Modified Rotation Joint Connection Unite Versus Double Aker Clasp used for Bracing of Maxillary unilateral Free End Removable Partial Dentures (*In Vitro* Analysis of Stresses on Principle Abutments and Edentulous Ridge)

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Abstract: Aim: This study aimed to evaluate the stresses transmitted to the principal abutment teeth and residual ridge. In maxillary class II Kennedy classification removable partial denture (RPD) using two different bracing designs on the tooth supported side used in conjunction with extracoronal attachment on the tooth tissue supported side. Material and methods: Twenty duplicates of educational casts of maxillary class B Kennedy classification RPD were constructed. According to the bracing design used, the casts were classified into two equal groups, each group consists often casts. Group I design with extra coronal attachment toward the tissue side ad double Akers clasp on the tooth supported side. Group II with extra coronal attachment toward the tooth tissue side and modified rotation joint in the intact side. Strain gauges were used to record the micro stresses when a load of 60 N applied for both groups. Results; The results showed that there was statistically highly significant differences for the recorded micro stresses far group II than group I on the principle abutments and the residual ridge from the buccopalatal and mesiodistal directions. Conclusion: Modified rotation joint connection unite is a promising bracing approach in the management of unmodified unilateral free end saddles. [Journal of American Science 2010;6(9):109-114]. (ISSN: 1545-1003).

Keywords: Joint Connection; Unite Versus Double Aker Clasp; Maxillary; Dentures

1. Introduction

Rehabilitation of partially edentulous cases in absence of distal abutments is notably troublesome for both the prosthodontist and the patient1. Various methods and materials have been used for the treatment of patients with unilateral distal extension ridges. Numerous studies had conducted to test effect of distal extension partial dentures on both abutments and residual alveolar ridge2-8.

Although there are numerous factors that influence success, stress control is a fundamental requirement for a physiologic prosthesis9.

In the unilateral distal extension spaces, the removable prostheses restoring such space normally require support from the teeth of both sides of the arch. Without this support, the denture and its abutment stand little chance of resisting forces causing the base to whip4. It used to be argued that under occlusal load the tooth and mucosal supported part of the prostheses might be displaced more than the tooth supported section, thereby introducing more unfavorable forces on the abutments10.

The design used for the management of the unmodified unilateral free end saddle usually comprise rigid clasping placed as far distally on the non edentulous side to provide support and cross arch stabilization". Many extra coronal attachments with stress releasing properties can be used with unilateral distal extension bases such as Dalbo, Ceka, ERA, and Tach-EZ semi precision plunger, which produce equal stress distribution between the abutments and the residual alveolar ridges 12.

The Rotation Joint was designed for the unilateral distal extension prostheses. Steiger designed the Rotation Joint to allow only slight rotational and lateral movements in order to minimize torque transmitted from the distal extension base to the opposite side. A typical unilateral distal extension design, would therefore, incorporate an Axial Rotation Joint connecting the distal extension base to the retainers and major connectors, while the retainers on the opposite side, tooth supported side, would be connected through a Rotation Joint 13.

Steiger originally designed the axial rotation joints as a connector for distal extension denture. He felt that the screw should be at the top of the window when the teeth were apart, and should move downward as load was applied to the artificial teeth. Since the most favorable distribution of the load to the edentulous ridge occurs with a combination of vertical and rotational movements, it was suggested that a small amount of metal to be removed from the mesio-gingival and disto-occlusal sections of the male unite. The amount of relief required was extremely small.

It was aimed in this study to evaluate the effect on the principle abutments and residual ridge when decreasing the vertical load by using Modified Rotation Joint in comparison to the conventional double Aker clasp design on the unmodified tooth supported side in conjunction with extracoronal Dalbo semi precision attachment in thetooth tissue supported side.

2. Material and Methods

Acrylic resin educational model with maxillary unilateral free end saddle with missing left first and second molars was constructed for this study. Abutment preparation was made for receiving ceramometallic crowns on the premolars of the tooth tissue supported side. After preparation, the maxillary cast was duplicated into heat cured acrylic resin* maxillary cast.

According to the bracing design used in the tooth supported side, two different preparations were made for the maxillary casts as follows; Group I For this group, standard extra coronal Dalbo attachment was adjusted to the distal surface of the wax pattern of the ceramometallic crown using parralelometer, palatal guiding plane was prepared in the palatal surface of the first and second premolar to receive palatal guiding planes. Final splinted ceramometal crowns were constructed, finished and glazed. On the tooth supported side, mesial occlusal rest seat of standard thickness was prepared on the first premolar to receive an indirect retainer.

