

Assessment of Bite Force and Masticatory Efficiency in Flexible Partial Dentures: An In-Vivo Study

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ABSTRACT

The aim of the study is to find the effect of flexible denture base material on bite force and masticatory efficiency in partially edentulous patients. The patients aged between 25 to 50 years were recruited from the Department of Prosthodontics. The inclusion criteria was Kennedy's Class III partially edentulous condition, with missing first molar in any one quadrant of mouth, to be restored with flexible RPD with full set of remaining natural teeth. Biting force was measured bilaterally in first molar region, on the dentate side and the prosthetic side using a customized digital gauge. Masticatory efficiency was evaluated bilaterally on the basis of the degree of standardized food sample fragmentation. The mean bite forces in the test side was less (8.04 ± 3.39 N) as compared to the non-test side with bite force with 31.22 ± 3.40 N inferring significant difference between the groups. The masticatory efficiency was also significantly less on the test side as compared to the non-test side. The amount of filtrate material left in the test side was more in comparison to the non-test side. The comparison of maximum bite force and masticatory efficiency have concluded that there is a direct co-relation between their two parameters.

KEY WORDS: dentures, efficiency, masticatory, muscles

INTRODUCTION:

Healthy diet in the form of fresh fruits and vegetables are recommended for humans and such food requires efficient chewing^[1]. The word 'efficient chewing' means the breakdown of food with minimum effort and maximum rate of particle size reduction. Chewing efficiency is related to the status of dentition and loss of teeth decreases the chewing efficiency^[2].

Assessment of masticatory function in clinical and experimental conditions can be done by measuring bite force and chewing efficiency^[3]. Bite force can be defined as the force applied by the masticatory muscles in dental occlusion^[4]. In dental research, bite force has been recorded as a variable to assess functional efficiency of various dental procedures like prosthesis, orthodontic treatment or to study effects of deformities and pathologies of the masticatory system and temporomandibular joint^[5,6]. A variety of devices with a diversity of designs and working principles have been used to record bite force. It includes portable hydraulic pressure gauge, strain gauge transducers, pressurized rubber tube foil transducers, pressure sensitive sheet and gnathodynamometer^[7,8].

According to George A Zarb, average value of

occlusal force in natural dentition is approximately 20 kg and 6-8 kg with the denture during chewing and deglutition^[9]. There are wide range of variables which influence bite force. They are categorized under individual factors and technique related factors. Individual related factors includes the person's craniofacial morphology, height, age, weight and body mass index (BMI). Technique related factors includes inter-occlusal distance, hardness of biting surface and head position during measurement^[10]. It also varies with different means and types of prosthetic restorations and materials.

Injection molded thermoplastic materials like polyamide (PA) and acetal (AC) are alternative to widely used polymethyl methacrylate (PMMA) denture base material. The thermoplastic materials have low modulus of elasticity than PMMA resin and so are flexible in nature^[11].

Clinical studies have compared the masticatory performance of patients wearing flexible complete denture (CD) and removable partial denture (RPD) with natural dentition^[12,13]. Co-relation between biting force and chewing efficiency in patient wearing flexible RPDs is needed to be evaluated. Therefore the aim of the present study was to evaluate and compare bite force and masticatory efficiency between natural dentition and flexible removable partial dentures. It was hypothesized that flexible denture base material has significant effect on bite force and masticatory efficiency in partially edentulous patients.

MATERIALS AND METHODS:

Participants (n= 15; 9 Male, 6 Female) for the study were recruited from Department of Prosthodontics

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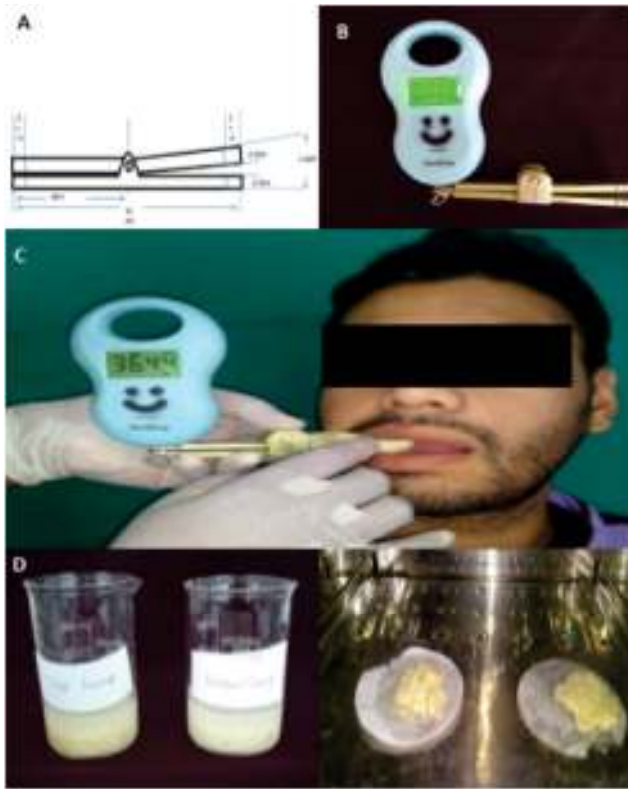


