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Comparison of the maximum bite force in patient with heat cure acrylic and flexible partial dentures (Bounded posterior edentulous area)

Zainab Mahmood Al-Jammali

Department of Prosthodontics, College of Dentistry, University of Babylon, Iraq

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Abbreviations:
FEE: free end extension, RPD: removable partial denture, PMMA: polymethyl methacrylate, cl.III: class three, MBF: maximum bite force, N: Newton

Corresponding Author:
Al-Jammali Z.M.
Email: zainab.jouid@yahoo.com

Abstract
Objective: The purpose of this study was to measure and comparism the maximum bite forces of acrylic and flexible partial dentures in patient with CL.III Kennedy classification during different adaptation period. *Subjects/Methods:* Twenty four free end extension patients (FEE) were selected. Three testing sessions made for both types of partial denture that used in this study by using a portable occlusal force gauge. *Results*: There is a significant differences were found in the values of maximum bite force between the two types of partial dentures with mean of (46.8750±1.02479) for the acrylic denture and (93.7292±2.15794) for the flexible denture in all adaptation periods in group one, and with mean of (33.6875±0.72515) for the acrylic denture and (64.6875±0.84853) for the flexible denture in all adaptation periods in group two. *Conclusion:* The flexible partial dentures give highest values of the maximum bite force in all adaptation period than the acrylic partial dentures, the maximum bite force was increased with increased the adaptation period, and the patients in group one have the highest maximum bite force than group two in both types of partial denture and in all adaptation periods.

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1. Introduction

Rehabilitation of missing teeth with removable partial denture (RPD) is often utilized to improve patients masticatory function. However if all missing teeth have been replaced, the masticatory function is usually improved to a lesser extent than that of previous complete dentition. Denture patient were reported as handicapped and have less masticatory performance (Fontijn-Tekampand et al, 2000), bite force (Shinkal et al., 2001)than people with natural teeth, in inter individual comparisons, masticatory function and bite force of denture patient were about one half to one sixth those of dentate subjects, depend mainly on type of denture and numbers and distribution of remaining teeth (Miyaura et al., 2000).

1.1 Polymethyl methacrylate

Since ages, polymethyl methacrylate (PMMA) has been used to fabricate the dentures. The acrylic denture base prostheses have their own advantages and disadvantages. Some problems with these prostheses are difficult to address, such as insertion in undercut areas, brittleness of methyl methacrylate which leads to fracture, and allergy to methyl methacrylate monomer (Anusavice, 1996).

1.2 Flexible dentures

The innovation of the nylon-derived denture base material in the 1950s paved the way for a new type of dentures. Flexible dentures are an excellent alternative to conventionally used methyl methacrylate dentures (Singh et al., 2011), which have several advantages over the traditional rigid denture bases, aesthetics due to translucency of the

material picks up underlying tissue tones, making it almost impossible to detect in the mouth. No clasping is visible on tooth surfaces. Being flexible, the denture base adapts well in the undercut areas. Complete biocompatibility is achieved because the material is free of monomer and metal (Shamnur et al., 2007). Flexible denture material is so strong that it can be made very thin which makes it comfortable to wear. As the flexible dentures are fabricate during the injection molded technique, they exhibit better accuracy compared to conventional techniques. Flexible denture material has been reported to have therapeutic advantage in overcoming midline denture fractures (Dhiman and Chowdhury, 2009).

1.3 The bite force measurements

Determination of individual bite force level has been widely used in dentistry, mainly to understand the mechanics of mastication for evaluation of the therapeutic effects of prosthetic devices and to provide reference values for studies on the biomechanics of prosthetic devices (Fernandes et al., 2003). In addition, bite force has been considered important in the diagnosis of the disturbances of the stomatognathic system (Calderon et al., 2006).

The bite force measurements can be made directly by using a suitable transducer that has been placed between a pair of teeth. This direct method of force assessment appears to be a convenient way of assessing the sub maximal force. An alternative method is indirect evaluation of the bite force by employing the other physiologic variables known to be functionally related to the force production (Ferrario et al., 2004).

Several factors influence the direct measurements of the bite force. Thus, different investigators have found a wide range of maximum bite force values. The great variation in bite force values depends on many factors related to the anatomical and physiologic characteristics of the subjects. Apart from these factors, accuracy and precision of the bite force levels are affected by the mechanical characteristics of the bite force recording system (Van Der Bilt et al., 2008).The normal aging process may cause the loss of muscle force (Shinogaya et al,2001). Bakke et al., in 1990 have reported that bite force decreases with age after 25 years in females and after 45 years in males. Bite force decreases significantly with age, especially in women (Shinogaya et al., 2001). Shinogaya et al., in 2000 have evaluated the effects of age on maximum bite force, average magnitudes of pressure, and occlusal contact areas in elderly (53–62 years) and young (20–26 years) Japanese subjects.

