

Comparative failure load values of acrylic resin denture teeth bonded to three different heat cure denture base resins: An *in vitro* study

Sumit Singh Phukela, Amit Dua¹, Mahima Dua², Varun Sehgal¹, Gaurav Setya³, Rupinder Singh Dhall⁴

Departments of Prosthodontics and ³Conservative, Faculty of Dental Science, SGT University, Gurgaon, Haryana, ¹Private Practitioner, Zonal Dental Clinic, Clove Dental, New Delhi, ²Department of Oral Pathology, Indraprastha Dental College and Hospital, Ghaziabad, Uttar Pradesh, ⁴Department of Prosthodontics, Himachal Institute of Dental Science, Himachal Pradesh, India

Corresponding author (email: <phukelasumit@yahoo.com>)

Dr. Sumit Singh Phukela, 4, Gopi Nath Bazar, Delhi Cantonment, New Delhi - 110 010, India.

Received: 30-01-16

Accepted: 22-03-16

Published: 26-04-16

Abstract

Aim and Objectives: Acrylic teeth are used for fabrication of dentures. Debonding of tooth – denture base bond is routine problem in dental practice. The aim of this study was to comparatively evaluate failure load of acrylic resin denture teeth bonded to three different heat resin. **Materials and Methods:** Four groups were created out of test samples central incisors (11). Group I: Control, whereas Group II, Group III and Group IV were experimental groups modified with diatoric hole, cingulum ledge lock and Teeth modified with both diatoric hole and cingulum ledge lock, respectively. These test specimens with 3 teeth (2 central [11, 21] and 1, lateral [12] incisors) positioned imitating arrangement of teeth in the conventional denture, prepared by three different heat cure materials (DPI, Trevalon, Acralyn-“H”). A shear load was applied at cingulum of central incisor (11) at 130° to its long axis using universal tester at a cross head speed of 5 mm/min until failure occurred. Failure load test was conducted and statistical analysis was performed using SPSS 16 software package (IBM Company, New York, U.S). **Results:** Highest failure load was seen in Group IV specimens, prepared by Trevalon but did not significantly differ from that of DPI. **Conclusion:** The failure load of bonding denture teeth to three different heat cure materials was notably affected by modifications of ridge lap before processing. The specimens with a combination of diatoric hole and cingulum ledge lock, prepared by Trevalon showed highest failure load but did not significantly vary from that of DPI. The control group prepared by Acralyn-“H” showed lowest failure load but did not significantly differ from that of DPI.

Key words: Cingulum ledge lock, denture base resin, diatoric hole, failure load

INTRODUCTION

Acrylic teeth and denture base materials are widely used in the restoration of missing teeth. One of the principal benefit of acrylic teeth is their property to bond to

the denture base resins.^[1] Darbar *et al.*^[2] reported tooth – denture base separation to be 33%, Vallittu *et al.*^[3] showed it to be 26%. Morrow *et al.*^[4] reported debonding is seen commonly between teeth and heat cure resin. Zuckerman reported the high incidence

Access this article online	
Quick Response Code:	Website: www.jispcd.org
	DOI: 10.4103/2231-0762.181161

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Phukela SS, Dua A, Dua M, Sehgal V, Setya G, Dhall RS. Comparative failure load values of acrylic resin denture teeth bonded to three different heat cure denture base resins: An *in vitro* study. J Int Soc Prevent Communit Dent 2016;6:S12-6.

of damage to dentures caused by tooth debonding.^[5] Clashing results with the use of monomer and placement of a diatoric have been seen.^[6]

Suitable bonding of acrylic teeth to denture base is mandatory as it increases strength since teeth become an essential part of the prosthesis.^[7] Morrow *et al.*^[4] inferred that the bond strength of the high impact resin to plastic teeth was not significantly greater (11%) than that of the standard resin. Barpal *et al.*^[6] showed that highest failure loads occurred when the ridge lap was left with an intact glaze and did not have a diatoric, with no influence from the use of monomer. The results of studies have been clashing. The influence by modifications to the ridge lap before processing on failure load of bonding denture teeth to conventional and high impact resin is unclear. Hence, an endeavor has been made to comparatively assess the failure load of denture teeth bonded to three different heat cure materials.

