

EVALUATION OF BONE HEIGHT CHANGES AND BITING FORCES IN DISTAL EXTENSION PROSTHESIS WITH DIFFERENT DENTURE BASE MATERIALS

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ABSTRACT

Statement of problems: Partially edentulous patients with distal extension (class I Kennedy) show morphological changes in bone height that may be also associated with some difficulties during mastication.

Purpose: The present study aims to evaluate the bone height changes around abutments and distal extension area with different denture base materials and to record and compare biting forces associated with it.

Materials and methods: Ten partially edentulous patients (Kennedy class I) were selected and received two unilateral partial dentures in a split mouth study design in which each patient received one partial denture with conventional metal framework with acrylic resin base and one partial denture with Acetal resin framework and resin denture base. Biting forces were measured using I Load star sensor. Digital radiography was used for bone height assessment at time of prosthesis insertion, 6 and 12 months later.

Results: There was a statistically significant difference in bone changes between the conventional and the Acetal RPDs after one year. There was no statistically significant difference in biting forces between the two sides throughout the period of the study.

Conclusion: Bone changes were significantly higher with the conventional acrylic partial denture and the Acetal partial denture showed more favorable results. Both types of unilateral partial dentures showed comparable biting forces after one year of clinical use.

KEYWORD: Denture base materials, Removable partial denture, Biting forces, Bone changes.

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INTRODUCTION

Rehabilitation of partially edentulous arch can be challenging when it is a distal extension situation or long edentulous span. The use of fixed partial dentures (FPDs) in oral rehabilitation may not be recommended when the remaining teeth are unable to withstand masticatory loadings. Distal extension base partial dentures are known for their negative impact on the remaining oral structures specially abutment teeth and the residual ridge.¹⁻⁴ Thus, from the biomechanical point of view, the use of dental implants may be the choice. When the use of dental implants and/or conventional FPDs is limited or not indicated, due to insufficient amount of bone and economic reasons, association between an FPD and removable partial denture (RPD) by means of attachments becomes an important alternative to a conventional clasp-retained RPD.^{2,5}

Various types of extracoronal attachments were successfully used in unilateral distal extension base in combinations of FPDs and RPDs to achieve retention, stability and favorable distribution of stresses to the abutment teeth. Attachment retained RPD is the treatment modality that can facilitate both esthetic and a functional replacement of missing teeth and oral structures.⁶⁻⁸

The OT Unilateral castable bar attachment has an exclusive feature two in one design, in which a combination of horizontal and vertical micro spheres are used with the OT Cap and OT Strategy attachment systems. This gives the partial denture better retention, stability and load distribution which positively affects the masticatory function.^{7,9-12}

Previous studies showed that different denture base material has a significant effect on chewing efficiency and the occlusal force,¹³ in addition to significant differences in bone reduction level around the terminal abutments.² One of the indications of a functionally stable masticatory system is the biting

force which has been used in dentistry for evaluation of various prosthetic restorations.¹⁴⁻¹⁷

Acetal resin is a chain of alternating methyl groups linked by an oxygen molecule with a monomer free crystalline structure.¹⁸ Acetal as a homo-polymer has good short term mechanical properties, but as a co-polymer has better long-term stability. Acetal resin is very strong, resists wear and fracturing, and is quite flexible. These characteristics makes it an ideal material for preformed clasps for partial dentures, single pressed unilateral partial dentures, partial dentures frameworks, provisional bridges, occlusal splints, and even implant abutments.^{19,20}

Till present there are not enough clinical studies to compare different partial denture frameworks and base material. The present study aims to evaluate clinically the effect of using thermoplastic Acetal resin as a partial denture framework on the biting force and its impact on bone changes.

MATERIALS AND METHODS

Patient selection:

Ten female patients were selected from the outpatient clinic Prosthodontics Department, Faculty of oral and dental Medicine, Cairo University, their ages ranged from 40 to 55 years. All patients were systemic diseases free as detected by lab analysis. All patients were Kennedy class I partially edentulous mandibular arch with the second premolar being the last abutment showing sufficient crown occluso-gingival height. Intact opposing arch without noticeable over eruption or tilting. Only patients restored with acceptable fixed restoration were included in the study. The remaining natural teeth had apparently good periodontal condition with no signs of inflammation, firm and healthy marginal gingiva. All patients had sufficient bone height and width, as well as, adequate bone quantity as confirmed radiographically.