Ferrario et al in 2004 have recorded larger bite force values in males and explained this result by their larger dental size. Because the larger dental size presents larger periodontal ligament areas, it can give a greater bite force. In contrast, Wichelhaus in et al., 2003 have found no significant differences in bite force between males and females. They have suggested that it might be due to the small number of subjects included in their study and to the investigation of functional forces occurring during nocturnal sleep. Even if some authors have found a non-significant gender effect, most studies have confirmed the differences of bite force values between males and females (Shinogaya et al., 2001). Miyaura et al., in 2000 have compared maximum bite force values in subjects with complete denture, fixed partial denture, removable partial denture and full natural dentition groups. Whereas the individuals with natural dentition have shown the highest bite forces, the biting forces have been found to be 80, 35, and 11% for fixed partial dentures, removable partial denture and complete denture groups, respectively, when expressed as a percentage of the natural dentition group. On the other hand, technique-related factors include interocclusal separation, location of the measuring device on the dentition, and head posture at the time of measurement.

A number of different devices have been used to obtain direct measurement of bite force including the bite fork (Helkimo et al, 1977), strain gauge transducers (Proffit et al.,1983), foil transducers (Proffit et al.,1983 and Burke et al., 1973), the pressurized rubber tube (Braun et al.,1995),the gnathodynamometer (Ortug , 2002), the pressure-sensitive sheet (Hidaka et al., 1999), and force-sensing resistors (Fernandes et al., 2003).

The purpose of this study was to measure and comparism the maximum bite forces of acrylic and flexible partial dentures in patient with cl. III Kennedy classification posteriorly edentulous area during different adaptation period.

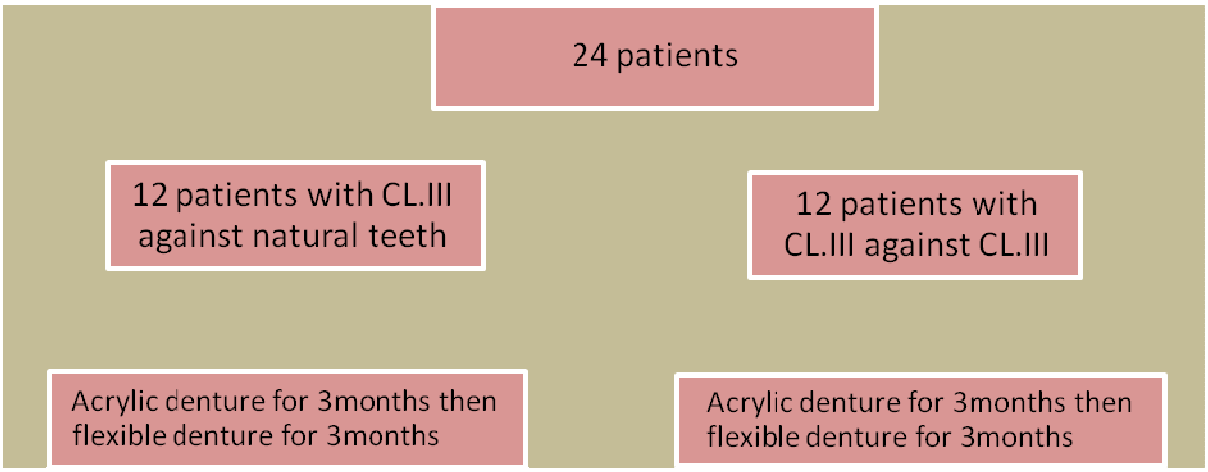
2. Objective of Research

This study was accomplished to compare the masticatory efficiency of patient wearing two different types of denture bases; heat cured acrylic and flexible denture base, by measuring the maximum bite force, and so we can advise the patient about the better RPD efficiency in the mastication.

3. Materials and methods

3.1 Sample selection

This study was made at 2014 (February), twenty four free end extension patients (FEE) were selected (12 male and 12 female) attending the removable prosthodontics clinic ,at Babylon dental university , the voluntary patients participated after receiving thorough information about the aim and design of the study and fulfilling the following criteria: a Class I skeletal pattern, (35-45) years and means 40 years of age, an adequate inter arch space, and educated patient with good physical capability to carry out the instructions.



Twelve of these patients were selected having a maxillary or mandibular Kennedy class III with no modification (first and second molars missing teeth against natural dentition) with no complaint of pain or discomfort at the time of study, while the remaining 12 patients having Cl. III against Cl.III Kennedy classification (first and second molars missing teeth against first and second molars missing).