Aims and objectives

- To evaluate failure load of acrylic resin denture teeth bonded to three different heat cure material
- Comparative evaluation of mechanical modifications of denture teeth on the bond strength between heat cured material and teeth.

MATERIALS AND METHODS

The sample size was 30 per group and calculated using the results of the previous studies by Barpal *et al.*^[6] We took acrylic tooth of same company of the same make and were arbitrary distributed with 30 sample each into four groups. The calculated sample size was 30 per group keeping a confidence interval of 95% and a power of at least 80%.

A total number of 120 maxillary central incisors (11) (ORA-DENT), 120 maxillary lateral incisors (12) (ORA-DENT) and 120 maxillary central incisors (21) (ORA-DENT) of same mould with regard to size and shape were chosen to be bonded to three different types of heat cure, i.e. DPI, Trealon and Acralyn-“H.” The test specimens (central incisors [11]) were demarcated into four groups [Figure 1].

- Group I (control): Denture teeth without any mechanical retention preparation
- Group II: Teeth with diatoric hole (1.5 mm depth)
- Group III: Teeth with cingulum ledge lock (1 mm depth)
- Group IV: Teeth with both diatoric hole and cingulum ledge lock.

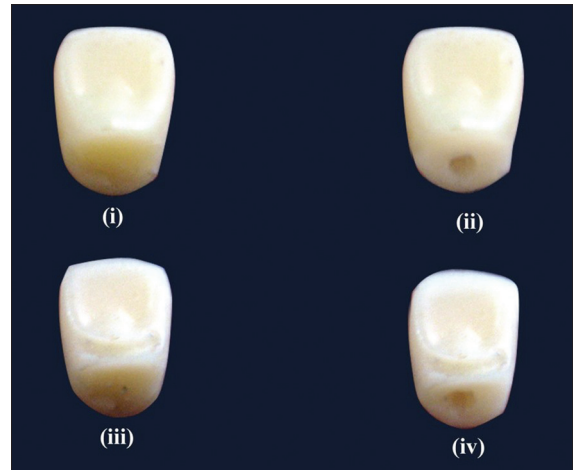


Figure 1: Mechanical preparation of the test specimen (central incisor [11]) (i) control, (ii) diatoric hole (iii) cingulum ledge lock (iv) diatoric hole and cingulum ledge lock

Three teeth, i.e., 2 central (11, 21) and 1, lateral (12) incisors were used to make study models. The wax model dimension^[8] (8 mm × 10 mm × 30 mm) with 3 teeth positioned simulating arrangement of teeth in conventional denture was used for making an index. Polyvinyl siloxane putty was used for making an index. The test specimens were repositioned back in the putty index, modelling wax was poured into the putty index. These test specimens (wax models) were prepared by following materials

- Subgroup A: Consist specimens prepared from DPI
- Subgroup B: Consist specimens prepared from Trealon
- Subgroup C: Consist specimens prepared from Acralyn-“H”.

These specimens were sorted into four groups with 10 teeth in each group. Each group was tested for failure load with three different materials. Thus each group consists of $10 \times 3 = 30$ test specimens and total of 120 specimens from 4 study groups.

Curing of the specimens

The prepared wax models were invested in the flask following the manufacturer’s directions, and thereafter dewaxing was done. Polymer and monomer in the ratio of 3:1 by volume was proportioned before mixing. Once the mix achieved the dough consistency, it was kneaded by hand and then packed in the mold. Final closure was done under pressure of 20 kN. The flasks were then immersed in water in an Acrylizer at room temperature and processing was done according to manufacturer’s recommendation. A total of 120 test samples were prepared using this procedure [Figure 2].

