

## Masticatory Ability Assessments and Related Factors

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### Abstract

One of the most important aspects of denture treatment is to restore masticatory function to improve food intake. Masticatory ability assessments are done either objectively or subjectively. There are various factors that affect the masticatory ability of denture wearers. The aim of this study was to analyze the relationship between subjective and objective assessments of masticatory ability and the factors that can possibly affect this ability, including the residual ridge heights, age, gender, and denture type. A cross-sectional study of 34 denture wearers was carried out. All the dentures were fabricated in the Dental Teaching Hospital Faculty of Dentistry, Universitas Indonesia. The data collected were as follows: sociodemographic data, denture type, and masticatory ability, which was measured using two different methods. Masticatory ability was assessed subjectively using a validated questionnaire while the objective portions were carried out by asking the subjects to chew on Xylitol chewing gum (Evaluating Gum Xylitol®). Residual ridge heights were measured using modified mouth mirror number 3. There was no significant correlation between the results of the objective and subjective assessments of masticatory ability ( $p=0.136$ ). Residual ridge height ( $p=0.003$ ) had a significant relationship with masticatory ability; however, age ( $p=1.000$ ), gender ( $p=0.711$ ), and denture types ( $p=0.218$ ) did not. In conclusion, residual ridge height was found to have a relationship with masticatory ability.

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### Introduction

Masticatory function is crucial for numerous oral tasks. It is a complex process characterized by the comminution of food into small particles to increase the food's surface area, stimulating an enzymatic function and improving the food's digestibility. Masticatory performance is the ability to break down food to facilitate digestion, and its role in nutrition is important. It is measured by assessing the distribution of the food's particle size when chewed for a given number of strokes.<sup>1</sup>

Tooth loss is a condition frequently found in pre-elderly and elderly, and it affects masticatory function. Krall et al. stated that

individuals who are either edentulous or have fewer natural teeth tend to avoid hard foods and prefer soft, easily chewable food.<sup>2</sup> Tooth loss could decrease masticatory performance when it comes to slicing food into small particles, especially food with rough textures. Hence, rehabilitation of the masticatory function should be done using removable dentures.

However, not all removable dentures will give the same masticatory ability. Several factors are related to the masticatory ability of removable denture wearers. Successful oral rehabilitation using removable dentures could be evaluated from the aspects of retention, stabilization, phonetic, aesthetic, and masticatory ability.<sup>3</sup> These factors can be divided into two factors related with the denture type—retention and stabilization of the denture—and into the factors associated with the morphological, physiological, and psychological attitudes of denture wearers.<sup>4</sup> The most common complaint of masticatory ability in denture wearers is loss of retention and stabilization of the removable denture. The physiological factors that affect masticatory

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performance include loss and restoration of posterior teeth, tooth wear, occlusal force, basal area, volume, and height of the residual ridge and oral motor function which seem to accelerate dysfunction with aging.<sup>4</sup> Therefore, the physiological factors of aging are related to mastication.

Masticatory performance is one aspect that influences the success of a removable denture. The masticatory function should be assessed subjectively or objectively to evaluate masticatory performance. Assessment of masticatory ability requires straightforward and efficient evaluation methods. Hama et al. found that it was sufficient to assess the masticatory performance of individuals with natural dentition and those with complete dentures by having the subjects chew color-changeable chewing gum.<sup>5</sup> The objective assessment of masticatory objectively could be more accurate, but an evaluation of subjective masticatory function is needed to evaluate an individual's perception of his or her masticatory ability. One possible method to assess masticatory ability subjectively is by using an assessment tool in a questionnaire format. Good masticatory ability for removable denture wearers is the most important aspect of successful oral rehabilitation. Therefore, an analysis on the relationship between the subjective and objective assessments of masticatory ability and the factors that can affect masticatory ability, such as residual ridge heights, age, gender, and denture type, was carried out.

