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EVALUATION OF ADAPTATION AND STRESS INDUCED BY DIFFERENT DESIGNS OF PALATAL MAJOR CONNECTORS

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ABSTRACT

The purpose of this in-vitro study was to evaluate adaptation and stresses induced over the abutment teeth and residual ridge through different designs of maxillary major connectors.

Materials and methods: An acrylic resin model was fabricated and three different designs of upper major connectors were constructed, the first design was anterior palatal strap, the second design was anterior palatal bar and the third design was anterior-posterior palatal strap. Stress analysis was evaluated using strain gauge and strain developed was recorded. The adaptation was measured by Leica Micro System LTd, made in Germany. Data were calculated, tabulated and analyzed using statistical ANOVA test to compare between the last 10 readings obtained from the different designs when unilaterally and bilaterally loaded. Data were presented as mean and standard deviation (SD) values.

Results: The results revealed that the stresses transmitted to the abutments teeth and residual ridge by the anterior palatal bar major connector was of lower values than those recorded when the anteroposterior and anterior palatal strap were used. Regarding the adaptation of the major connectors no significant differences occurred before or after loading.

Conclusion: It can be concluded that much higher stresses transmitted by the anteroposterior palatal strap and the anterior palatal strap than that transmitted by the anterior palatal bar. Future research should focus on the minimal dimensions for relevant major connectors' adaptation.

INTRODUCTION

Restoring missing natural teeth with removable partial dentures must be proceeding with adequate plane and useful design following favorable biological and mechanical principles, in order to reduce the harmful effects on the supporting structures. [1], otherwise, inadequate support and stability will arise, an overloading and destructive stresses would applied over the abutments and residual ridge.[2]

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Major connectors are an important component of removable partial denture; it is a part to which all other parts are directly or indirectly attached. It provides cross arch stability which helps to resist displacement by functional stresses. It contributes to the support and bracing of a partial denture by distributing functional loads widely to the teeth and to the mucosa.

All major connectors should be rigid in order to functioning effectively and aid in distribution of stresses evenly over supporting structures. Flexibility in major connectors will concentrate stresses causing damage to the perioduntium and resorption of the ridge and soft tissue irritation. [(3)]

A decision on the choice of connector type is based upon the requirements of function such as connection of components, support, retention, anatomical constraints, hygiene, patient acceptability and stress distribution.

Electrical resistance strain gauges were used in the form of pressure transducers to study different clasp design on abutment tooth in distal extension cases [(4)]. The pressure distribution using tissue conditioners on simplified edentulous ridge model and the effect of occlusal scheme on the pressure distribution of complete denture supporting tissues. [(5)]

Some studies show that anteroposterior bars are preferable to anterior palatal bars, U-shaped plates are preferable to palatal straps and palatal plates are preferable to posterior palatal bars. [(6)]

Most researchers prefer palatal strap and /or double palatal bar and antero-posterior bar design.

Optical method in the dental fields photogrammetry is becoming more popular for determining adaptation properties of the connectors. [(7)]

The aim of this in-vitro study was to evaluate the stress transmitted to the residual ridge and the abutment teeth. And the adaptation of different maxillary major connectors.

MATERIAL AND METHODS

Standard maxillary Kennedy class III modification 1 with standing abutment canines and second molars bilaterally was fabricated by modifying commercially available typodont.

Acrylic resin model (master cast) was surveyed and after preparation of the model, blocking out of undesirable undercuts procedures were performed to accommodate Aker clasp on posterior abutments and I-bar on anterior abutments. Saucer shaped rest seats were prepared on occlusal surfaces of the second molars, cingulum rest seats were prepared on lingual surfaces of the canines.

Partial denture designs were constructed in 3 designs according to major connector design. First design was anterior palatal strap; second design was anterior palatal bar; and the third design was the antero- posterior palatal strap. (Figure 1)

Each acrylic model with its removable framework was placed on the lower metal plate of the universal testing machine.

A channel strain meter was used to record the micro-strains transmitted to each strain gauge, t-shaped load applicator bar of the testing machine was applied to the canines and the 2nd molar teeth of the denture. Load was applied unilaterally and bilaterally, the applied load started from zero up to 100N. (Figure 2)

The micro-strain readings were transferred to micro strain units through the channel strain meter. Enough time was elapsed (about 15 minutes) between each two successive measures to allow the strain gauges to be on zero balance before making the next reading.

