

Comparing masticatory performance between dentate individuals and removable denture wearers

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Abstract. Tooth loss replacement with dental prostheses aims to restore stomatognathic function, including masticatory performance. Masticatory performance is one of the factors that affect stomatognathic function and health in general. The aim of this study was to compare the masticatory performance of fully dentate subjects and removable denture wearers and determine which method is most suitable, whether using color-changeable chewing gum or gummy jelly. Subjects were classified into two groups: fully dentate (n=10) and removable denture groups (n=10). Masticatory performance was measured using color-changeable chewing gum with 30, 45 and 60 strokes and gummy jelly with 10, 20 and 30 strokes. A Mann-Whitney analysis was done to compare the masticatory performance of the fully dentate and removable denture groups. There was a significant difference ($p < 0.05$) in masticatory performance between the two groups, both with chewing gum and gummy jelly. Spearman's correlation was used to analyze the correlation between the chewing gum and gummy jelly measurements. Statistically, a significant correlation ($P < 0.05$) was found between the color-changeable chewing gum and gummy jelly. A removable denture does improve masticatory performance, but it is not able to fully restore masticatory performance comparable to dentate individuals. Color-changeable chewing gum and gummy jelly can differentiate masticatory performance in fully dentate and removable denture groups.

1. Introduction

The loss of natural teeth not only results in aesthetic issues for individuals but can also seriously risk masticatory performance [1]. Missing teeth need to be replaced with artificial teeth. Masticatory performance can be evaluated; for example, several methods are using paraffin wax, artificial test food (gummy jelly and Optocal), two-color and color-changeable chewing gum [2]. Examination of the material can be done visually or with an instrument. The use of the instrument is usually carried out at the research institution, whereas visual examination may be used more generally, to facilitate the evaluation of prosthetic treatment and the patient's condition [2-4]. Gummy jelly containing β -carotene has manual measuring methods and a fully automatic system for evaluating masticatory performance, in which the increase in surface area of the comminuted gummy jelly is calculated by measuring the concentration of glucose or β -carotene. This serves as the measurement index, being dissolved in



water from the surface of the comminuted gummy jelly after a specified time. Additionally, a visual scoring method with a test gummy has been developed that needs no special devices or professional skills [4,1].

Chewing gum can be used to evaluate masticatory performance, chewing gum that changes its color as it is chewed [3,5,6]. It is possible to produce a chewing gum of uniform hardness, weight, cohesiveness, adhesiveness and composition, and it is easy to devise uniform measurement conditions. Unlike specific test foods such as alginate, and wax, there are frequent opportunities to use chewing gum as a part of the ordinary diet, and it can be used safely as a test food. It has been reported that it is possible to measure masticatory performance for both dentate subjects and denture wearers in Japan [7]. A new chewing gum (Masticatory Performance Evaluating gum XYLITOL [30x20x1 mm, 3 g]) for denture wearers from LOTTE Co., Ltd. (Saitama, Japan) is the gum base of a new color-changeable chewing gum that hardly adheres to dentures, so it is easily applied to denture wearers [2].

The masticatory process consists of the ability to crush, tear and mix food. Gummy jelly measures the ability of mastication in the crushing (comminuting), while chewing gum checks the degree of mixing. Some studies have found a correlation between the ability to crush and mix the food, but several other studies claim that the processes of crushing and mixing are different aspects of mastication, so both are not significantly correlated. The goal of the present study is to analyze the masticatory performance between dentate individuals and removable denture wearers and the relationship between color-changeable chewing gum and gummy jelly.

2. Materials and Methods

This study was done in the Dental Teaching Hospital Faculty of Dentistry, Universitas Indonesia and was approved by the Ethical Committee of the Faculty of Dentistry, Universitas Indonesia (No. 27/*Ethical Approval*/FKGUI/VII/2016). The design of the study is cross-sectional. The subjects were selected with consecutive sampling and classified into two groups: fully dentate ($n=10$) and removable denture groups ($n=10$). The inclusion criteria were willingness and ability to give consent for study participation and to undergo denture treatment, ability to communicate with people, fully dentate or having 10 missing teeth at minimum, non-Islamic religion and no prior history of temporomandibular disorders. Subjects' masticatory performances were measured by asking them to chew color-changeable chewing gum with 30, 45 and 60 strokes and gummy jelly with 10, 20 and 30 strokes. Immediately after a subject chewed the gum, it was compressed to 1.5mm in thickness between two glass plates and then measured using a color chart. For the gummy jelly, after a subject had chewed the jelly, they were asked to spit it into a paper cup covered with gauze; then it was measured using a visual chart.

Statistical analysis was performed using SPSS V.20. Statistical significance was set at $p < 0.05$. The normality and variance homogeneity of the data were calculated using the Shapiro-Wilk test, in which the confidence level was set at 95%. The data was analyzed with a Mann-Whitney test to compare the masticatory performance of fully dentate and removable denture groups for both chewing gum and gummy jelly. Spearman's rank correlation coefficient (r) was used to analyze the correlation between the chewing gum and gummy jelly measurements.