Prosthetic treatment:

Primary impressions* were made using suitable stock trays, poured and primary casts were obtained on which acrylic special trays were constructed. The lower first and second premolars on each side were prepared to receive two connected full Porcelain Fused to Metal (PFM) crowns. Putty impression** was made and a dual impression was carried out in the conventional manner. The prepared abutments were protected by readymade temporary crowns which were cemented using temporary cement.*** The impression was then washed, inspected and poured into extra-hard dental stone.**** Wax patterns of both crowns were built-up and the completed wax pattern of the crown-attachment assembly***** was sprued, invested and cast into a nickel-chromium***** metal. Fig. (1) The crown-attachment assembly was tried in the patient mouth and proper positioning of the attachment was checked in relation to the ridge. Metal and Acetal# resin framework construction and jaw relation records were obtained respectively. Each patient received two partial dentures retained

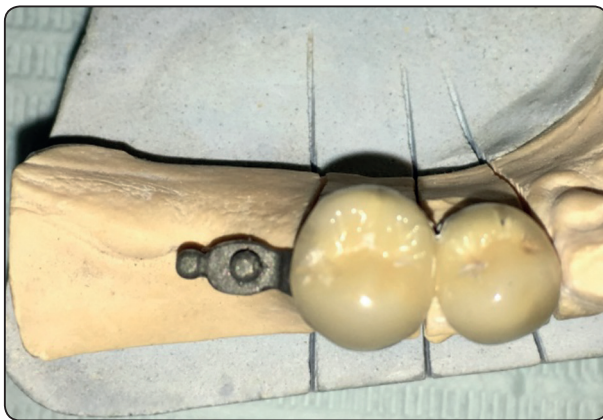


Fig. (1): Crown and attachment assembly.

with the OT extra coronal attachment; one with conventional metal framework and acrylic resin denture base and the other with Acetal resin framework and resin denture base fig. (2) In a split mouth design in which 5 patients received on right side an Acetal framework and the other 5 patients received on the left side a metal framework. Biting force and bone height measurements were done for each partial denture at time of denture delivery, 6 and 12 months after.

Biting force measurement:

Biting force measurements were done using the Load star sensor### in Newton, placed horizontally on the chewing surface of the denture teeth, at the central point of the edentulous ridge and the patient was instructed to clench maximally. Fig. (3) The position of the measurement was identical for all dentures made of different materials by placing the sensor on the first molar area. The biting force was measured for each side and the highest 5 measurements were included in the statistics.

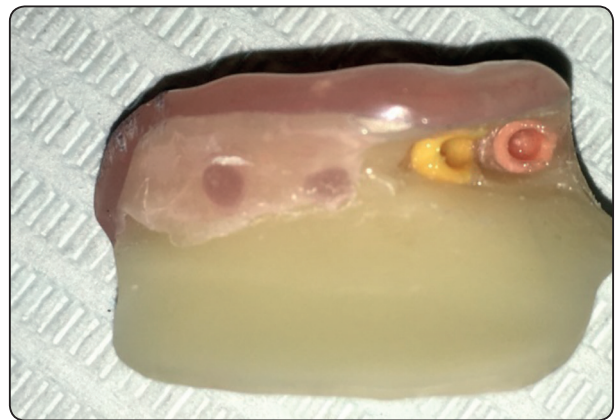


Fig. (2): Acetal framework and denture base.

* Chromopan –Lascod. B A . 50019 Sesto Fiorentino Firenze, Italy.

** Zetaplus, Zermack, Italy.

*** Temp-Bond™ Temporary Dental Cement | Kerr Dental, Germany.

**** Type III Dental stone, Lascod SPA, Sestofino, Italy.

***** Rhein 83 OT unilateral.

***** Nickel Chromium metal framework, Vita, Switzerland.

Thermoflex; Austenal, Inc, pen, USA.

Iload digital USB sensor, Loadstar sensor, Mountain View, CA



Fig. (3): Load star sensor placed for measuring biting force.

Bone height measurements:

A radiographic stent was constructed for each patient for repeatable imaging sensor position and standardization purposes. Digital radiography was used to measure marginal bone level distal to the last abutment bilaterally using the long cone paralleling technique at insertion, 6 and 12 months. Measurements were done using Digora software* in the following manner; a horizontal line was extended tangential to the apex of the tooth, then distal to the last abutment three equidistant vertical lines were extended from the horizontal line to the highest point of the alveolar crest. Fig. (4)

