Fig 1). Group A has contacts in 4 support zones; group B has contact in 1 to 3 zones (B1, B2, and B3) or in the anterior area only (B4); and group C has no support zone at all, although a few teeth can still remain. Group B was stratified into B1/B2 (stable support on opposing dentition), and B3/B4 (unstable or no support on opposing dentition).[13] These groups also represent the course of tooth loss and record the functional value of the natural dentition.[15] Thus, this classification provides a standard for the degree of morbidity of the dentition and is suitable for application in studies on morbidity statistics.

The number of posterior contacts ranges from 0 to 8 (9 groups). However, the Eichner Index can classify subjects into only 3 groups, which means that each group may have a larger number of samples than posterior tooth contacts. This is useful in a statistical analysis.

Table 1 Satisfaction with Masticatory Function in Relation to Eichner Index*

		Satisfaction with masticatory function (%)			
Eichner Index	n	Satisfied	Fairly satisfied	Dissatisfied	Homogeneous subset†
A	395	53.7	29.4	17.0	a
B1/B2	164	32.3	33.5	34.1	b
B3/B4	71	28.2	43.7	28.2	b
C	78	29.5	35.9	34.6	b
Total	708	43.5	32.5	24.0	

*Kruskal-Wallis test and multiple comparisons were done by scoring as "satisfied" = 3, "fairly satisfied" = 2, and "dissatisfied" = 1. Chi-square: 42.3, $P < .001$.
†$\alpha = .05$ for groups with the same letter.

Therefore, the Eichner Index was used rather than number of posterior tooth contacts.

Satisfaction with Masticatory Function

Satisfaction with masticatory function was evaluated using the question "Are you satisfied with your chewing function?"[2,16] The participants were asked to respond to the question by indicating if they were "satisfied," "fairly satisfied," or "dissatisfied."

Food Acceptability

Food acceptability was evaluated using the questions "Can you chew apples, grilled beef, and hard rice crackers without difficulty?"[2,17] The volunteers were asked to answer this question separately for all 3 foods with a "yes" or "no." In pretesting the questionnaire, the authors determined that these foods represent 3 of the most difficult foods to chew among more than 100 common foods consumed by Japanese people.[5,18] In addition, these 3 foods are eaten in different ways; for example, apples must be bitten with the anterior teeth, hard rice crackers must be crunched, and beef must be ground.

Masticatory Performance

Masticatory performance was determined by the concentration of dissolved glucose obtained from test gummy jellies, which are a standardized food developed for measuring masticatory performance.[19] The subjects were instructed to chew the gummy jelly using 30 chewing strokes on their preferred chewing side (left, right, or both) and to expectorate the bolus of comminuted particles as thoroughly as possible. The collected particles of the comminuted jelly were rinsed with running water for more than 30 seconds to remove the saliva, soaked in 15 mL of distilled water, and stirred. The supernatant fluid of the solution was sampled, and the concentration of dissolved glucose from the comminuted jelly was measured with a portable blood glucose meter (Glutest, Sanwa Chemical Laboratory).[20,21] Evaluation by linear regression analysis has shown that the concentration of glucose has a significantly high correlation to the surface area (mm^2) of the comminuted jelly ($r = 0.993$, $P < .01$).[20,21] The masticatory performance was assessed by calculating the surface area of the particles from the glucose concentration using linear regression.

Data Analysis

The data analyses were carried out using SPSS Version 13.0 for Windows (SPSS). Statistical significance was set at $P < .05$.

First, the Kruskal-Wallis test was used for bivariate analysis. Pairwise comparisons between groups were made by means of Mann-Whitney *U* tests with Bonferroni adjustment. Results were considered significant at $\alpha = .05$.[22]

In addition, a multiple logistic regression analysis for dissatisfaction with masticatory function was conducted. The outcome variable was satisfaction with masticatory function, which was dichotomized as satisfied/fairly satisfied = 0 and dissatisfied = 1. For explanatory variables, age and masticatory performance were used as continuous variables. Posterior occlusal contacts according to the Eichner Index and food acceptability had 4 categories, of which the reference categories were Eichner group A and all 3 foods. Gender was scored as females = 0 and males = 1. All explanatory variables were entered into the model.