## Materials and methods

The design of the study was cross-sectional. This study was conducted at Dental Teaching Hospital Faculty of Dentistry, Universitas Indonesia and was approved by the ethical committee of the Faculty of Dentistry, Universitas Indonesia, Indonesia (No. 4/ Ethical Approval/FKG/I/2016). There were 34 subjects who were new denture wearers; the dentures were fabricated and adjusted adequately by undergraduate and postgraduate students under the supervision of clinical instructors. The subjects agreed to partake in the study and gave their written, informed consent. The inclusion criteria were as follows: tooth loss of more than 10 teeth, wearing a partial denture, single complete denture, or full denture, no systemic disease, and able to communicate. The data collected were as

follows: socio-demographic data (gender and age), denture type, and masticatory ability, which was measured using two different methods. The subjective elements were measured using a validated questionnaire called, "*Panduan Pengisian Alat Ukur Kemampuan Mastikasi Bagi Dokter Gigi*," which consisted of eight questions.<sup>6</sup>

The objective portion was measured by asking the subjects to chew a masticatory performance evaluating gum (XYLITOL®, 70 mm × 20 mm × 1 mm, 3.0 g; Lotte, Saitama, Japan); this color-changing chewing gum is a simple method for objective evaluation of masticatory ability, which can be easily used with denture wearers, and is also suitable for a large-scale epidemiological study because of its ease of use and administration. The gum does not adhere to denture materials and can be easily chewed, even by those wearing complete dentures. The gum comprises red, yellow, and blue dyes; xylitol; and citric acid, which maintains a low pH level. Its color remains yellowish green before chewing because the red dye is pH-sensitive and only appears under neutral and alkaline conditions. The yellow and blue dyes seep into the saliva during mastication, and the red dye appears because of the reaction with an acid.<sup>8,9</sup> For partial denture and single complete denture (SCD) subjects, the gum was chewed for 60 seconds, and full denture wearers chewed the gum for 100 seconds. Immediately after the subjects had chewed the gum, the gum was flattened by compression between two glass plates and measured using a five-color chart ranging from 1 to 5 (1, very poor; 2, poor; 3, moderate; 4, good; 5, very good chewing ability).<sup>2</sup> The color of the chewing gum turned from yellowish green to red during mastication. The changes in color depended on chewing performance; a higher score indicated better masticatory ability.

Residual ridge heights were measured using modified mouth mirror number 3 with metric measurements. The measurement was divided into three regions: the anterior, left posterior, and right posterior region. Data were analyzed using the SPSS Statistical Package. The normality of the data was calculated using the Shapiro-Wilk test. The data of the residual ridge heights were analyzed using a student t-test. Furthermore, the data of age, gender, and denture type were analyzed using a chi-squared and Fisher exact test. All p-values is smaller than

0.05 were considered statistically significant. Spearman's rank correlation coefficients ( $r$ ) were calculated to evaluate the statistical correlations between the objective and subjective assessments of masticatory ability.

## Results

In this study, 34 subjects (12 men and 22 women) were recruited. The age range was between 45 and 78 years old, and the participants were divided into two categories based on the World Health Organization classification: <60 years old ≥60 years old. The data comprised of 15 subjects wearing partial dentures, eight subjects wearing single complete dentures, and 11 subjects wearing complete dentures. The masticatory ability assessment was evaluated objectively and subjectively. For comparison, all the participants were assigned into one of two groups: a relatively low or high masticatory ability in the objective category and a poor or good masticatory ability in the subjective category. Categorical data are shown in Table 1.

The mean and standard deviation of residual ridge heights were  $6.38 \pm 1.21$  mm. The correlation among masticatory ability with gender, age, and denture type showed no significant differences, but residual ridge height showed a significant difference (Table 2). Moreover, there was no statistical significance, tested with Spearman's rank correlation between the results of the objective and subjective assessments of masticatory ability with  $r=0.264$  and  $p\text{-value}=0.136$ .