Figure 1: (A) Schematic diagram; (B) Customized digital gauge; (C) Bite force reading displayed on digital meter; (D) Collected chewed food in the biker; (E) Filtrate material dried in hot air oven.

dentics and Crown & Bridge, Hitkarini Dental College and Hospital, Jabalpur, India. The inclusion criteria were patients of age limit between 25 to 60 years with Kennedys Class III partially edentulous condition with missing first molar in any one quadrant of mouth, to be restored with flexible RPD with full set of remaining natural teeth. Remaining natural teeth should show no sign and symptoms, no restorations, carious lesions, no mobility > grade I with vital pulp. The Kennedys Class III partially edentulous condition is used in the study as maxillary posterior teeth is mainly used for chewing and was able to compare with other side of the same patient. Patients should have no systemic condition affecting neuromuscular system, no crossbite or Class I facial profile.

Bite force measurement: Biting force was measured bilaterally in first molar region, on the dentate side and the prosthetic side using a customized digital gauge [Fig. 1(A)]. The customized digital gauge had a digital display unit to show readings [Fig. 1(B)]. It was attached to two stainless steel thongs of dimension 12cm x 1cm x 0.5cm at one end. On the other end of

the thongs the subjects were asked to bite with maximum force for 5 ± 1 seconds to record the readings [Fig.1(C)]. The biting force was measured 3 times, with 1 min intervals between the consecutive measurements, and highest value was recorded. All participants were in upright position on dental chair during bite force measurement.

Masticatory efficiency measurement: Masticatory efficiency was evaluated bilaterally on the basis of the degree of standardized food sample fragmentation. Each patient received three portions of 15 ± 1 gram serving of peanuts (Salted peanuts), measured with the aid of a laboratory balance and packed in sealed disposable polyethylene foil bags. The participants were instructed to chew each portion for 20 chewing cycles with a single cycle corresponding to one complete sequence of abduction and adduction of the mandible, along with laterotrusive and mediotrusive movements resulting in crushing and rubbing of the peanuts. The chewed food was collected in a disposable cup. Subjects were asked to rinse twice with water, and the rinsing were added to the cup. Each side was tested three times and the chewed food was pooled for a single measurement for each side of the mouth [Fig. 1 (D)]. The chewed food in the cup was stirred with a glass rod to break up clumps of food and then poured on a stack of sieves 80 mesh U.S. standard sieves. The smaller particles were washed through successive sieves. The particles remaining on sieve were placed on plastic sheets and transferred into 50 C.C. graduated centrifuge tubes. The sieves were rinsed with a cup of water, which were added to their respective tubes. Since no food passed through the 80 mesh sieve, the filtrate was discarded. The tubes were centrifuged for 3 minutes at 1,500 rotation per minute. The volume of the test material (sediment) in each tube was recorded and total volume of recovered food was determined by adding the volumes from all tubes. Filtrate material was filtered with filter paper, remaining material dried in hot air oven for 30 minutes [Fig. 1 (E)] and weighted by laboratory balance and recorded. Greater the quantity of filtrate leftover, less was the masticatory efficiency and vice versa.