The stereoscope Leica S8APO was used to measure (figure 3), and evaluate the adaptation by determine six points on each major connector and take the record before and after loading. (Figure 4)

Fig. (1) Three different designs of maxillary major connectors

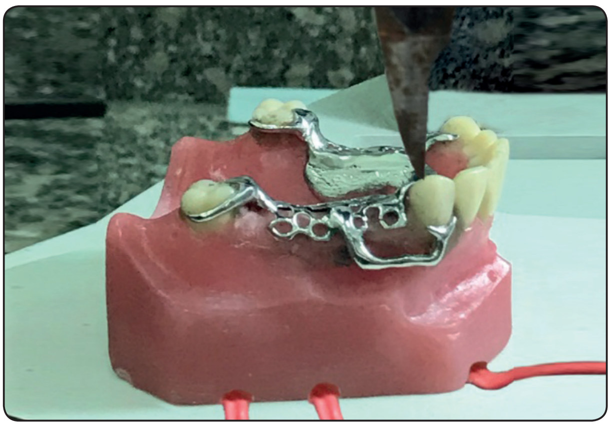

Fig. (2) Acrylic model with load applicator bar of the Universal Testing Machine

Fig. (3) Model placed on stereoscope

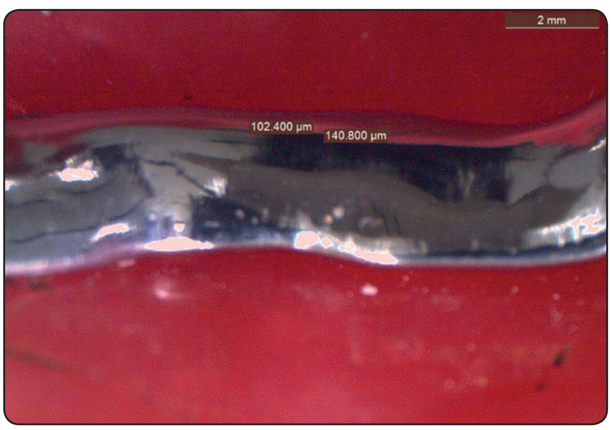

Fig. (4) Measures recorded by stereoscope for adaptation

RESULTS

TABLE (1): Mean of micro-strain with the three designs during bilateral loading

	A-p Strap	Anterior Strap	Anterior bar
Canine	57±11	49 ± 12	44 ± 10
Molar	126 ± 27	113 ± 17	98 ± 6
Ridge	28 ± 4	25 ± 2	22 ± 5

The significance level was set at p>0.05.

There was no statistically significant differences in mean measurements between the A-P strap and the anterior palatal straps while there was statistical significant differences between the anterior palatal bar and the two other designs during the bilateral load at the canine, the second molar and the residual ridge.

TABLE (2): Mean of micro strain with the three designs during the left unilateral loading.

	A-p Strap	Anterior Strap	Anterior bar
Canine	58±11	56 ± 17	45 ± 13
Molar	129 ± 24	125 ± 24	101 ± 23
Ridge	29 ± 2	28 ± 3	22 ± 3

The significance level was set at p> 0.05.

There was no statistically significant differences in mean measurements between the A-P strap and the anterior palatal straps while there was statistical significant differences between the anterior palatal bar and the two other designs during the left load at the canine, the second molar and the residual ridge.

TABLE (3): Mean of micro strain with the three designs during the right unilateral loading.

	A-p Strap	Anterior Strap	Anterior bar
Canine	58±10	55 ± 11	45 ± 10
Molar	129 ± 24	126 ± 24	103 ± 27
Ridge	28 ± 3	25 ± 2	23 ± 2

The significance level was set at p> 0.05.

There was no statistically significant differences in mean measurements between the A-P strap and the anterior palatal straps while there was statistical significant differences between the anterior palatal bar and the two other designs during the right load at the canine,the second molar and the residual ridge. (figure 5)

The adaptation of the of A-P palatal strap and the Ant. palatal strap was statistical significant more than the adaptation of Ant. palatal bar. There was no statistical significance difference in the adaptation of the three designs before and after loading. (figure 6)

TABLE (4): Mean of adaptation of the three designs before and after loading.

