FAILURE LOAD OF ACRYLIC RESIN DENTURE TEETH BONDED TO TREVALON HEAT CURE RESIN

Phukela SS,* Chowdhry P, Dua A,*** Yadav H******

Debonding of denture teeth from a denture base remains a major problem in prosthodontic practice. Therefore, the methods to improve tooth bonding requires investigations to reduce failure rates and to ensure greater patient satisfaction. The present study was aimed to evaluate failure load of acrylic resin denture teeth bonded to Trevalon heat cure resin. This objective was achieved by mechanical preparation of cross-linked acrylic teeth which were bonded to Trevalon heat cure resin. The test samples [central incisors (11)] were divided in 4 groups.

Group I (control) : Denture teeth without any mechanical retention preparation.

Group II : Teeth with diatoric hole (1.5 mm depth) as mechanical retention.

Group III : Teeth with cingulum ledge lock (1mm depth).

Group IV : Teeth with both diatoric hole and cingulum ledge lock.

These test specimen 11 along with 21 and 12 were positioned simulating arrangement of teeth in conventional denture prepared by Trevalon heat cure resin. 40 Specimens were divided into 4 groups with 10 teeth in each group. A shear load was applied at cingulum of Central incisor (11) at 130^0 to its long axis using Universal testing machine until failure occurred. The specimens with combination of diatoric hole and cingulum ledge lock, prepared by Trevalon heat cure resin showed highest failure load value while the specimens without any mechanical preparation denture showed lowest failure load value.

Key words : Failure load, Diatoric hole, Cingulum ledge lock.

Acrylic teeth and denture base materials are used extensively in restoration of missing teeth. Darbar UR, Huggott R, Harrison A [1] in their survey found debonding to be approximately 33%, while Vallittu PK, Lassila VP, Lappalainen R [2] found it amounted to 26%. In 1978 Morrow RM, Matvias FM, Windeler AS, Fuchs RJ [3] wrote, "bond failures do occur, however, between plastic teeth and heat curing denture base resins." Debonding of denture teeth from a denture base remains a major problem in prosthodontic practice.[4] Adequate bonding of acrylic resin teeth to denture base resin is necessary because it increases stiffness and strength since the teeth become an integral part of the prosthesis.[5]The strength of bond achieved at the interface of acrylic teeth and denture base is multifactorial including mechanical and chemical methods for improving bond between teeth and denture base resin. Therefore this tooth denture base resin interface is very important and the means by which retention can be increased has to be considered. Hence an attempt has been made to evaluate the failure load of acrylic resin denture teeth bonded to Trevalon heat cure denture base resin.

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Aims and Objectives

1. To evaluate failure load of acrylic resin denture teeth bonded to Trevalon heat cure denture base resin.
2. To compare and evaluate which mechanical retention technique is better for fabrication of acrylic denture

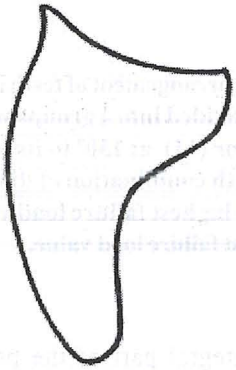
Material and Methods:

a) Standardization of specimen :

A total number of 40 cross linked maxillary right central incisors [11] (ORA-DENT), 40 maxillary right lateral incisors [12] (ORA-DENT) and 40 cross linked maxillary left central incisors [21] (ORA-DENT) of same mould with regard to size and shape were selected to be bonded to Trevalon heat cure denture base resin.

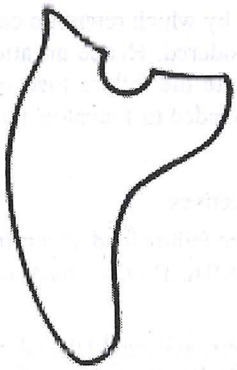
The test specimens (central incisors [11]) were divided into 4 groups.

Group I (control) : Denture teeth without any mechanical retention preparation (Fig IA)



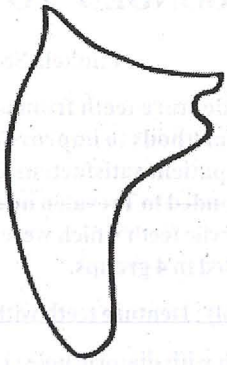
A. Group I (control)

Group II : Teeth with diatoric hole (1.5 mm depth) as mechanical retention (Fig IB)



B. Group II (diatoric hole)

Group III : Teeth with cingulum ledge lock (1 mm depth) (Fig IC)



C. Group III (cingulum ledge)

Group IV : Teeth with both diatoric hole and cingulum ledge lock (Fig ID)



