ORIGINAL RESEARCH

Adhesive Strength of Acrylic Teeth to Denture Base Material

[1]Dr. Sumit Singh Phukela, [2]Dr. Nisha Garg, [3]Dr. Omkar Krishna Shetty, [4]Dr. Bhupender Yadav , [5]Puja Malhotra, [6]Dr. Akansha Srivastava

[1]Professor, Department of Prosthodontics, Associate Dean Faculty of Dental Science, SGT University, Gurgaon, India
[2]Private Practitioner, India ,MDS Prosthodontics
[3]Professor, Department of Prosthodontics, Dean Faculty of Dental Science, SGT University, Gurgaon, India
[4]Professor and head , Department of Prosthodontics, Faculty of Dental Science, SGT University, Gurgaon, India
[5]Professor, Department of Prosthodontics, Faculty of Dental Science, SGT University, Gurgaon, India
[6]BDS, Hazaribagh College of Dental Sciences and Hospital, India

Corresponding author: Dr. Sumit Singh Phukela, Professor, Department of Prosthodontics, Associate Dean Faculty of Dental Science, SGT University, Gurgaon, India Email: sumit.phukela@sgtuniversity.org

ABSTRACT

Aims and objective: Debonding of denture teeth from a denture base is a routine problem in dental practice. The present study was conducted to comparatively evaluate shear bond strength of crosslinked Denture Teeth to denture base Resin with mechanical modifications

Methodology :The test samples central incisors {11} were divided into 4 groups. Group 1: control, whereas group 2, group 3 and group 4 were experimental groups modified with half moon shaped groove, crisscross shaped grooves and combination of half moon shaped and crisscross grooves respectively. The teeth were arranged with the angulation of 130 degree on wax blocks.

These test specimens were prepared by DPI heat cure resin. A shear load was applied at palatal surface of central incisor (11) using Universal Testing Machine until failure occurred

Results: The lowest shear bond strength value was seen with the Group 1 specimens prepared by DPI and the highest shear bond strength value was seen with the Group 4 specimens prepared with combination of half moon shaped and crisscross grooves packed with DPI

Conclusion: Within the limitations of this study, it can be concluded the specimens with combination of half moon shaped and crisscross grooves packed with DPI showed highest shear bond strength value while the specimens without any mechanical preparation showed lowest shear bond strength value.

Key words: Shear Bond strength, half moon shaped groove, crisscross shaped grooves and Denture base Resin

INTRODUCTION

Denture teeth often separate from the denture base without any evidence of damage to the denture base or the teeth. The most common type of failure in a denture is adhesive bond failure between the acrylic resin polymer tooth and the denture bases.[1,2] 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. Over the years many researchers have tried to improve the bond strength by altering the ridge lap surface mechanically . **Yadav NS et al** [3] reported debonding occurs within body of the tooth rather than tooth acrylic interface.**Akin HK**[4]reported that surface treatment should be done overcome teeth separation from denture base resin. **Cardash et al (1986)** [5] found 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 et al**[6] reported that the vertical retention grooves cut in the ridge lap surface of the teeth increased retention to acrylic resin.The results of various studies have been mixed and conflicting.The advantage of mechanical modifications of denture teeth on bond strength between denture base material and cross linked teeth is unclear. Hence an attempt has been made to comparatively evaluate shear bond strength of croslinked Denture Teeth to denture base Resin with mechanical modifications

AIMS AND OBJECTIVES

1. To evaluate shear bond strength of heat cure denture base resin with denture teeth without modification.
2. Comparatively evaluate shear bond strength of denture base resin to croslinked Denture Teeth modified with half moon shaped groove, crisscross shaped grooves and combination of half moon shaped and crisscross grooves respectively.

MATERIAL AND METHODOLOGY

a) Standardization of Test specimen :A total number of 80 cross linked maxillary right central incisors [11] [4] (Premadent), of same mould with regard to size and shape were selected to be bonded to DPI heat cure denture base material

The test specimens central incisors{ 11} were divided into 4 groups.

Group 1 (control): Denture teeth without any mechanical modifications and were used as supplied by manufacturer

Group 2: A Half moon shaped groove 2 mm deep and 2mm wide was prepared into the ridge lap surface of the denture teeth with a straight fissure bur.

Group 3: A Criscross shaped groove 2 mm deep and 2mm wide was cut into the ridge lap surface of the denture teeth with a straight fissure bur.