	Point 1		Point 2		Point 3		Point 4		Point 5		Point 6	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
A-P strap	109.363	109.303	121.431	121.400	120.755	120.750	114.487	114.480	102.400	102.00	103.197	103.195
A strap	114.843	114.553	103.197	103.190	118.010	118.000	105.551	105.500	102.400	102.00	110.110	110.100
A bar	141.380	141.080	128.000	127.990	137.860	137.850	154.663	154.660	140.800	140.500	138.453	138.450

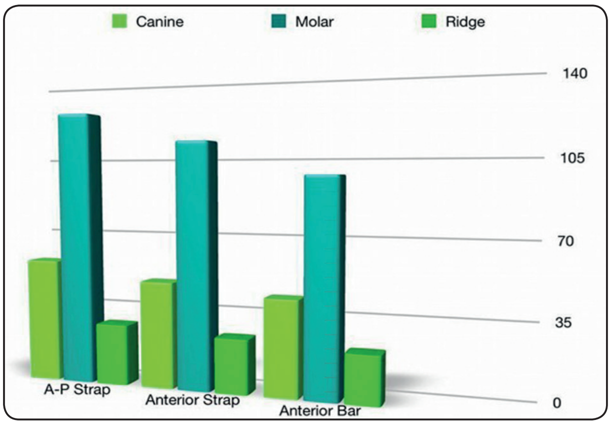

Fig. (5) Bar chart revealing stress analysis measures for the three designs

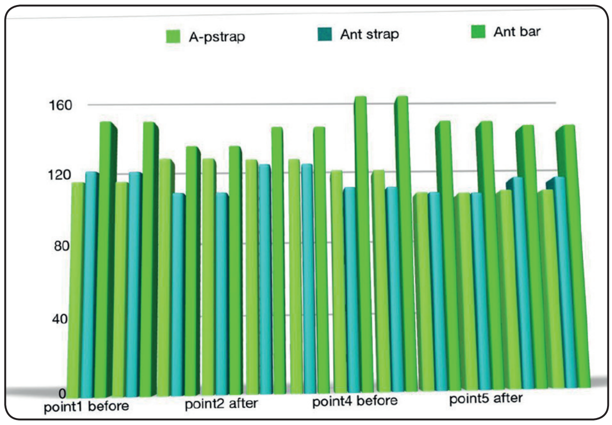

Fig. (6) Bar chart revealing adaptation readings results for the three designs

DISCUSSION

This in-vitro study was conducted to evaluate and compare stress patterns of three types of maxillary major connectors. This study was carried out in-vitro to allow for better control over variables and to facilitate measurements of changes which occur.

The three types of maxillary major connectors were antero-posterior palatal strap, anterior palatal strap and anterior palatal bar. They were selected because they are the commonly used maxillary major connectors. They cover minimal amount of palatal tissues, distribute masticatory stresses over a wide area.[8]

All frameworks were made using standard fabrication techniques with performed wax patterns used to wax the frameworks, and all frameworks followed the structural requirements for maxillary major connectors.

Bilateral and unilateral vertical load was applied to simulate biting forces as advocated by several authors. [9-11] Vertical forces were directed at the molar where the maximum biting forces were often exerted and the maximum contraction of the elevator muscle present

The stresses recorded. Bilaterally and unilaterally on the anterior palatal bar major connector was of lower values of stresses than those recorded by the anteroposterior palatal strap and anterior palatal strap, this means that the stresses induced by the anterior palatal bar was within the physiologic limit of the bone thus will preserving the bone height and favorably. This can be attributed to the more rigidity of A-p and anterior palatal straps than the anterior palatal bar. Because it extends in three planes making the former more rigid. [12]

There was no significant difference of adaptation between before and after loading this may be due to the few numbers of samples.

CONCLUSION

Due the limitation s of this study, it was concluded that;

- The anterior palatal bar major connector was the favorable major connector to distribute the vertical forces on the abutments and the ridge.
- The antero-posterior and the anterior palatal straps were more adapted than the anterior palatal bar.

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