3.2 Experimental procedure design for testing

Three testing sessions made for both types of partial denture that used in this study, each session was done in the morning after breakfast, the experimental schedule included measurements of maximum bite force in the first molar region using a portable occlusal force gauge (GM10, Nagano Keiki, Tokyo, Japan; figure 1), that consisted of a hydraulic pressure gauge and a biting element made of a vinyl material encased in a polyethylene tube. Bite force was displayed digitally in Newton. The accuracy of this occlusal force gauge has previously been confirmed (Sakaguchi et al., 1996). This device has several advantages: it is easy to use, does not need any special mounting, has a small thickness of about 5.4 mm, does not interfere with the tongue, and can be easily disinfected by changing the disposable plastic coverings (Elham and Abu Alhaija, 2009). Before the recording, the patient was seated in upright position with the Frankfort plane nearly parallel to the floor. Each patient was instructed to bite as hard as possible on the gauge. Bite force was measured three times with a 30 second resting time between each bite. From these three readings, one value was obtained from the mean of these readings the maximum bite force (MBF), which is the maximum measurement achieved in each patient.

The device was placed between the first artificial molar and the opposite natural teeth (in the first group) and opposite artificial teeth (in second group). First, the finish dentures are inserted in patient mouth, check it if there is any nodule, spicule, or any sharp projection, because it will affect our measurement. Then, the measurements done at the first day of insertion of the partial denture ,after 10 days, after the 30 days, and lastly after 90 days from insertion for the flexible denture first then for acrylic denture or the opposite.

Figure 1: Occlusal force gauge

4. Statistical analysis

Data analysis was carried out using the Statistical Package for Social Science version 20 (SPSS Inc.®, Chicago, Illinois, USA). Descriptive data were tabulated. T-test was used to find the variance and to determine whether significant differences existed between the groups, the criterion level for statistical significance was set at ($p<0.05$) (two-tailed). All data are expressed as mean ± standard deviation (SD).

5. Results and Discussion

Table (1) showed the data of the study groups, the range of age, the Kennedy classification and the gender distribution. This intra-individual study, that the individual differences among subjects were eliminated. Table (2) showed that the largest mean value of the maximum bite force was registered in group one after 90 days from wearing the flexible partial denture (116.3333 N).

Table 1: Study groups data

No. of patients	Gender		Age range	Kennedy classification
12	Male 6	Female 6	37-45	Kennedy Cl.III against natural dentition (group 1).
12	Male 6	Female 6	35-45	KennedyCl.III against Cl. III (group 2).

Table 2: Comparison of the mean and standard deviation of the maximum bite force (in Newton) between the two types of the denture base in different adaptation periods in group (1)

Adaptation period (days)	Type of denture	Mean	SD. Deviation	Mean Differences
1	Acrylic	41.0833 N	3.05877	-39.33333
	Flexible	80.4167 N	3.75278	
10	Acrylic	45.0000 N	2.66288	-39.83333
	Flexible	84.8333 N	3.71320	
30	Acrylic	50.5000 N	10.95030	-42.83333
	Flexible	93.3333 N	4.27112	
90	Acrylic	50.9167 N	2.53909	-65.41667
	Flexible	116.3333 N	8.46741	

Table 3: Comparison of the mean and standard deviation of the maximum bite force (in Newton) between the two types of the denture base in different adaptation periods in group (2)

Adaptation period(days)	Type of denture	Mean	SD. Deviation	Mean Differences
1	Acrylic	28.1667 N	1.40346	-29.25000
	Flexible	57.4167 N	2.71221	
10	Acrylic	31.0833 N	1.31137	-30.66667
	Flexible	61.7500 N	2.34036	
30	Acrylic	36.4167 N	2.99874	-31.58333
	Flexible	68.0000 N	2.87640	
90	Acrylic	39.4167 N	2.39159	-32.25000
	Flexible	71.6667 N	1.49747	

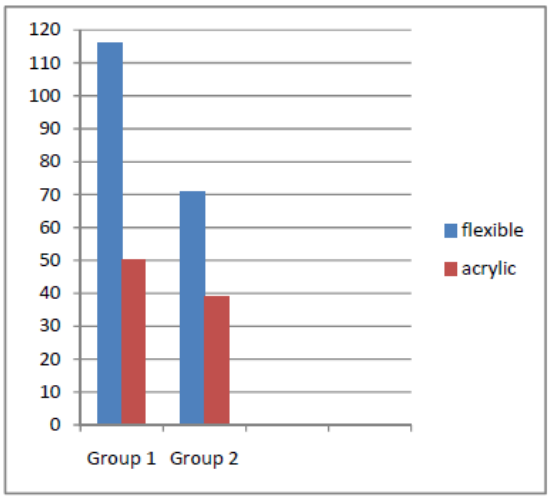
Table 4: Comparison of the mean and standard deviation of the maximum bite force (in Newton) between the two groups in different adaptation periods with acrylic partial denture