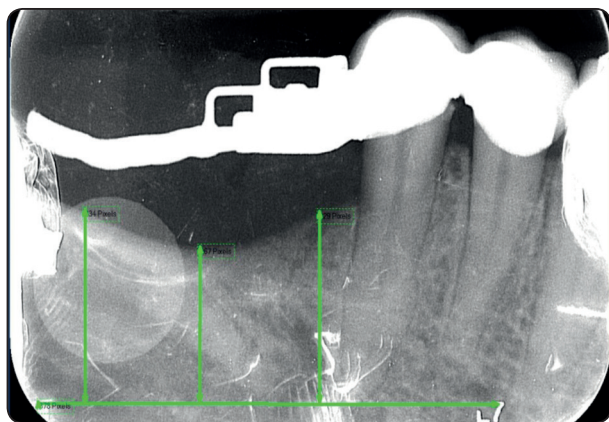


Fig. (4): Digital radiography measuring marginal bone height change

Statistical analysis:

Calculation of bone height changes and the effect of time were carried out using the following equation:

One way analysis of variance (ANOVA) followed by Tukey’s post hoc test for multiple comparisons was performed to calculate the significance between both sides.

Independent sample-t test was used to compare between independant samples for parameric data. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

RESULTS

A) Biting force measurements:

This study showed that there was insignificant difference in biting force records between both Acrylic and Acetal resin sides at all-time intervals as P -value > 0.05 , as listed in table (1) and showed in figure (5,6).

TABLE (1): Mean and standard deviation of biting force for both groups for each interval:

M ± SD	Group I (Acrylic Resin)	Group II (Acetal)	P-value
At insertion (0)	135.72 ^a ± 62.6	107.17 ^a ± 49.41	0.3622*
After six months (6)	135.81 ^a ± 59.5	107.21 ^a ± 46.64	0.3366*
After twelve months (12)	136.199 ^a ± 54.92	107.34 ^a ± 44.87	0.3028*
P-value	0.99*	1.0*	

M%; Mean Percentage, SD; Standard deviation, P; Probability Level *insignificant difference Same superscript letters in same column indicate insignificant difference

* DIGORA® for Windows. Soredex, Finland

B) Bone height changes:

Regarding bone height changes this study showed that there was a significant difference

between Acrylic resin side and the Acetal resin side at all-time intervals as P-value < 0.05, as listed in table (2) and showed in figure (8).

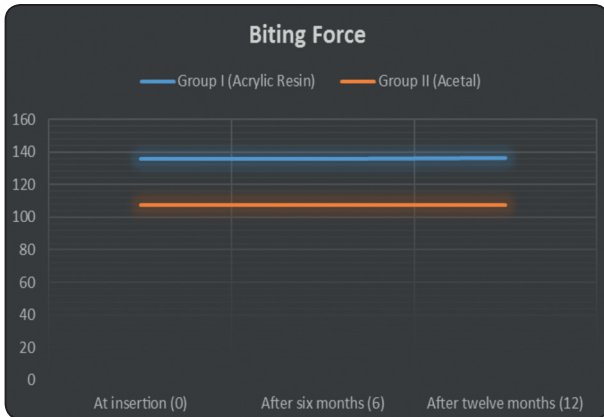


Fig. (5): Line chart revealing biting force of both groups

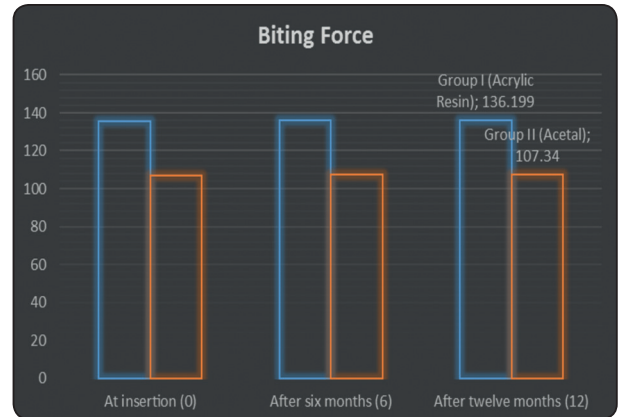


Fig. (6): Bar chart revealing biting force of both groups

TABLE (2): Mean and standard deviation of bone height change percentage at the distal, middle and end of the ridge for both groups for each interval:

The ridge	Group I (Acrylic Resin)			Group II (Acetal)			P-value
	End	Middle	Distal	End	Middle	Distal	
0-6 months	0.86±0.019 ^d	1.7±0.017 ^c	1.05±.027 ^c	0.23±0.051 ^a	0.46±0.091 ^b	0.33±.064 ^c	0.0001**
0-12 months	2.18±0.084 ^c	3.18±0.067 ^d	2.8±.024 ^c	0.54±0.038 ^a	1.14±0.047 ^b	0.67±.071 ^a	0.0001**
P-value	0.0001**			0.0001**			

