Comparison of the maximum bite force in patient with heat cure acrylic and flexible partial dentures (Free end extension)

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RESEARCH ARTICLE

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ABSTRACT

Objective. The purpose of this study was to measure and comparison the maximum bite forces of acrylic and flexible partial dentures in patient with free end edentulous area during different adaptation period. ***Subjects/ Methods***. In this intra-individual study twenty four free end extension patients (FEE) were be selected, twelve of them having Kennedy Cl. I against natural dentition, while the remaining 12 patients having Cl. I against Cl. I Kennedy classification. Three testing sessions made for both types of partial denture that used in this study, by using a portable occlusal force gauge, and each patient was instructed to bite as hard as possible on the gauge. 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*.* ***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 (39.9375±1.04949) for the acrylic denture and (72.39±3.07194) for the flexible denture in all adaptation periods in group one, and with mean of (28.6250±0.69038) for the acrylic denture and (51.7292±1.37954) 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.

KEYWORDS: The maximum bite force, heat cureacrylic denture, flexible partial dentures,free end extension partial denture.

INTRODUCTION:

Loss of teeth, which may be due to trauma, dental diseases, pathology, or otherwise not only alters the psychological thought of the patients but also disturbs the esthetics, phonetics, and functional occlusion.[1] Replacement of missing teeth is highly essential in order to restore the defect and regain function as best as possible.

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.[2]

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[3], 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.[4] 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.[5]

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Bite force is one indicator of the functional state of the masticatory system that results from the action of jaw elevator muscles modified by the craniomandibular biomechanics.(6) 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.(7) In addition, bite force has been considered important in the diagnosis of the disturbances of the stomatognathic system.(8)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 submaximal 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.(9)

Fontijn-Tekamp proved that a significant correlation was found between maximum bite force and chewing efficiency and nearly half of the variation in chewing efficiency was explained by bite force alone.(10) Several factors influence the direct measurements of the bite force. 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.(11) The normal aging process may cause the loss of muscle force.(12) Indeed, the jaw closing force increases with age and growth, stays fairly constant from about 20 years to 40 or 50 years of age, and then declines.(6) In children with permanent dentition between the ages of 6 and 18, bite force has been significantly correlated with age.(13)In relation to the gender, maximum bite force is higher in males than females. The greater muscular potential of the males may be attributed to the anatomic differences.(12,14-16) The masseter muscles of males have type 2 fibers with larger diameter and greater sectional area than those of the females.(6,17)The authors have suggested that hormonal differences in males and females might contribute to the composition of the muscle fibers.(17) In addition, the correlation of maximum bite force and gender is not evident up to age 18. It is apparent that maximum bite force increases throughout growth and development without gender specificity.(18)

Dental status formed with dental fillings, dentures, position and the number of teeth is an important factor in the value of the bite force.(19) There is a positive correlation between the position and the number of the teeth at both maximal and submaximal bite force.(20) The number of teeth and contact appears to be an important parameter affecting the maximum bite force. The greater bite force in the posterior dental arch may also be dependent on the increased occlusal contact number of posterior teeth loaded during the biting action. For example, when maximum bite force level increased from 30% to 100%, occlusal contact areas double.(21) Bakke et al(22) have suggested that the number of occlusal contacts is a stronger determinant of muscle action and bite force than the number of teeth. Lasilla et al(20) have compared bite force in complete denture, partial denture and natural dentition. Their results are consistent with those of Miyaura et al(23) who have found the greatest bite force in the natural dentition group.