Results

About 60% of the total population had natural dentition. One-third wore a removable partial denture in at least 1 arch. Overall, more than three-quarters of the subjects were satisfied or fairly satisfied with their masticatory function (Table 1). Subjects in Eichner group A reported greater satisfaction than those in the other 3 groups ($P < .05$). However, no significant difference was found in satisfaction among the other 3 groups.

Table 2 Satisfaction with Masticatory Function in Relation to Food Acceptability*

		Satisfaction with masticatory function (%)			
Food acceptability	n	Satisfied	Fairly satisfied	Dissatisfied	Homogeneous subset†
0	108	7.4	29.6	63.0	a
1	84	22.6	44.0	33.3	b
2	120	36.7	40.0	23.3	c
3	396	59.8	28.5	11.6	d
Total	708	43.5	32.5	24.0	

*Kruskal-Wallis test and multiple comparisons were done by scoring as "satisfied" = 3, "fairly satisfied" = 2, and "dissatisfied" = 1. Chi-square: 170.7, $P < .001$.
†$\alpha = .05$.

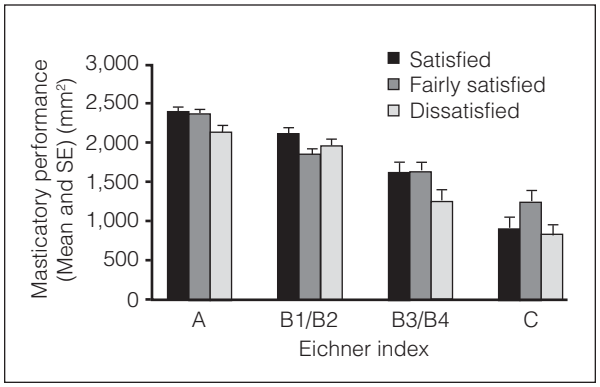

Fig 2 Masticatory performance in relation to satisfaction with masticatory function and Eichner Index.

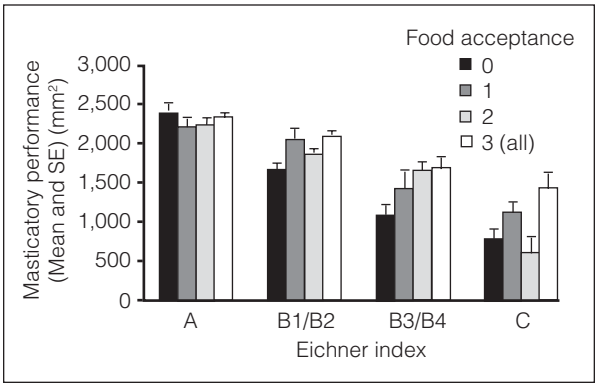

Fig 3 Masticatory performance in relation to food acceptability and Eichner Index.

Fifty-six percent of participants responded that they could eat all 3 foods without difficulty (Table 2). Satisfaction with masticatory function was positively related to food acceptability ($P < .001$). In a multiple comparison test, masticatory function was significantly different between any 2 food-acceptability groups ($P < .05$).

Overall, masticatory performance was significantly associated with posterior occlusal contacts and satisfaction with masticatory function ($P < .001$). For posterior occlusal contacts, the masticatory performance of groups B1/B2, B3/B4, and C was found to be 84%, 65%, and 43%, respectively, when compared to subjects in group A, and there was significant difference between any 2 groups in a multiple comparison test ($P < .05$). Within the group reporting the same satisfaction with masticatory function, masticatory performance decreased with loss of posterior occlusal contacts (Fig 2). On the other hand, among participants with the same Eichner index, masticatory performance was not significantly associated with satisfaction with masticatory function (Fig 2). As a result, participants who were satisfied with their masticatory function in groups C or B3/B4 had a significantly lower masticatory performance than those who were dissatisfied with their masticatory function in group A ($P < .05$).

Similarly, among the participants who were in the same group in terms of food acceptability, masticatory performance also decreased with loss of posterior occlusal contacts (Fig 3). Therefore, the participants who reported being able to eat all 3 foods without difficulty in groups C or B3/B4 had a significantly lower masticatory performance than the participants who reported being unable to eat any of the foods without difficulty in group A ($P < .05$).