D. Group IV (diatoric hole and cingulum ledge)

Test specimen 11 along with 21 and 12 were used to make study models. The wax model dimension (60 x 10 x 3) mm with 3 teeth positioned simulating arrangement of teeth in conventional denture was used for making index. An index of this wax model was made by polyvinyl siloxane putty material .The test specimens were repositioned back in putty index, modelling wax which has been melted using a wax bath was poured into the putty index and finally 10 identical wax models were obtained. These test specimens (wax models) were prepared by the Trevalon heat cure resin.These Specimens were divided into 4 groups with 10 teeth in each group. Each group was tested for failure load with

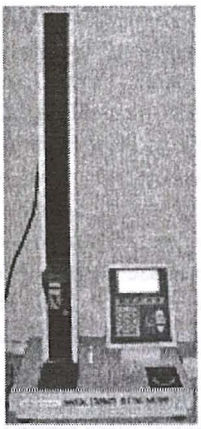


Fig. II Hounsfield universal testing machine

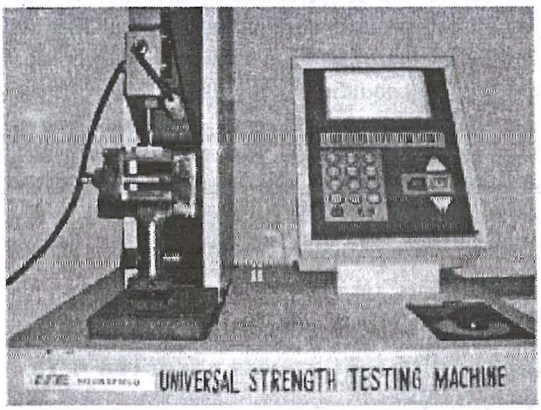


Fig. III Comparative failure load values (newton) of different groups prepared with trevalon heat cure denture base resin.

Trevalon heat cure denture base resin Thus each group consists of 10 test specimens and total of 40 specimens from 4 study groups.

b) Preparation of moulds :

The prepared wax models were invested in the flask using dental stone, following the manufacturer's instructions for water – powder ratio, mixing time and setting time. One hour after the stone sets, flasks were kept for dewaxing by immersing in boiling water for 5 minutes. A thin film of alginate separating media was applied on all surfaces of the mould except the saddle portion of teeth with the help of a brush and dried.

c) Packing and Curing of specimens :

A mixture of polymer and monomer in the ratio of 3:1 by volume was proportioned prior to mixing. Mixing was done in porcelain jar and once the mix reached the dough consistency it was kneaded by hand to increase its homogenicity and integrity and then packed in the mould.

The flasks were clamped and closure was done under pressure of 20 KN and kept for 30 mins. Then the flasks were immersed in water in an Acrylizer at room temperature and processing was done according to manufacturer's recommendation. After all the specimens were cured, the flasks were bench cooled to room temperature and deflasked. All specimens were stored in water for 72 hours to ensure complete polymerization. A total of 40 test specimens were prepared using this procedure.

d) Failure load test :

Failure load test was carried out at the Textile Department, BIET, Davangere. Each specimen was placed in a Jig held securely in order to avoid any change of position. A shear load was applied at cingulum of central incisor (11) at 130^0 to its long axis using Universal Testing Machine at a cross head speed of 5 mm/min, until failure occurred (Fig II). The digital monitor connected to the testing machine showed the failure load value for each specimen.

e) Statistical Analysis :

Multiple group comparisons were done by one-way ANOVA followed by Newman Keul's range test, $p<0.05$ was considered as statistically significant

RESULTS

Table I and Fig III shows comparative failure load values (Newton) of different groups prepared with Trevalon heat cure denture base resin. The comparative analysis of failure load value between different groups prepared with Trevalon heat cure denture base resin was found to be statistically significant ($P<0.05$). Among the specimens prepared with Trevalon heat cure denture base resin Group IV

showed highest failure load value (697.9 Newton) followed by Group III (654.4 Newton), Group II (599.6 Newton) and lastly, Group I (510.5 Newton).

DISCUSSION

Acrylic teeth are most popular artificial teeth for denture construction. Unlike porcelain teeth, they are suitable for a chemical union between the teeth and the denture base resin [6]. Debonding of denture teeth from a denture base remains a major problem in prosthodontic practice. Studies that have evaluated the frequency of various denture repairs have found tooth debonding to be the most frequent repair for conventional prosthodontics. Failure of the tooth-denture bond may be caused by excessive failure or by fatigue. The strength of the bond is related to the composition of the material, for example, to the extent of co-polymerization of the acrylic denture base. Poor laboratory technique, including faulty boil-out technique and indiscriminate use of separating medium in particular have been held responsible for preventing optimum tooth denture base bond strength, thus causing many failures [6]