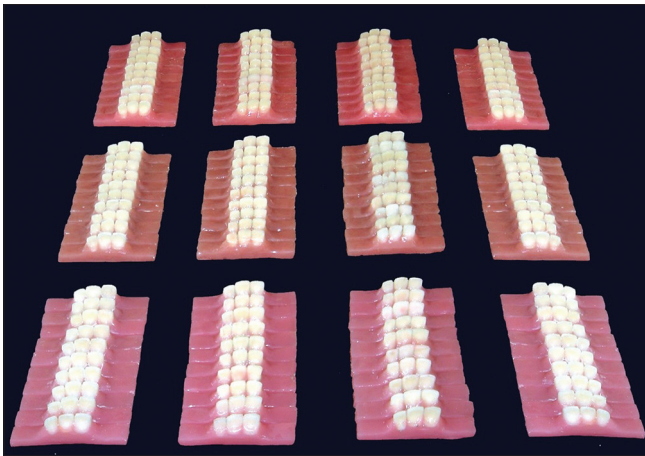


Figure 2: A total of 120 test specimens

Failure load test

Failure load test was performed at the Textile Department, BIET, Davangere. Each specimen was placed in a Jig held securely to avoid any change of position. A shear load was applied at cingulum of central incisor (11) at 130° to its long axis using Universal Tester at a cross head speed of 5 mm/min until failure occurred. Multiple group comparisons were done by one-way ANOVA.

RESULTS

There was a notable difference in failure load between the Group I specimens prepared by DPI (449.6 N) and Trevalon (510.5 N) [Table 1]. There was a significant difference in failure load amongst both the control group prepared by Trevalon (510.5 N) and Acralyn-“H” (438.3 N). Among the control group, the samples prepared by Trevalon gave maximum failure load (510.5 Newton), followed by DPI (449.6 Newton) and Acralyn-“H”. There was a significant difference in failure load between both the Group II specimens prepared by DPI (550.5 N) and Trevalon (599.6 N) [Table 1]. There was a significant difference in failure load between both the Group II specimens prepared by Trevalon and Acralyn-“H.” Among the Group II, the specimens prepared by Trevalon gave highest failure load, followed by DPI and lastly Acralyn-“H.” There was a significant difference in failure load between both the Group III specimens prepared by DPI (612.4N) and Trevalon (654.4 N) [Table 1]. No statistically significant difference was found between failure load of the control group, Group II or Group III specimens prepared by either DPI or by Acralyn-“H.” There was a significant difference in failure load between both the Group III specimens prepared by Trevalon and Acralyn-“H.” Among the Group III, the specimens prepared by

Table 1: Comparison between subgroups (A vs. B vs. C) at each group (I/II/III/IV)

Sub groups	Groups			
	I	II	III	IV
A (DPI)	449.6±45.8	550.5±50.8	612.4±30.0	660.8±19.0
B (Trevalon)	510.5±42.3	599.6±31.3	654.4±33.5	697.9±30.7
C (Acralyn-“H”)	438.3±46.3	511.9±31.6	601.6±33.0	620.9±68.8
ANOVA,	7.51	12.7	7.50	7.36
F value	<i>P</i> <0.01, S	<i>P</i> <0.01, S	<i>P</i> <0.01, S	<i>P</i> <0.01, S
Difference between sub groups				
A-B	<i>P</i> <0.05, S	<i>P</i> <0.05, S	<i>P</i> <0.05, S	NS
A-C	NS	NS	NS	NS
B-C	<i>P</i> <0.01, S	<i>P</i> <0.01, S	<i>P</i> <0.01, S	<i>P</i> <0.01, S

The Group IV specimens prepared by Trevalon showed higher failure load (697.9±30.7 Newton) and Group I specimens prepared by the Acralyn-“H” showed lowest failure load (438.3±46.3 Newton). Test one-way ANOVA. DPI=Dental Products of India, NS=Not significant, S=Significant

Trevalon depicted highest failure load followed by DPI and Acralyn-“H.” No statistically significant difference was discovered between the failure load of Group IV prepared by either DPI or Trevalon and Group IV prepared by either DPI or Acralyn-“H.” There was a significant difference in failure load between both the Group IV specimens prepared by Trevalon (697.9 N) and Acralyn-H (620.9 N) [Table 1].

DISCUSSION

Over the years, many researchers have tried to enhance the bond strength by mechanically modifying the ridge lap surface. Akin *et al.*^[9] reported that two chemically variable denture base polymers showed different shear bond strength values to teeth. Krishna *et al.*^[10] reported that chemical surface treatment of denture teeth with ethyl acetate provided highest bond strength followed by control, chloroform, acetone groups. Jain *et al.*^[11] reported increased bond strength between the denture teeth and heat cure material with use of dichloromethane Consani *et al.*^[12] stated that different polymerization cycle have similar effects on the hardness of heat-activated denture base resin. Grando *et al.*^[13] proved that (Trilos and Saluut) different brands of teeth do not have a difference in their wear resistance. Cardash *et al.*^[14] reported that retention is not affected by grinding retention grooves in the ridge lap of acrylic teeth. However contradicting the earlier study, Cardash *et al.*^[15] reported that the vertical grooves in the ridge lap surface of the teeth increased retention to the acrylic resin. Yadav *et al.*^[16] reported bond failure occurs within the body of the tooth rather than tooth acrylic interface. Akin *et al.*^[17] reported that surface treatment should be done overcome tooth bonding. Mahadevan