The recording devices vary from simple springs to complex electronic devices. The first experimental study defining the intra-oral forces was performed by Borelli in 1681 who designed a gnatodynamometer.(24) He attached different weights to a cord, which passed over the molar teeth of the open mandible, and with closing of the jaw, up to 200 kg were raised.(25) Black made the first scientific examination of forces in 1893. Subsequently, several researchers continued to investigate this subject and designed the lever-spring, manometer-spring and lever, and micrometered devices.(24,26) Today, sensitive electronic devices are used. Such instruments are both accurate and precise enough for common load measuring purposes. Gnatodynamometers have been used to measure bite force for a long time and some investigators use strain-gages mounted dynamometer for recordings.(25,27) A digital dynamometer has been developed. This appliance uses electronic technology and consists of the bite fork and digital body. 20,45 The most widely accepted recording device is the strain-gage bite force transducer.(28,29-34) The strain-gage bite force transducer is available in different heights and widths. Ferrario et al(9) and Kogawa et al(35) have measured bite force with 4 mm height and 5x7 mm wide strain-gaged transducer.

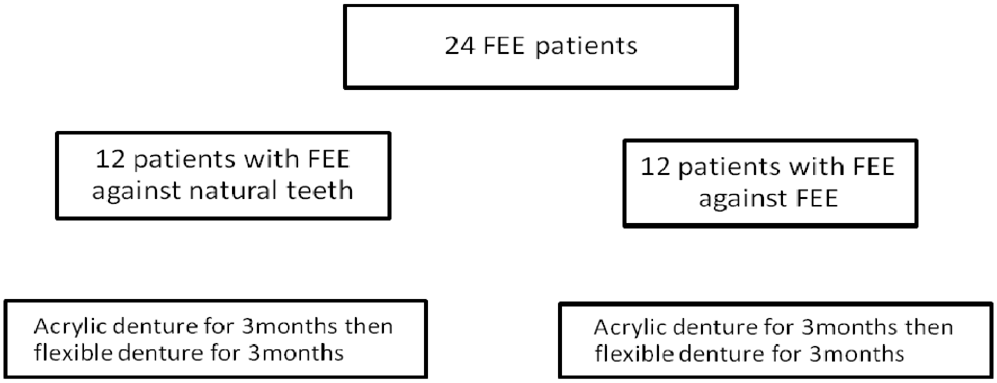
Bite force varies in different regions of the oral cavity.(9) The more posteriorly the transducer is placed in the dental arch, the greater the bite force.(36) It has been explained by the mechanical lever system of the jaw.(18,37) In addition, greater bite force can be tolerated better in posterior teeth, because of the larger area and periodontal ligament around posterior teeth roots.(31)

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

MATERIALS AND METHODS:

Sample selection

Twenty fourfree end extension patients (FEE) were be 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 I with no modification(first, second and third 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.I against Cl.I Kennedy classification.

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 [38].

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.[39] 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 obtain 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 daysfrom insertion for the flexible denture first then for acrylic denture or the opposite.

Figure (1) Occlusal force gauge

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).

RESULTS:
Table (1) showed the data of the study groups, the range of age, the Kennedy classification and the gender distribution. 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 **(105.5833 N)**. 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 shiftthe 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 itis 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.[9]

DISCUSSION:

Table (2) show that among the first group patients (having a maxillary or mandibular Kennedy class I 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 was that the maximum bite force increased significantly with the increasing in the adaptation periods. Bite force measurement was found to bepositively related to masticatory efficiency.[43-45]Fontijn-Tekamp[10]proved that a significant correlation was found between maximum bite force and chewing efficiency and nearly half of the variation in chewing efficiency was explained by bite force alone. Therefore, the results of this study agreed with the Miyaura[23],Murata [43] and Hayakawa [44,45]. And also agree with the study of Aung et al [46]which showed that the new dentures providedhigher 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 partial denture, the probable explanation is that in group one we have single denture (cl.I 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[47] , the bite force was greater in natural teeth than artificial teeth that will facilitate better food breakage and so better masticatory performance.[10]

CONCLUSION:

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.I Kennedy classification against natural teeth), the maximum bite force was higher than patient with paired denture (cl.I Kennedy classification against cl.I Kennedy classification) .