The second premolar and first molar were prepared to receive distal and mesial rests of Double Akers clasp, and middle palatal strap was used as cross arch stabilizer. Ten duplicate investment maxillary casts were constructed using reversible hydrocolloid impression material (Fig. 1,2).

Group II.

In this group, the Dalbo extracoronal attachment was cemented to the ceramometallic crown on the second premolar in the tooth tissue side as in group I. On the tooth supported side, mesial rest was constructed on the first premolar. The second premolar and first molar were prepared to receive two ceramometallic crowns. Ten duplicate investment maxillary casts were constructed using reversible hydrocolloid impression material.

During construction of the wax pattern of the two crowns, the plastic pattern of the Modified Rotation Joint was embedded in the embrasure area between the wax patterns of the two abutments and modified by making a small window around the screw. After construction of the final ceramometallic crowns on the two abutments with the Modified Rotation Joint in between, they were connected to the ball attachment using middle palatal strap as major connector and cross arch stabilizer. After construction of the metallic framework, a wax occlusal rim of standard height and width were constructed on the unilateral edentulous area to arrange acrylic resin artificial teeth. The waxed up maxillary trial denture bases were processed into heat cured acrylic resin.

Silicon material which acts as natural periodontal ligament was placed in the socket of the second premolar in the tooth tissue supported side and the second premolar and first molar of the tooth supported side after relieving the inner surface of the socket for 0.25mm and then painted with the primer of auto polymerized silicon soft liner. The socket was packed with the soft liner and the artificial premolar was inserted into the socket and held vertically into position until complete polymerization.

To simulate the viscoelasticity of the supporting mucosa, the unilateral extension ridge surfaces were ground out to a depth of 2mm of even thickness and were painted with the prime of auto polymerized silicon soft liner. The removable partial denture fitting surfaces were packed with silicon soft liner and then inserted on the model until complete polymerization. The silicon was adhered to the ridge segments and excess was trimmed.

Tow linear strain gauges of 1mm length and resistance of 120.2-+ 0.2 were cemented to the mesial, distal buccal and palatal surfaces of the second premolar in the tooth tissue side. Buccal and palatal strain gauges were cemented to the second premolar and first molar in the tooth supported side .The mean stresses transmitted to the principle abutments on both sides were calculated.

After cementation of the gauges with the strain gauge cement, the wires of the gauges were connected to the strainometer to measure the strains directly as shown in Fig (3), (4).

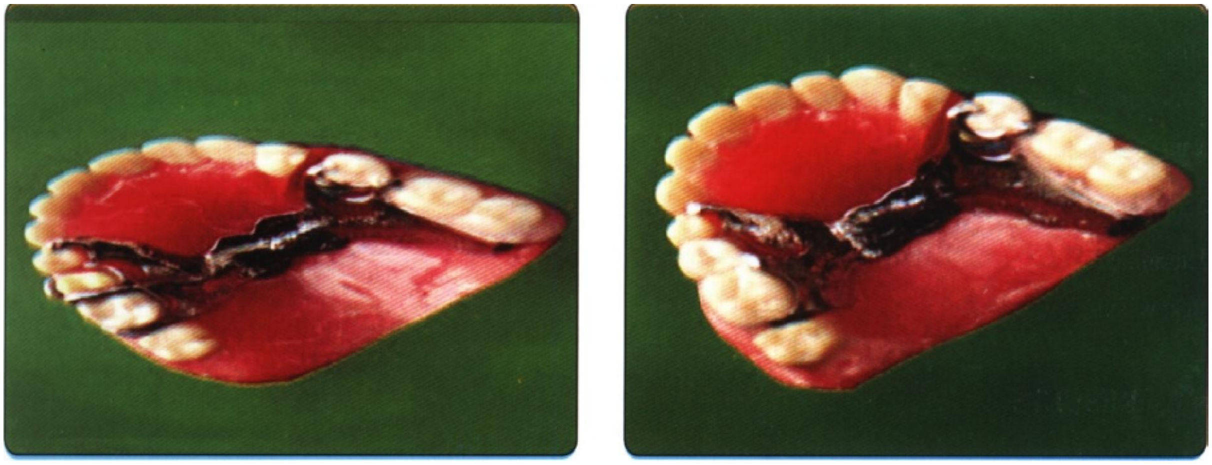

Fig. (1.2) Group I with double aker design, and Group II with modified rotation joint.