et al.^[18] reported enhancement in shear bond strength of modified teeth compared to the unmodified teeth. Regrettably the results of these studies are contradictory.

This study was conducted to comparatively evaluate the mechanical modifications of denture teeth on the bond strength between denture base resin and teeth.

The control group prepared by the DPI showed significantly lower failure load than that of Group II prepared with DPI. The control group prepared by the Trevalon showed significantly lower failure load compared to that of Group II prepared with Trevalon. The control group prepared by the Acralyn-“H” showed significantly lower failure load compared to that of Group II prepared with Acralyn-“H.” These results are in harmony with the previous study done by Takahashi *et al.*^[8] The diatoric increases the surface area available on the acrylic teeth to interact with polymerizing denture base material.

The control group specimens prepared by the DPI showed significantly lower failure load compared to that of Group III specimens prepared by the DPI. The control group samples prepared by the Trevalon showed significantly lower failure load compared to that of Group III specimens prepared by the Trevalon. The control group specimens prepared by the Acralyn-“H” showed significantly lower failure load compared to that of Group III specimens prepared by the Acralyn-“H” These results are similar to the results reported by Zuckerman.^[5] The cingulum ledge lock mechanically strengthens the bond between denture tooth and resin material.

Group I prepared by DPI showed lower failure load value compared to that of Group IV specimens prepared by DPI. The control group specimens prepared by Trevalon showed lower failure load compared to that of Group IV specimens prepared by Trevalon. The control group specimens prepared by Acralyn-“H” showed lower failure load compared to that of Group IV specimens prepared with Acralyn-“H.” The diatoric hole and cingulum ledge lock produced a predictable mechanical joint between teeth and the resin material.

Group III specimens prepared by DPI showed higher failure load compared to that of Group II specimens prepared by DPI. Group III specimens prepared by Trevalon showed significantly higher failure load compared to that of Group II specimens prepared by Trevalon. Group III specimens prepared by Acralyn-“H” showed significantly higher failure load compared to that of Group II specimen prepared with Acralyn “H.” The

probable reason for these results is that the cingulum ledge area being wider area than diatoric hole has more chances of flow of resin material into that area.

The Group IV specimens prepared by DPI showed higher failure load compared to that of Group III specimens prepared by DPI. The Group IV specimen prepared by Trevalon showed higher failure load compared to that of Group III specimens prepared by Trevalon. The probable reason might be due to the combined effect of diatoric hole and cingulum ledge which provided better mechanical retention between denture teeth and resin material than with cingulum ledge alone. No statistically significant difference was found between failure load of both Group IV and Group III prepared by Acralyn-“H.”

The control group specimens prepared by Trevalon showed higher failure load compared to that of control group specimens prepared by DPI. The Group II specimens prepared by Trevalon showed higher failure load compared to that of Group II specimens prepared by DPI. The Group III prepared by Trevalon higher failure load compared to that of Group III specimens prepared by DPI. The probable reason for these results may be the difference in the composition of the heat cure material.

Strength of the study

Debonding of denture teeth from a denture base remains a major concern in prosthodontic practice. Our study helps the clinician in selecting best design to increase bond strength with different types of heat cure material. The mechanical modification (combination of diatoric hole and cingulum ledge) can be recommended as a reliable method to secure denture teeth in denture bases.

Limitations of our study

- We have used only one type of denture tooth material, the interaction between denture teeth material and various denture base resin need to be evaluated further
- We have done *in vitro* study, the influence of various intraoral conditions such as bite forces, saliva, intraoral temperature variations might influence the outcome of the study.