Group 4: A combination of Half moon shaped groove (2 mm deep and 2mm wide) and Criscross shaped groove 2 mm deep and 2mm wide was cut with a straight fissure bur, bisecting the ridge lap surface of the denture teeth

b) Preparation of Wax models:

The central incisors were arranged with the angulation of 130 degree on wax model . This angle was chosen to stimulate the average angle of contact found between maxillary and mandibular teeth when dentures are in function. The studies by **Barpal D, Curtis DA, Finzen F, Perry J, Gansky SA et al**[7] used similar angular forces for evaluating bond strength of denture teeth to acrylic bases. The wax model dimension (30x 8x 3) mm 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 was poured into the putty index and finally 80 identical wax models were obtained. These test specimens (wax models) were prepared by the DPI heat cure resin. These specimens were divided into 4 groups with 20 teeth in each group. Each group was tested for shear bond strength with DPI heat cure denture base resin. Thus each group consists of 20 test samples and total of 80 samples from 4 study groups.

c) Preparation of moulds and Dewaxing:

The prepared wax models were invested in the flask 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.

d) Curing of specimens:

A mixture of polymer and monomer in the ratio of 3:1 by volume was proportioned prior to mixing.[8,9]Once the mix reached the dough consistency it was kneaded and then packed in the mould. The flasks were clamped and closure was done under pressure of 20 KN and kept for 30 mins. [10]The flasks were then kept at room temperature for one hour.

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. A total of 80 test specimens were prepared using this procedure. Finishing and polishing was done for all the test speciments (Figure 1)

FIGURE 1 TEST SPECIMEN AFTER POLISHING

e) Shear Bond strength test

The prepared specimens were subjected to load testing using Hounsfield Universal Testing Machine (EZ20 20 kN, Computerised, Lloyd Company, Ametek technologies, U.K). Shear Bond strength test was carried out at the Textile Department, BIET, Davangere. Each specimen was placed in a metallic fixture and kept in a Universal Instron Testing Machine (BIET Davengere) to avoid any change of position. A shear load was applied with stainless steel pin of diameter 1mm[11] at a cross head speed of 5 mm/min, until failure occurred . (FIGURE 2)

FIGURE 2 UNIVERSAL TESTING MACHINE

Statistical Analysis

The software used for the statistical analysis were **SPSS (statistical package for social sciences) version 21.0 and Epi-info version 3.0**. Multiple group comparisons were done by one-way ANOVA test, followed by Newman-Keul's Range Test

One-way ANOVA test

- **The equation of ANOVA is given by:**

$$SS_{\text{Total}} = SS_{\text{Error}} + SS_{\text{Treatments}}$$

Level of Significance (p-value)

- **P-value < 0.05 - Significant**

RESULTS

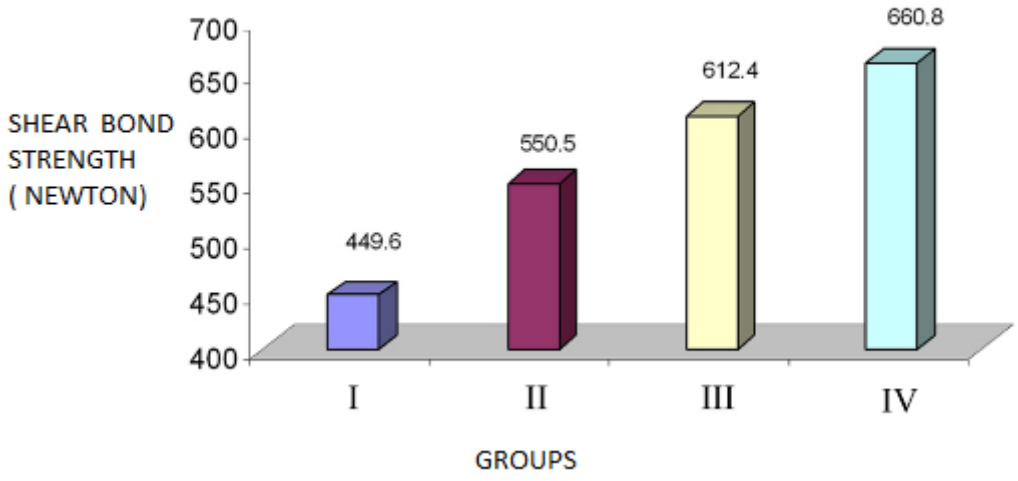
Table I and Graph I shows comparative shear bond strength values (Newton) of different groups prepared with DPI heat cure denture base resin. The comparative analysis of shear bond strength value between different groups prepared with DPI heat cure denture base resin was found to be statistically significant (P<0.05). Among the specimens prepared with DPI, Group IV showed highest shear bond strength (660.8 Newton) followed by Group III (612.4 Newton), Group II (550.5 Newton) and lastly, Group I (449.6 Newton).

TABLE I: COMPARATIVE SHEAR BOND STRENGTH VALUES (NEWTON) OF DIFFERENT GROUPS PREPARED WITH DPI HEAT CURE DENTURE BASE RESIN.

Groups	Shear Bond strength values (Newton) Mean ± SD	Difference between groups		
		II	III	IV
I (Control)	449.6 ± 45.8	P < 0.01, S	P < 0.01, S	P < 0.01, S
II (Half moon shaped groove)	550.5 ± 50.8	-	P < 0.01, S	P < 0.01, S
III (Criscross shaped groove)	612.4 ± 30.0	-	-	P < 0.05, S
IV (Half moon shaped groove Criscross shaped groove)	660.8 ± 19.0	-	-	-

One way ANOVA F = 56.0, P < 0.01, Sig.
Newman-Keul's Range Test
Least Sig. Diff, LSD = 46.5 P < 0.05
= 57.2 P < 0.01

GRAPH I COMPARATIVE SHEAR BOND STRENGTH VALUES (NEWTON) OF DIFFERENT GROUPS PREPARED WITH DPI HEAT CURE DENTURE BASE RESIN.