RESULTS:

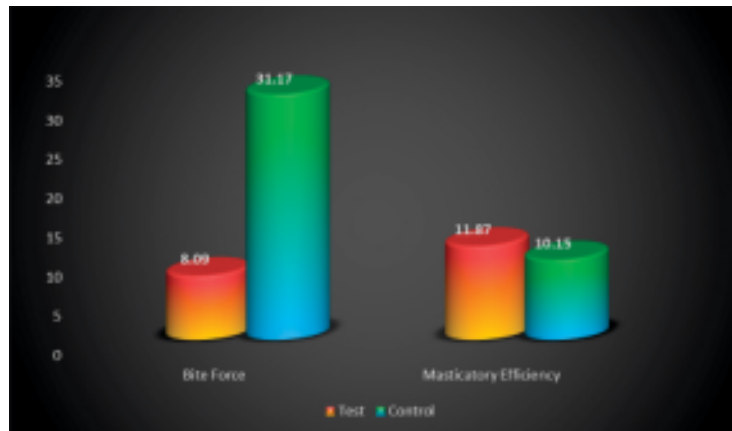
The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2007) and then exported to data editor page of SPSS version 20.0 (SPSS Inc., Chicago, Illinois, USA). The data shows non normal distribution in Shapiro Wilk test. Hence, non parametric test was applied for

Table 1: Comparison of Bite Force and Masticatory Efficiency between the Flexible RPD (Test Group) and dentate side (Control Group).

Measurement	Group	N	Mean	Std. Deviation	p- value
Bite Force (in Kgs)	Test	15	8.09	3.39	0.001 *
	Control	15	31.17	3.40	
Masticatory Efficiency (filtrate weight)	Test	15	11.87	1.13	0.001 *
	Control	15	10.15	0.69	

*Significant

Graph 1: Comparison of BF and ME between the Flexible RPD (Test Group) and dentate side (Control Group).



quantitative data (mean values). Mann Whitney U test was applied between the mean values of test and control groups for bite force (in kgs) and masticatory efficiency (in grams). Level of significance was set at 0.05.

The bite force (BF) and masticatory efficiency (ME) for test and control group were calculated. Table 1 and Graph 1 shows comparison of BF and ME between the Flexible RPD (Test Group) and dentate side (Control Group). It could be assessed that $p < 0.001$ showed that there was statistically significant difference between the bite force of natural teeth and the flexible partial denture. The mean bite force value and masticatory efficiency was more on dentate side.

DISCUSSION:

Loss of teeth causes extensive change in the oral function, physiology and health. It results in decreased masticatory efficiency, disturbed digestion, malnutrition altered speech and develop esthetic problems.¹⁴ Prosthetic replacement of lost teeth is aimed towards solving the associated problems with lost teeth. According to the clinical condition replacement could be in the form of complete dentures, partial denture, over denture, fixed

prosthesis (FPD) etc. Studies have concluded that individuals using CD or RPD show reduced masticatory efficiency as compared to those with natural teeth or FPD. These results are parallel to the present study which found high masticatory efficiency in test group.

Masticatory efficiency is defined as the capacity to grind a certain amount of food in aspecific period of time^[4]. Various methods are described to evaluate masticatory efficiency in-vivo. Among these, the use of sieve system is the most commonly used method for measuring efficiency. This method was first introduced by Gaudenz in 1901. Many variations of the the original sieve system are found in literature. It includes the number of the chewing cycle, number of sieve used, diameter of sieve hole and the type of test food used.

In this method, the key point is that, fineness with which the food particles are ground. Quantity of particle reaching the smallest size sieve decide the masticatory efficiency which have direct relation^[15]. There is a variety of natural test foods which are used in testing masticatory efficiency (like peanut, hazelnut, apple, potato, almond, carrot ham, coconut bread, turnip soya etc) distributed into different classes according to Manley &Bradley and Kapor et al.

According to a study on evaluation of various test foods for measuring masticatory efficiency by Kapoor et al fibrous food like lettuce ,celery were difficult to be chewed, which chestnuts peanuts were the easier one to be chewed and sieved^[16,17]. Considering this in the present study peanuts was used as a test food material. Stakes of sieves were used in the present study after considering the study conducted by the Vander Bilt in 2002 where they compared use of single and multiple sieve method for determining masticatory efficiency and recommended multiple sieve method as according to them it provides more accurate results.

Masticatory or bite force is related to the presence of periodontal proprioception.¹⁸The study found that the mean bite force value of partially edentulous patients were much lesser than the dentate patients, this simulate the result obtained in the present study in terms of bite force. The results described the importance of prosthetic rehabilitation of lost teeth. The mean maximum bite force obtained in the present study on the dentate side was around 305.06N which is near to the values obtained by earlier report^[19].