CONCLUSION

- The failure load of bonding acrylic teeth to three different resin materials was significantly influenced by modifications of ridge lap before processing

- The specimens with combination of diatoric hole and cingulum ledge lock, prepared by Trevalon showed highest failure load but did not significantly differ from that of DPI
- The control group specimens prepared by Acralyn-“H” showed lowest failure load but did not significantly differ from that of DPI.

Controversies raised by the study

A single class of denture base resin was not used in our study. We have to three different resin materials. The composition could have influenced the bond strength.

Future research direction

The bond strength could be evaluated between Nanocomposite teeth and latest light cured material and injection molded denture base material and microwave cured resin material.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. More V, Dange SP. Comparative evaluation of chemical and mechanical modifications of ridge lap area on bond strength between denture base resin and teeth. *J Indian Prosthodont Soc* 2004;4:29-32.
2. Darbar UR, Huggett R, Harrison A. Denture fracture – A survey. *Br Dent J* 1994;176:342-5.
3. Vallittu PK, Lassila VP, Lappalainen R. Evaluation of damage to removable dentures in two cities in Finland. *Acta Odontol Scand* 1993;51:363-9.
4. Morrow RM, Matvias FM, Windeler AS, Fuchs RJ. Bonding of plastic teeth to two heat-curing denture base resins. *J Prosthet Dent* 1978;39:565-8.
5. Zuckerman GR. A reliable method for securing anterior denture teeth in denture bases. *J Prosthet Dent* 2003;89:603-7.
6. Barpal D, Curtis DA, Finzen F, Perry J, Gansky SA. Failure load of acrylic resin denture teeth bonded to high impact acrylic resins. *J Prosthet Dent* 1998;80:666-71.
7. Kawara M, Carter JM, Ogle RE, Johnson RR. Bonding of plastic teeth to denture base resins. *J Prosthet Dent* 1991;66:566-71.
8. Takahashi Y, Chai J, Takahashi T, Habu T. Bond strength of denture teeth to denture base resins. *Int J Prosthodont* 2000;13:59-65.
9. Akin H, Tugut F, Guney U, Akar T. Shear bond strength of denture teeth to two chemically different denture base resins after various surface treatments. *J Prosthodont* 2014;23:152-6.
10. Krishna VP, Premalatha A, Babu PJ, Raju DS, Kumar MP, Rao DB. Effect of various chemicals on the bond strength of acrylic tooth and denture base – An *in vitro* comparative study. *J Int Oral Health* 2014;6:100-5.
11. Jain G, Palekar U, Awinashe V, Mishra SK, Kawadkar A, Rahangdale T. The effect of different chemical surface treatments of denture teeth on shear bond strength: A comparative study. *J Clin Diagn Res* 2014;8:ZC15-8.
12. Consani RL, Pucciarelli MG, Mesquita MF, Nogueira MC, Barao VA. Polymerisation cycles on hardness and surface gloss of denture base. *Int J Contemp Dent Med Rev* 2014;2014:1-6.
13. Grando M, Pacneco LM, Botega DM, Hiraka LM, Hilgert JB. Artificial teeth; evaluation of wear resistance, microhardness and composition. *Rev Gauch Odontol* 2015;63:263-70.
14. Cardash HS, Liberman R, Helft M. The effect of retention grooves in acrylic resin teeth on tooth denture-base bond. *J Prosthet Dent* 1986;55:526-8.
15. Cardash HS, Applebaum B, Baharav H, Liberman R. Effect of retention grooves on tooth-denture base bond. *J Prosthet Dent* 1990;64:492-6.
16. Yadav NS, Somkuwar S, Mishra SK, Hazari P, Chitumalla R, Pandey SK. Evaluation of bond strength of acrylic teeth to denture base using different polymerization techniques: A comparative study. *J Int Oral Health* 2015;7 Suppl 1:54-6.
17. Akin H, Kirmani O, Tugut F, Coskum ME. Effects of various surface treatment in the ridge lap area of acrylic resin teeth on the shear bond strength to heat polymerized PMMA denture base resin. *Photomed Laser Surg* 2014;32:512-6.
18. Mahadevan V, Krishnan M, Krishnan CS, Azhagarasan NS, Sampathkumar J, Ramasubramanian H. Influence of surface modifications of acrylic resin teeth on shear bond strength with denture base resin – An *in vitro* study. *J Clin Diagn Res* 2015;9:ZC16-21.