*M%; Mean Percentage, SD; Standard deviation, P; Probability Level **significant difference*
Same superscript letters in same row indicate insignificant difference
Different superscript letters in same row indicate significant difference

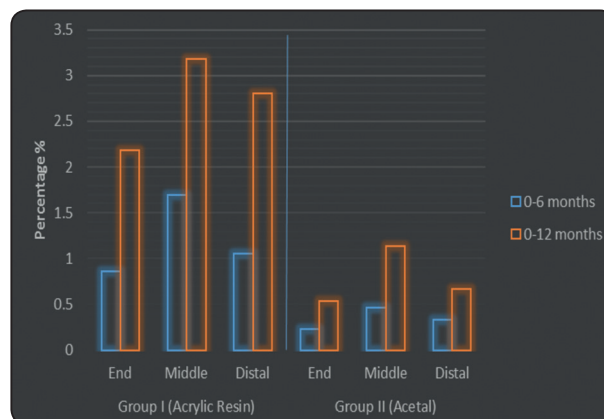


Fig. (7): Bar chart revealing percentage of bone height changes in twelve months at the distal, middle and end of the ridge

DISCUSSION

In this study ten female patients with mandibular class I (Kennedy classification) having the second premolar as the last standing tooth were selected and their ages ranged from 40-55 years. Female patients were selected so that the measurements for amount of bone loss would not be contributed to any sexual variation related factor.^{21,22} The selection of patients with close age range to eliminate age effect on biting force and bone metabolism.^{23,24} The opposing arch in all selected patients was either dentulous or partially edentulous restored with fixed prosthesis to standardize the effect of opposing occlusion and their effect on force transmission.^{25,26}

Today many limitations of poly-methyl methacrylate have been overcome by the various advancements in denture base resins. The possible use of polyacetal resin as a denture base material was considered by Smith over 40 years ago to provide better treatment and care to the patients.²⁷ Acetal resin is considered an ideal material for partial denture frameworks, unilateral partial dentures since it is very strong, has high wear and fracture resistant in addition to its flexibility.^{19,28-30}

Bite force is an important variable to investigate proper oral function which is related to occlusal factor, dentition, dentures, and treatment with implants, orthognathic surgery, temporo-mandibular disorders and neuromuscular changes.^{31,32} Muscle force and the number of functional teeth are determinate factors in masticatory function. Measuring maximum bite force is an attempt to quantify the force that mandible elevator muscles can perform.³³

Although there was higher readings in the Acrylic side, the present study showed no significant difference between both sides in measuring biting forces, where in acrylic denture base side higher readings in biting forces were recorded than in the other side, considering that patients participating in the study did not use a specific side for mastication before denture insertion, this difference in biting

forces may be due to that occlusal forces exerted on this side was higher due to marked difference in the mechanical properties and stresses between the conventional PMMA and the Acetal resin as discussed before.

The ideal RPD design principle is to transfer forces that are applied to removable partial dentures to the supporting teeth and tissue in an atraumatic fashion.²⁶ A major concern with the use of a distal extension removable partial denture (RPD) is the control of excessive torquing forces that may act on the abutments distally towards the edentulous area and by time lead to distal wall resorption and tooth movement.³⁴

Radiographic evaluation was carried out using the Digora computerized system which avoided the disadvantages of the conventional radiographic techniques. Also the Digora system offered the advantage of instant image display and lower radiation dose. Besides, it is considered as an accurate and reliable method for evaluating bone changes when compared to the other methods.^{35,36}

Measurements of alveolar bone height were limited to distal, middle and end of the ridge to the last abutment, as it was proved that, in natural teeth, significant amount of bone loss occur interproximally than buccally and lingually.³⁷

The data obtained from the present study showed significant decrease in the marginal bone height distal to the last abutment, middle and end of the ridge in both sides, with significant difference between both sides which can be attributed to the effect of partial denture framework material on the teeth and surrounding bone. The fact that Acetal resin is more flexible which transmit less stress to the abutment and ridge compared to the metal framework.³⁰

The bone height changes for the Acetal framework side was less than the metal framework side, this may be due to flexibility of the Acetal resin and a lower modulus of elasticity than PMMA that transmit less load onto the abutment and the mucosa under the partial denture.

CONCLUSION

This study showed that denture base material exerts significant effects on the biting forces and bone height changes, the use of partial denture made of material with a lower modulus of elasticity was associated with decreased biting forces and less bone height changes.

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