Studies conducted on the comparison of maximum bite force and masticatory efficiency have concluded that there is a direct co-relation between their two parameters. Results of the present study simulate the earlier study. A custom made device to record bite force was used in the present study. Validity of the device, and accuracy with which it can record bite force is needed to be evaluated.

CONCLUSION:

The study result found that there is statistically significant difference in bite force and masticatory efficiency between the flexible RPD and natural dentition . The bite force was more and the amount of material remainig was less in natural dentition side. Therefore it was concluded that the bite force and masticatory efficiency was comparatively less in flexible RPD as compared to the natural dentition.

REFERENCES:

- Wilding RJ. The association between chewing efficiency and occlusal contact area in man. *Archs Oral Biol* 1993;38(7):589-596
- Sharma AJ, Nagrath R, Lahori M. Acomparative evaluation of chewing efficiency, masticatory bite force and patient satisfaction between conventional denture implant supported amdibular overdenture: An In-vivo Study. *J Ind Prosthodont Soc* 2017;17:361-72.
- Enkling N, Saftig M, Worni A, Stern RM. Chewing efficiency, bite force and oral health related quality of life with narrow diameter implants. *Clin Oral Implants Res*. 2017 Apr;28(4):476-482.
- Driscoll CF, Freilich MA, Guckes AD, Knoernschild KL, McGarry TJ. The Glossory of prosthodontics Term 9th edition. *J Prosthet Dent* . 2017: 117(Supp 5); e1-e105.
- Winocur E, Davidov I, Gazit E, Brosh T and Vardimon AD. Centric slide, bite force and muscle tenderness changes over 6 months following fixed orthodontic treatment. *Angle Orthod* 2007;77(2): 254–59.
- Awad GD, Ausama A. Relationship of maximum bite force with craniofacial morphology, body mass and height in an Iraqi adults with different types of malocclusion. *J Baghdad Coll Dent* 2013;25(1): 129–38.
- Verma TP, Kumathalli IK, Jain V, Kumar R. Bite force recording divices-A review.*J Clin Diag Res* 2017;9:1-6.
- Flanagan D, Obren B, Macmans A, Larrow B. Jaw bite force measurement divice. *J Oral Implant* 2012;361-364.
- Hobrink J, Zarb GA, Bolender CL, Eckert S, Jacob R, Fenton A, Mericske-Stern R. Prosthodontic treatment for edentulous patients: complete dentures and implant-supported prostheses. *Elsevier Health Sciences*; 2003 Sep 17.
- Zarea B. Maximum bite force following unilateral fixed prosthetic treatment: A within subject comparison to the dentate side. *Med Princ Pract* 2014; 24:142-6.
- Al-Jammali ZM. Comparison of the maximum bite force in patient with heat cure acrylic and flexible partial denture (Bounded posterior edentulous area). *J Dent Photon* 2015;244-9.
- Shala K, Bicaaj T, Pustina-Krasniqi T, Ahmedi E, Dula L, Lila-Krasniqi Z. Evaluation of the masticatory efficiency at the patients with new complete dentures. *Open Access Maced J Med Sci*. 2018;20(6):1126.
- Bessadet M, Nicolas E, Sochat M, Hennequin M, Veyrone JL. Impact of removable partial denture prosthesis on chewing efficiency. *J appl oral sci*. 2013;21(5):392-6.
- Goiato MC, Garcia AR, Dos Santos DM and Zuim

- PR. Analysis of masticatory cycle efficiency in complete denture wearers. *J Prosthodont*. 2010; 19: 10-13.
15. Kabrowik MA, Kladic G, Zumudki J, Kasperski J. Chewing efficiency and occlusal force in PMMA acetal and polyamide removable partial denture wearers. *Acta Bioengi Biomech* 2016;18:127-134.
 16. Manly RS and Vinton P. A survey of the chewing ability of denture wearers. *J Dent Res* 1951;30(3):314-21.
 17. Kapor K, Soman S, Yarkstas A. Test food for measuring masticatory efficiency of denture wearers. *J Prosthet Dent* 1964;14:483-491.
 18. Koo D, Dogan A, Bek B. Bite force and influential factors on bite measurement: Literature review. *Ero J Dentistry* 2010;4:223-231.
 19. Kassem M, Saief-Elnasr M, Baraka Y, Helal MA. Bite Force Evaluation of Acetal Resin Denture Base in Kennedy Class I Partially Edentulous Patients. *EC Dental Science* 2019;19(1):01-8.

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