Adaptation period(days)	Group	Mean	SD. Deviation	Mean Differences
1	Group 1	41.0833 N	3.05877	12.9166
	Group 2	28.1667 N	1.04346	
10	Group 1	45.0000 N	2.66288	13.9166
	Group 2	31.0833 N	1.31137	
30	Group 1	50.5000 N	10.95030	14.08333
	Group 2	36.4167 N	2.99874	
90	Group 1	50.9167 N	2.53909	11.50000
	Group 2	39.4167 N	2.39159	

Table 5: Comparison of the mean and standard deviation of the maximum bite force (in Newton) between the two groups in different adaptation periods with flexible partial denture

Adaptation period(days)	Group	Mean	SD. Deviation	Mean Differences
1	Group 1	80.4167 N	3.75278	23.0000
	Group 2	57.4167 N	2.71221	
10	Group 1	84.8333 N	3.71320	23.08333
	Group 2	61.7500 N	2.34036	
30	Group 1	93.3333 N	4.27112	25.3333
	Group 2	68.0000 N	2.87640	
90	Group 1	116.3333 N	8.46741	44.66667
	Group 2	71.6667 N	1.49747	

Figure 2: Bar chart of the mean (with its 95% confidence interval) maximum bite force of the two types partial dentures of the two groups after three months adaptation periods



And in general, it is obvious that the flexible partial dentures give the highest bite force in the two groups and in all patients than the acrylic partial dentures figure (2) and the differences between the two denture base types in the maximum bite force was significant at ($p<0.05$) in both study groups. The probable explanation for this result is because the flexible denture base has the flexibility to disengage forces on individual teeth and prevent transfer of forces to remaining natural teeth and the other side of the arch because it acts as stress-breaker to disengage forces on individual saddles. We shift the burden of force control from the design features of the appliance to the material properties of the base material. A lever is more efficient if it is made from rigid materials. One way to control leverage effects is to make the lever out of inefficient materials. A flexible lever does not work well as a lever. So let's make the partial flexible to reduce the leverage effects of its extensions (Ferrario et al., 2004).

Table (2) show that among the first group patients (having a maxillary or mandibular Kennedy class III with no modification against natural dentition) the flexible partial dentures give highest bite force in different adaptation period (at day of insertion, after 10 days, after 30 days, and after 90 days) than the acrylic partial dentures, and also the maximum bite force was increased with increased the adaptation period, that the lowest bite force at the first days and the highest after 90 days in both groups. The results of this study were that the maximum bite force increased significantly with the increasing in the adaptation periods. And also agree with the study of Aung et al in 2013 which showed that the new dentures provided higher biting forces after adaptation.

Tables (4 and 5) show that the differences between the two groups in maximum bite force values was significant at ($p<0.05$), the largest maximum bite force values in group one in all adaptation periods and with both types of partial denture, the probable explanation is that in group one we have single denture (cl.III Kennedy classification against natural teeth), so that the occlusal force gauge placing between the artificial and natural teeth, in the presence of physiological human factors influence such as the bite force and the oral sensorimotor of the natural teeth(Hirano K et al, 2004), the bite force was greater in natural teeth than artificial teeth that will facilitate better food breakage and so better masticatory performance (Fontijn-Tekamp et al., 2000).

Conclusion

With the limitation of this study, we can conclude that the maximum bite force in patient with flexible partial denture is higher than with acrylic partial denture, the bite force become higher with the increase in the adaptation periods, and also in patient with single denture (cl.III Kennedy classification against natural teeth), the maximum bite force was higher than patient with paired denture (cl.III Kennedy classification against cl.III Kennedy classification).

Recommendations

1. Comparing the masticatory efficiency between the flexible and heat cure acrylic partial denture by using different types of food such as carrots and peanuts or even artificial food.

2. Comparing the masticatory efficiency between the flexible and heat cure acrylic partial denture by using EMG records.

3. Comparing the masticatory efficiency between the flexible and heat cure acrylic partial denture with different adaptation periods.

4. Multiple variables could be included in further studies to accurately assess the effect of the type of denture base on the masticatory efficiency.

5. Further studies are needed to find if there are any differences between both sexes chewing strokes.

6. Further longitudinal study may be needed to estimate better results.

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