Multiple logistic regression analysis using dissatisfaction with masticatory function as the dependent variable (Table 3) suggested that the number of foods that could be eaten without difficulty was the most important explanatory variable (odds ratios = 12.3 for 0 food; 3.7 for 1 food; and 2.1 for 2 to 3 foods, $P < .01$). Evaluating posterior occlusal contacts, only subjects in group B1/B2 (odds ratio = 1.7, $P = .025$) were significantly different from group A (reference category) after controlling for the other variables. Odds ratios for dissatisfaction with masticatory function for subjects in group B3/B4 (0.83) and group C (0.63) were fewer than 1, suggesting that these participants reported a comparatively greater satisfaction with mastication than group A after controlling for the other variables. Objective masticatory performance was likely to be associated with dissatisfaction with masticatory function (odds ratio = 0.75, $P = .057$). Age and gender were not significantly associated with dissatisfaction with masticatory function.

Table 3 Logistic Regression Model for Dissatisfaction with Masticatory Function by Forced Enter Method*

Explanatory variables	Odds ratio	95% CI		*P*
Age (y)†	1.00	0.95	1.05	.942
Gender‡				
Male§	1			
Female	1.23	0.83	1.82	.307
Food acceptability‡				< .001
0	12.33	7.13	21.30	< .001
1	3.66	2.07	6.47	< .001
2	2.08	1.22	3.56	.007
3§	1			
Eichner index‡				.017
A§	1			
B1/B2	1.72	1.07	2.76	.025
B3/B4	0.83	0.41	1.70	.612
C	0.63	0.29	1.36	.236
Masticatory performance (1,000 mm^2)†	0.75	0.55	1.01	.057

*Outcome variable: dissatisfaction with masticatory function. The overall accuracy of the model in predicting dissatisfaction with masticatory function was 80.2% (sensitivity = 92.9 %; specificity = 40.0%).
†Continuous variable.
‡Categorical variable; §reference category.

Discussion

This cross-sectional study evaluated a sample of functionally independent and cognitively healthy older urban adults. How representative these individuals are of elderly Japanese is not precisely known. However, in Japan, the great majority of elderly people (95.5% of those 75 to 79 years old) are functionally independent and have no limitations in their daily activities.[23] Therefore, it is important to understand the oral health of this group of people, who appear to represent a large component of the elderly Japanese population.

Masticatory performance, which is the ability to break down foods into discrete portions by chewing to permit swallowing, is usually assessed by measuring the size of test food samples that have been chewed for a specific number of chewing cycles.[24] The advantage of the present test with gummy jelly has been discussed previously.[20,21] Because of significant advantages such as speed and accuracy of measurement and discriminating ability between subjects with various dentitions, gummy jelly is the preferred food for measuring masticatory performance when investigating large populations.[10,19]

More than three-quarters of all participants were satisfied or fairly satisfied with their masticatory function. Interestingly, 37% of those who could not eat any of the foods were satisfied with masticatory function, and 40% of those who could eat all 3 foods were less than satisfied.

In this study, masticatory performance gradually decreased with loss of posterior occlusal contacts, although the subjects were provided with clinically acceptable dentures. This is in agreement with previous studies.[9,17,21,25]

Overall, posterior occlusal contacts, food acceptability, and masticatory performance were associated with satisfaction with masticatory function when evaluated with bivariate analysis. However, among participants who were satisfied with their masticatory function, or participants who reported eating all 3 foods without difficulty, masticatory performance was significantly different depending on the amount of posterior occlusal contacts. As a result, participants with poor subjective masticatory function in Eichner group A had significantly better objective masticatory performance than participants with good subjective masticatory function in Eichner groups B3/B4 or C. In other words, this suggests that the self-assessed ability to chew food by individuals with a reduced dentition does not have the same objective status as that of individuals with natural dentition, because of different judging criteria. This further suggests that a questionnaire regarding food acceptability should not be used for a comparison of objective masticatory function, especially between individuals with different dental statuses.