DISCUSSION

Failure of tooth-denture base bond remains a major problem in prosthodontic practice. Failure of tooth-denture base bond remains a major problem in prosthodontic practice. 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[12]. Acrylic teeth are most popular artificial teeth for denture construction.Unlike porcelain teeth, acrylic teeth are suitable for a chemical union between the teeth and the denture base resin.[13]

Studies that have evaluated the frequency of various denture repairs have found tooth debonding to be the most frequent repair for conventional prosthodontics. **Darbar UR, Huggett R, Harrison A** (1994) [1] showed that 33% of repairs carried out were due to debonded/detached teeth. Several attempts have been made to improve the bonding of acrylic resin teeth to denture bases by treating the ridge lap of the tooth mechanically.or chemically. **G Jain,U Palekar,V Awinashe ,S K Mishra** 2014[14] reported application of dichloromethane on the ridge lap surface of the tooth before packing of dough into the mold significantly increased the bond strength between the acrylic teeth and heat cure resin. **Cardash HS, Liberman R, Helft M** (1986)[5] investigated to determine whether retention grooves of various shapes cut into the ridge lap surface of acrylic resin teeth would enhance the shear strength of the bond between heat cured denture base resin and acrylic resin teeth. They concluded that the force required to separate the acrylic resin teeth from the denture base was approximately the same as the force required to cause fracture of the acrylic resin base. No statistically significant advantage was derived by preparing retention grooves of different shapes in the ridge lap surface of the teeth. **Cardash HS, Applebaum B, Baharav H, Liberman R** (1990)[6] investigated whether horizontal or vertical retention grooves cut into the ridge lap portion of acrylic resin teeth would improve the combined shear compressive strength of the bond to heat-cured standard resin and to high impact denture base resin. They concluded that the vertical retention grooves cut in the ridge lap surface of the teeth increased retention to acrylic resin. **Civjan S, Huget EF, Desimon LB[15]** reported that adequate retention of acrylic teeth to fluid resin in denture base can be obtained by grinding of the ridge laps. The results of various studies conducted by researchers were mixed and contradictory.

Hence an attempt has been made to Comparatively evaluate shear bond strength of denture base resin to croslinked Denture Teeth modified with half moon shaped groove, crisscross shaped grooves and combination of half moon shaped and crisscross grooves respectively. The control group specimens prepared by the DPI heat cure denture base resin showed significantly lower shear bond strength value (449.6 Newton) compared to that of Group II specimens (half moon shaped groove) prepared with DPI heat cure denture base resin (550.5 Newton). These results are similar to the results reported by **Zuckerman (2003)[16].** The half moon shaped groove produced a more reliable, consistent, and predictable mechanical joint between tooth and the denture base.

The control group specimens prepared by the DPI heat cure denture base resin showed significantly lower shear bond strength value (449.6 Newton) compared to that of Group III specimens (crisscross shaped groove) prepared by the DPI heat cure denture base resin (612.4 Newton). The probable reason may be that the crisscross shaped groove prepared in the denture tooth creates a path of resistance to fracture in a direction different from the tooth-denture base resin interface.

The control group specimens (Group I) prepared by DPI heat cure resin showed significantly lower shear bond strength value (449.6 Newton) compared to that of Group IV specimens (half moon shaped groove and crisscross shaped groove) prepared by DPI heat cure denture base resin (660.8 Newton). The probable reason for these results might be, that the half moon

shaped groove and crisscrossed shaped groove mechanically strengthens the bond between acrylic tooth and denture base resin.

Group III specimens (crisscross shaped groove) prepared by DPI heat cure denture base resin showed significantly higher shear bond strength value (612.4 Newton) compared to that of Group II specimens (half moon shaped groove) prepared by DPI heat cure denture base resin (550.5 Newton). The probable reason for these results might be, that the criss cross lock area being wider area than half moon shaped covered area has greater flow of acrylic resin denture base material into that area.

Group IV specimens (half moon shaped groove and crisscross shaped groove) prepared by DPI heat cure denture base resin showed significantly higher shear bond strength value (660.8 Newton) compared to that of Group III specimens (crisscross shaped groove) prepared by DPI heat cure denture base resin (612.4 Newton). The probable reason for these results might be due to the combined effect of half moon shaped covered area and crisscross shaped lock which provided better mechanical strength between tooth and denture base resin than with criss cross lock area alone.

CONCLUSION

1. The shear bond strength between DPI heat cure denture base material and denture teeth was increased with mechanical modifications of denture teeth
2. The specimens with combination of half moon shaped groove and crisscross shaped groove prepared by DPI heat cure denture base resin showed highest shear bond strength value ,while the specimens without any mechanical preparation showed lowest shear bond strength , therefore this modification can be one of reliable method to secure denture teeth in denture bases.

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