Zuckerman (2003) [7] reported that the teeth that separate most often from the denture base are the maxillary incisors and canines. These denture teeth often separate from the denture base without any evidence of damage to the denture base or the teeth. The teeth usually can be replaced in their undamaged recesses within the denture base. These findings suggest the following : i) Adhesion of the dislodged teeth to the denture base was insufficient to create a reliable union between the parts, ii) The material from which the teeth or the denture base are fabricated is slightly flexible, and iii) The teeth probably were retained in the denture base by a weak mechanical union. The best bonds were reported when denture base acrylic was processed to Methyl methacrylate (MMA) teeth by use of compression moulding and slow heat polymerization. Dentures can be processed by injection moulding, which requires the use of expensive elaborate equipment. The bond between denture teeth and an injection moulded, heat polymerized denture base has been reported as similar to the bond created by compression-moulded, heat polymerized resin. Over the years many researchers

Table I

Comparative Failure load values (Newton) of different groups prepared with Trevalon heat cure denture base resin

Groups	Mean ± SD	Difference between groups		
		II	III	IV
I	510.5 ± 42.3	P < 0.01, S	P < 0.01, S	P < 0.01, S
II	599.6 ± 31.3	-	P < 0.01, S	P < 0.01, S
III	654.4 ± 33.5	-	-	P < 0.05, S
IV	697.9 ± 30.7	-	-	-

One way ANOVA F = 54.0, P < 0.01, Sig
Newman-Keul's Range Test
Least Sig. Diff. LSD = 41.7 P < 0.05
52.2 P < 0.01

have tried to improve the bond strength by mechanically altering the ridge lap surface. However, the results have been mixed and conflicting. Civjan S, Huget EF, Desimon LB (1972)[8] reported that adequate retention of acrylic teeth to fluid resin in found denture base can be obtained by grinding of the ridge laps. Cardash HS, Liberman R, Helft M (1986)[9] stated that no statistically significant advantage was derived by preparing retention grooves of different shapes in the ridge lap surface of the denture teeth. But contradicting the earlier study, Cardash HS, Applebaum B, Baharav H, Liberman R. (1990)[10]reported that the vertical retention grooves cut in the ridge lap surface of the teeth increased retention to acrylic resin. Vertical grooves placed on denture enhance their bonding, yet the advantage of the horizontal grooves is unclear.[11]

The present study was conducted to evaluate the failure load of acrylic resin denture teeth bonded to Trevalon heat cure denture base resin and also to compare and evaluate which mechanical technique is better for fabrication of acrylic dentures.

The control group specimens prepared by the Trevalon heat cure denture base resin showed significantly lower failure load value (510.5 Newton) compared to that of Group II specimens (diatoric hole) prepared with Trevalon heat cure denture base resin (599.6 Newton) . These results are in agreement with the previous study done by Takahashi Y, Chai J, Takahashi T, Habu T in (2000)[12]. The benefit of using a diatoric may be explained by 2 mechanisms. First, the diatoric increases the surface area available on the denture tooth to interact with polymerizing denture base resins. Second, the diatoric of denture base resin embedded in the denture tooth creates a path of resistance to fracture in a direction different from the denture tooth-denture base resin interface. This mechanically strengthens the bond between the denture tooth and the denture base resin.

The control group specimens prepared by the Trevalon heat cure denture base resin showed significantly lower failure load value (510.5 Newton) compared to that of Group III specimens (cingulum ledge lock) prepared by the Trevalon heat cure denture base resin (654.4 Newton). These results are similar to the results reported by Zuckerman (2003)[7]. The cingulum ledge lock produced a more reliable, consistent, and predictable mechanical joint between tooth and the denture base.

The control group specimens prepared by Trevalon heat cure denture base resin showed significantly lower failure load value (510.5 Newton) compared to that of Group IV specimens (diatoric hole and cingulum ledge lock) prepared by Trevalon heat cure denture base resin (697.9 Newton) . The probable reason for these results might be, that the diatoric hole and cingulum ledge lock mechanically strengthens the bond between acrylic tooth and denture base resin.

Group III specimens (cingulum ledge lock) prepared by Trevalon heat cure denture base resin showed significantly higher failure load value (654.4 Newton) compared to that of Group II specimens (diatoric hole) prepared by Trevalon heat cure denture base resin (599.6 Newton). The probable reason for these results might be, that the cingulum ledge lock area being wider area than diatoric hole has more chances of greater flow of acrylic resin denture base material into that area.

The Group IV specimens (diatoric hole and cingulum ledge lock) prepared by Trevalon heat cure denture base resin showed significantly higher failure load value (697.9 Newton) compared to that of Group III specimens (cingulum ledge lock) prepared by Trevalon heat cure denture base resin (654.4 Newton). The probable reason for these results might be due to the combined effect of diatoric hole and cingulum ledge lock which provided better mechanical retention between tooth and denture base resin than with cingulum ledge lock alone.

CONCLUSION

From the results of this study, the following conclusions were drawn :

1. The failure load of bonding denture teeth to Trevalon heat cure denture base resin was significantly influenced by incorporation of mechanical retentive means.
2. The specimens with combination of diatoric hole and cingulum ledge lock, prepared by Trevalon heat cure denture base resin showed highest failure load value ,while the specimens without any mechanical preparation showed lowest failure load value.

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