Table(1): Study groups data

No. of patients	Gender		Age range	Kennedy classification
1 2	Male 6	Female 6	35-44	Kennedy Cl. I against natural dentition (Group 1).
1 2	Male 6	Female 6	36-45	Kennedy Cl. I against Cl.I (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	32.1667 N	2.32900	-20.2500
	Flexible	52.4167 N	3.62963	
10	Acrylic	36.2500 N	3.84057	-21.7500
	Flexible	58.0000 N	5.04525	
30	Acrylic	41.3333 N	2.74138	-32.2500
	Flexible	73.5833 N	3.87201	
90	Acrylic	50.0000 N	2.21565	-55.5833
	Flexible	105.5833 N	4.14418	

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	22.5833 N	1.92865	-18.6667
	Flexible	41.2500 N	2.56285	
10	Acrylic	26.7500 N	1.81534	-19.5000
	Flexible	46.2500 N	3.27872	
30	Acrylic	30.0833 N	1.31137	-24.4167
	Flexible	54.5000 N	3.87298	
90	Acrylic	34.6667 N	1.61433	-30.2500
	Flexible	64.9167 N	2.71221	

Table (4): Comparison of the mean and standard deviationof 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	32.1667 N	2.32900	9.58333
	Group 2	22.5833 N	1.92865	
10	Group 1	36.2500 N	3.84057	9.50000
	Group 2	26.7500 N	1.81534	
30	Group 1	41.3333 N	2.74138	11.25000
	Group 2	30.0833 N	1.31137	
90	Group 1	50.0000 N	2.21565	15.33333
	Group 2	34.6667 N	1.61433	

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	52.4167 N	3.62963	11.16667
	Group 2	41.2500 N	2.56285	
10	Group 1	58.0000 N	5.04525	11.75000
	Group 2	46.2500 N	3.27872	
30	Group 1	73.5833 N	3.87201	19.08333
	Group 2	54.5000 N	3.87298	
90	Group 1	105.5833N	4.14418	40.66667
	Group 2	64.9167 N	2.71221	

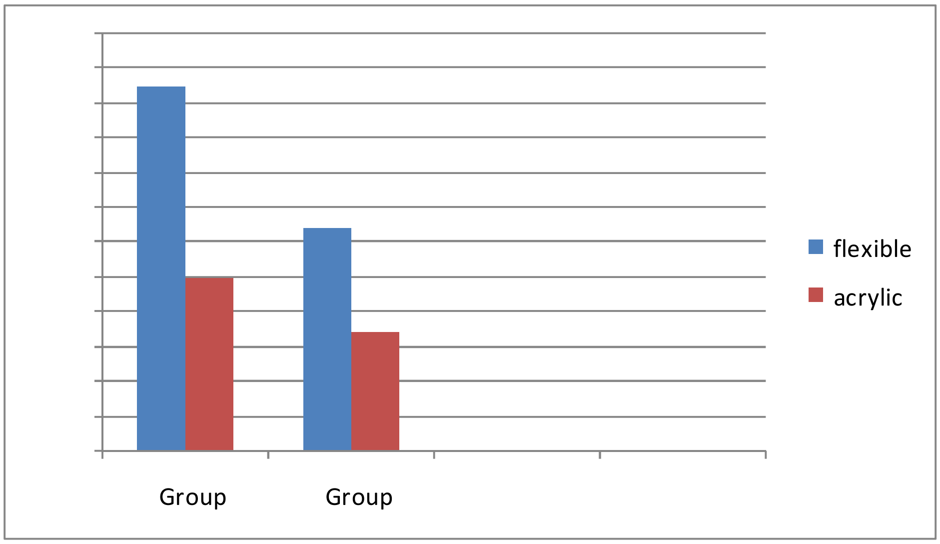


Figure (2) Bar chart of the mean (with its 95% confidence interval) maximum bite force of the two types partial dentures of the two groups after three months adaptation periods

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