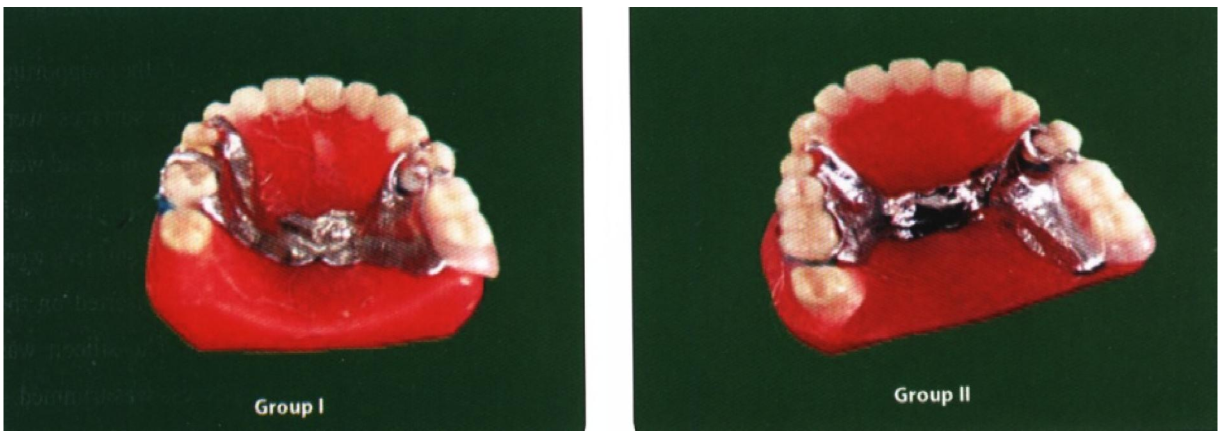

Fig. (3.4) Strain gauges cemented in their sites in the prepared acrylic casts for both groups.

A hydraulic device with a manometer was used as a loading apparatus. A load impact of 60 Newton/cm2 for 10 sec. was applied on the abutments and saddle area of the removable partial denture centrally and perpendicular on a St. St. bar fixed between the second premolars of both sides. All measurements were repeated 5 times for each loading impact. Two minutes rest interval was permitted between each loading. These procedures were repeated for the 10 dentures of each group. The stresses were measured according to the equation: stress/ strain=modulus of elasticity which is 2.7 for the acrylic resin 14.

The significance of the stress transmitted was determined with the one-way analysis of variance and t test was performed15.

3. Results

This simulation study was carried out to evaluate the effect of stress distribution on the principle abutment teeth and the ridge in class II Kennedy classification RPDs using strain gauge when a load of 60 N was applied to the abutments teeth and the ridge. To compare between the two studied groups, t-test procedure was applied. The differences among the four sides were analyzed by ANOVA test and the differences between the four sides in the same group by the least significant differences (LSD) and a probability level of P<0.0001 was considered statistically highly significant.

The results showed that the mean value of the recorded stresses on the principal abutment at the tissue site were 18.02, 18.07, 18.08, and 20.95 respectively at the buccal, palatal, mesial and distal aspects for group I. while for group II The results showed that the mean value of the recorded stresses on the principal abutment at the tissue site werel4.63, 11.73, 15.73 and 17.80 respectively at the buccal ,palatal, mesial and distal aspects for group II with the rotation joint. Statistically, there was highly significant difference in the recorded stresses between the two studied groups in all aspects, buccal, palatal mesial and distal sides P<0.0001 .

From Table (1) it was found that there was decrease of stresses in group II patients compared with group I patients in buccal, palatal, mesial and distal side when a load of 60 N was applied for both groups. Also the results showed that statistically there was highly significance differences on the distal aspect than buccal, palatal and mesial aspects in the same group (group I) where (LSD)=0.338, P<0.0001. While the (LSD)=0.403 and P<0.0001 for group II.

TABLE (l) The mean stresses transmitted on the buccal. palatal. mesial and distal aspects of the abutment teeth on the tooth tissue supported side for both groups In this study.

Group I			Group II		Group I vs Group II	
Side of stress	**Mean**	**S.D**	**Mean**	**S.D**	**T**	**P**
Buccal of abutment	**18.02**	**±0.310**	**14.63**	**0.049**	**18.53**	**0.0001**
Palatal of abutment	**18.07**	**±0.331**	**11.73**	**0.448**	**36**	**0.0001**
Mesial of abutment	**18.08**	**±0.472**	**15.73**	**0.448**	**11.4**	**0.0001**
Distal of abutment	**20.95**	**±0.550**	**17.80**	**0.386**	**14.81**	**0.0001**
LSD	**0.338**		**0.403**			
P Value	**0.0001**		**0.0001**			

TABLE(2) The mean stresses transmitted to the residual ridge in table(2) from both buccal and palatal aspects when a load of 60 N was applied for both groups.