Variable	Frequency	%
Age		
<60	17	50
≥60	17	50
Gender		
Male	12	35.3
Female	22	64.7
Denture Type		
Partial denture	15	44.1
SCD	8	23.5
Full Denture	11	32.4
Subjective Masticatory Ability		
<12 Poor	3	8.8
12-16 Good	31	91.2
Objective Masticatory Ability		
1-3 low	19	55.9
4-5 high	15	44.1

**Table 1.** Frequency distribution of age, gender, denture type, and masticatory ability assessment.

	Low (1-3)	High (4-5)	p-value
Age			
<60	9 (64.3%)	5 (35.7%)	1.000
≥60	13 (65%)	7 (35%)	
Gender			
Male	7 (58.3%)	5(41.7%)	0.711
Female	15 (68.2%)	7(31.8%)	
Denture Type			
Partial Denture	8(53.3%)	7(46.7%)	0.218
SCD and Full Denture	14(73.7%)	5(26.3%)	
Residual Ridge Height	5.942	7.175	0.003*

**Table 2.** Correlation among masticatory ability with age, gender, denture type, and residual ridge height. \* $p<0.05$

## Discussion

The study's design was cross-sectional; it aimed to analyze the relationship of the subjective and objective assessments of masticatory ability. The other aim was to analyze the factors that could possibly affect masticatory ability, such as residual ridge heights, age, gender, and denture type. In this study, statistically, there was no significant correlation between the results of objective and subjective assessments of masticatory ability. Reduced masticatory function is one of the major functional limitations of edentulism. Thus, masticatory ability is an important aspect for removable denture wearers. Masticatory ability can be assessed by subjective and objective assessments. Various methods have been used to obtain objective evaluations of masticatory performance. Komigamine et.al stated that one method to measure masticatory ability is using chewing gum. This method can be used because it is easy, simple, and quick, and changes in gum color are easy to analyze.<sup>8</sup> For the subjective assessment, a questionnaire was used. In this study, it was found that there was no correlation between the subjective and objective assessments. This is possibly because the questions on the employed questionnaire are more detailed. The questionnaire covered the satisfaction of the subjects with their masticatory function.<sup>6</sup> It was different than the objective assessment because satisfaction with masticatory function was significantly associated with the subjects' perceptions rather than with

masticatory ability. This result was similar to Gunne et al. In this study, the authors showed no positive correlation between the subjective and objective results of mastication and masticatory efficiency in complete denture wearers. Moriya et al. also showed that perceived masticatory ability was not significantly associated with masticatory performance in complete denture wearers.<sup>4</sup> This difference might be also due to the time difference between the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> assessments, which was 10 days after denture insertion; this might have been because some subjects had not adapted to their dentures yet. In this study, subjects chewed the gum for 60 and 100 seconds, depending on the group they were in, because it was assumed that one stroke could roughly equal one second.

In the current study, it was found that there was no correlation between age and masticatory ability. This is supported by other studies that showed age does not influence masticatory ability when there is a posterior contact tooth.<sup>9</sup> This indicates that masticatory ability does not decline with age if posterior occlusal contacts are restored or rehabilitated. Residual ridge height was related with masticatory ability. Residual ridge height was one of the factors that influenced the success of the denture because it supports the retention and stabilization of the denture.<sup>3</sup> This agrees with the previous study which found that in patients with advanced ridge resorption, the implant-retained overdenture was more suitable than mandibular conventional denture.<sup>10</sup> Masticatory ability was found to be objectively correlated with residual ridge height. The higher the residual ridge, the better masticatory ability of the denture wearers is.

In this study, gender and denture types were also chosen when checking for masticatory ability. Gender and denture types did not have a relationship. This result is similar to Monaco et al.'s study that prolongation in swallowing duration in healthy elderly people could be explained more by an ill-fitting prosthesis than by age-related muscle impairment. The study showed that increased swallowing time in aged denture wearers, compared to sex- and age-matched denture subjects, was because of the quality of the prosthesis.<sup>10</sup> Replacing missing teeth with a removable prosthesis cannot approach the efficiency of a complete natural dentition, but removable, partial denture wearers

with posterior occlusal contacts with natural teeth maintained better masticatory performance than those without these occlusal contacts.<sup>9</sup>

## Conclusions

There was no correlation between the results of the objective and subjective assessments of masticatory ability. Residual ridge height had a relationship with masticatory ability; the higher the residual ridge, the better the masticatory ability of the denture wearer was. However, age, gender, and denture types were not related. It is suggested to collect data a month after denture insertion so that the subject can first adapt to the denture. Future studies should also consider other factors such as bite force, the shape of residual ridge that influenced masticatory ability.

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## Declaration of Interest

The authors report no conflict of interest.

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