3. Results and Discussion

3.1 Results

In this study, 20 subjects were recruited and divided into 2 groups: fully dentate and removable dentures. The groups consisted of 10 women and 10 men. The frequency distributions of age, gender, and denture type of the subjects are shown in Table 1. There is a significant difference in masticatory performance (measured by chewing gum or gummy jelly) between the fully dentate and removable denture groups ($p < 0.05$). Masticatory performance in fully dentate groups is higher than removable denture groups (Table 2).

Table 1. Frequency distributions of age, gender and denture type

Variable	Frequency	%
Age		
20–40	10	50
40–60	2	10
≥60	8	40
Gender		
Male	10	50
Female	10	50
Denture Type		
Partial denture	4	40
Full Denture	6	60

Table 2. Visual score of color-changeable chewing gum and gummy jelly

		Median (Min-Max)	p- value
CG 30	D	3 (2-5)	0,01*
	RDW	2(1-3)	
CG 45	D	5 (3-8)	0,07*
	RDW	3,5 (2-6)	
CG 60	D	7,5 (5-9)	0,015*
	RDW	5 (2-8)	
G 10	D	3,5 (1-5)	0,00*
	RDW	0	
G 20	D	6 (3-7)	0,00*
	RDW	0 (0-2)	
G 30	D	8 (6-9)	0,00*
	RDW	1 (0-4)	

CG: Color-changeable chewing gum

G: Gummy Jelly

D: Dentate

RDW: Removable Denture Wearers

*p < 0.05

** Mann-Whitney

Statistically, a significant correlation ($P < 0.05$) is found between the color-changeable chewing gum and gummy jelly (Table 3).

Table 3. Correlation between Color-Changeable Chewing Gum and Gummy Jelly

Cor-Coeff	CG 30	CG 45	CG 60	G 10	G 20	G 30
CG 30						
CG 45	0,91*					
CG 60	0,86*	0,92*				
G 10	0,64*	0,7*	0,67*			
G 20	0,68*	0,77*	0,67*	0,92*		
G 30	0,7*	0,77*	0,71*	0,85*	0,93*	

CG: Color-changeable chewing gum

G: Gummy Jelly

D: Dentate

RDW: Removable Denture Wearers

*p < 0.05

**Spearman correlation

3.2 Discussion

This study aimed to analyze the masticatory performance between dentate individuals and removable denture wearers and the relationship between color-changeable chewing gum and gummy jelly. Statistically, there is a significant difference in masticatory performance between dentate subjects and removable denture wearers. There is also a significant correlation between the color-changeable chewing gum and gummy jelly. Rehabilitation of missing dentitions with removable partial dentures (RPDs) is often utilized to improve patients' masticatory function. However, even if all missing teeth have been replaced, masticatory function is usually improved to a lesser extent than that of the previous complete dentition [8]. Ikebe *et al.* hypothesized that a loss of posterior occlusal contacts would be associated with a reduced occlusal force and a decline in masticatory performance, even if partially edentulous arches were restored with removable prostheses [9]. Various studies have determined that a minimum of 20 functional teeth are necessary to achieve good mastication, although only if they are antagonist pairs [10]. In this study, removable denture subjects were limited to having a minimum of 10 missing teeth. The result is in accordance with preliminary studies. There is a significant difference in masticatory performance between dentate subjects and removable denture wearers; dentate subjects had higher masticatory performance than removable denture wearers.

Masticatory performance was measured by a visual scale of color-changeable chewing gum and gummy jelly. Various methods have been used to obtain objective evaluations of masticatory performance. Komigamine *et al.* state that one of methods to measure masticatory ability is using chewing gum. This method can be used because it is simple and quick to evaluate masticatory performance by measuring changes in gum color [11]. Hama *et al.* state that the evaluation method of the color-changeable chewing gum using the newly developed color scale is reliable and valid [2]. Nokubi *et al.* developed the "masticatory performance scoring method", which does not require any equipment and enables easy visual evaluation of the comminuted gummy jelly. It was developed to be utilized in dental clinics, hospitals and nursing institutions before clinical application. The visual scoring method was valid and reliable for evaluating masticatory performance [4]. In this study, there is a significant correlation between color-changeable chewing gum and gummy jelly, so both can be used for evaluating masticatory performance in fully dentate patients and removable denture wearers. Some limits of this study could be outlined, such as its minimal sample size. Thus, further studies are necessary to increase the sample size and divide the removable denture wearers more specifically between partially removable and fully removable dentures.

4. Conclusion

This study showed that removable dentures do improve masticatory performance, but they are not able to fully restore masticatory performance like fully dentate individuals. Color-changeable chewing gum and gummy jelly can differentiate masticatory performance in fully dentate and removable denture groups. There is a correlation of the chewing gum and gummy jelly measurements.

Acknowledgement

The research leading to these results has received funding from PITTA 2016 from Directorate Research and Community Engagement Universitas Indonesia. This study is also in collaboration with the Division of Comprehensive Prosthodontics, Niigata University Graduate School of Medical and Dental Sciences, Niigata, Japan.

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