Group I			Group II		Group I vs Group II	
Side of stress	**Mean**	**S.D**	**Mean**	**S.D**	**T**	**P**
Buccal of the ridge	**24**	**±0.373**	**18.05**	**±0.329**	**37.84**	**0.0001**
Buccal of the ridge	**35.38**	**±0.395**	**28.63**	**±0.359**	**38.21**	**0.0001**
T	**66.24**		**65.1**			
P	**0.0001**		**0.0001**			

The results showed that the mean value of recorded tresses on the residual ridge on the buccal side for both groups was 24 and 18.05 respectively. While the mean value of the recorded micro stresses on the palatal aspect of the ridge for both studied groups were 35.38 and 28.63 respectively.

Comparing the two recorded values the data reveled there was statistically highly significant difference between both groups (P<0.0001). The collected data reveled marked decreases in the recorded micro stresses on the buccal and palatal aspects of the residual ridge for group II than group I when the same load was applied for both groups. Also the results showed that statistically significant differences in bucco palatal in group II than group I as shown in table(2).

TABLE (3) The mean stresses transmitted to the abutment teeth on thv tooth side for cross arch stabilization for both studied groups when a load of 60 N was applied for the abutment teeth.

Group I			Group II		Group I vs Group II	
Side of stress	**Mean**	**S.D**	**Mean**	**S.D**	**T**	**P**
Buccal abutment	**15.13**	**±0.395**	**10.28**	**±0.381**	**27.94**	**0.0001**
Buccal abutment	**13.53**	**±0.381**	**9.83**	**±0.334**	**23.11**	**0.0001**
T	**9.19**		**2.81**			
P	**0.0001**		**0.0001**			

Table (3) showed the mean stresses on the principal abutments on the tooth supported side at buccal surfaces of the abutment teeth were 15.13 and 10.28 for both groups respectively. While, at palatal surfaces of the abutment tooth were 13.53 and 9.83 for both groups respectively. Statistically there was highly significant difference for group II than group I. P<0.0001 Also the results showed that there was marked decrease of micro stresses in distal than buccal for both groups, where the t=9.19 for group I and for group II t=2.81.

4. Discussion

During function every removable partial denture movements are converted into stresses to the abutments. In treatment of class II K-ennedy classification RPDs different designs of clasp systems have been used with less consideration of these guiding functions. Since vertical movement could be damaging to the teeth on the tooth supported side, Stieger designed the Modified Rotation Joint to allow only slight rotational and lateral movements in order to minimize torques transmitted from the extension base on the opposite side. As denture designs and impression techniques improved it was found that even the slight movement allowance provided by Stieger 's original design gave too much vertical play and led to damage of the distal papillae of the distal abutment tooth. Boitel finds that better results are obtained by using Rotation Joint for bilateral distal extension base as well by making slight widening of the window around the screw to allow minute amount of vertical play [1].

In this study double Akers clasp and Modified Rotation Joint connection unite were examined to measure the stresses on the principle abutments when loading the force. It was found that there was decrease of stresses in group II in compassion to group I in buccal, palatal, mesial and distal directions. Also the results showed that there was statistically highly significance differences on the distal aspect of the abutment than buccal, palatal and mesial aspects in the same group (group I) where (LSD)=0.338, P<0.0001. While the (LSD)=0.403 and P<0.0001 for group II. Increased stress transmitted to the distal surface of the abutment is in agreement with Kratchovil et al., who stated that Dalbo attachment produces the most force on the edentulous regions and the least forces on the abutment teeth[16]. The decrease of stresses transmitted during usage of modified rotation joint connection unit may be due to allowance of certain limited amount of play that give similar function to flexible major connector but act in more precise and predictable manner[17].

The collected data reveled marked decreases in the recorded stresses on the buccal and palatal aspects of the residual ridge for group II than group I when the same load was applied for both groups. Also the results showed that statistically significant differences in bucco palatal direction in group II than group I. This may be attributed to the allowance of the modified rotation joint connection unite to limited vertical movement in the tooth supported side that is equivalent to the vertical movement obtained from the resilient mucosa covering residual ridge on the tooth tissue side. This vertical movement during vertical load decreases the amount of stresses both on the residual ridges and on the abutments of the tooth supported side .This is in agreement with the result obtained in the study which showed that there was highly significant difference for group II than group I in the abutment on the tooth supported side., where the t=9.19 for group I and for group II t=2.81.

5. Conclusion

Modified Rotation joint connection unites is a promising bracing approach in the management of unmodified unilateral free end saddles.

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