A possible reason for the discrepancy between the subjective and objective evaluations is that satisfaction with masticatory function depends not only on an objective measure of masticatory performance per se, but also on consideration of oral health status compared with a patient's past experience. For example, complete-denture wearers may have longer denture-wearing experience, and may have developed a pattern of functioning and adapting their diet to complete dentures. They also may have lower expectations regarding their dentures.[3,26,27] Another explanation may be that patients who have poor masticatory performance prefer food that is more easily chewed,[7] or prefer to eat the same food as others but prepare it in a more easily chewable

form by cooking it longer or cutting it smaller.[22,28] In the present study, after controlling for age, gender, and amount of posterior occlusal contacts, satisfaction with masticatory function was significantly associated with the number of foods eaten without difficulty, rather than with masticatory performance, suggesting that self-assessed ability may be more important than the objective value for satisfaction. However, this finding does not imply that testing masticatory performance is clinically invaluable. As previously stated, it is important to know the patient's objective health status to find the cause of symptoms or unknown problems. For example, age-linked increases in blood pressure, body weight, and serum cholesterol levels may be symptomless, but are risk factors for cardiovascular disease.[29] The patient may not be aware of hyposalivation in the oral cavity, but it could make it difficult to wear complete dentures.[30] Both subjective and objective evaluations are useful and necessary in clinical decision-making.

Interestingly, the odds ratios for dissatisfaction of participants of Eichner groups B3/B4 and C were not significant, although they were less than 1, after controlling for food acceptability and masticatory performance. This was not found in bivariate analysis, suggesting that subjects with reduced occlusal contacts tend to be more satisfied with mastication. Clinicians should recognize that patients' satisfaction with masticatory function reflects their experience and dental status and in general is more optimistic when compared with the results of masticatory tests.[17] In contrast, participants in group B1/B2 had not lost many teeth and had not been wearing dentures long enough to adapt to them, and thus were unable to cope with dentures functionally and psychologically. They may also have had higher expectations concerning removable partial dentures compared with patients who had lost a larger number of teeth or who wore complete dentures.[3] Therefore, group B1/B2 was found to be the most dissatisfied with masticatory function.

These findings can be related to current theories of aging. Rowe and Kahn[29] stated that heterogeneity in physical and mental condition appears to increase with age; therefore, the concept of successful aging should focus on heterogeneity among elderly people. Coping and adaptive behaviors in elderly people are important for successful aging because many age-associated declines can be explained in terms of life style, habits, diet, and an array of psychosocial factors, rather than cognitive and physiologic deficits. Brandstädter and Greve[31] stated that although assumptions that relate psychologic aging to reduced well-being, loss of control, and self-esteem problems were widespread, recent evidence gives testimony to a considerable resourcefulness and adaptive flexibility in older people. They concluded that in managing personal aging, many elderly people are apparently capable of finding an acceptable solution for problems on their own. Similarly, Carlsson et al[32] stated that elderly people often recognize and use their own resources for making their situation better, and adjust their personal expectations to a level they can live with. Recently, MacEntee[33] stated that psychometric instruments specific to oral health accentuate the negative impacts of oral dysfunction. However, a questionnaire that accepts a positive response regarding the impact of oral function has revealed that respondents essentially offer a positive opinion on how the mouth functions. From these previous reports and the results of the present study, the potential of older people to adapt and cope with dental impairments, especially masticatory ability, must be recognized.

Conclusion

There was significant discrepancy between satisfaction with mastication, food acceptability, and masticatory performance in older adults with various occlusal statuses. After controlling for age, gender, and posterior occlusal contacts, satisfaction with masticatory function was significantly associated with the number of identified foods that could be eaten without difficulty, rather than with masticatory performance, probably because many subjects had learned to cope with their current occlusal status.

Acknowledgments

The authors are especially grateful to Dr Ronald L. Ettinger, BDS, MDS, DDSc, for his comments and advice. The authors are also grateful to Mikiko Amemiya, DDS, PhD, Masahiro Wada, DDS, Tomohiro Hazeyama, DDS, Ryosuke Kagawa, DDS, and Fukuko Nokubi, DDS, for data collection. This research was supported by a Grant-in-Aid for Scientific Research (no. 16390555) from the Japan Society for the Promotion of Science.

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