

Bench Curing Affecting Bond Strength of Denture Base with Artificial Teeth

Strength of Denture Base with Artificial Teeth

Beenish Mehtab¹, Kashif Aslam², Saad ud Din Siddiqui³ and Syed Kashif Abrar⁴

ABSTRACT

Objective: To evaluate the effect of bench curing on bond strength of denture base with acrylic teeth.

Study Design: An experimental, in-vitro study.

Place and Duration of Study: This study was conducted at the Sir Syed College of Medical Sciences (dental section) for Girls and Dow Dental College, Dow University of Health Sciences, Karachi from February 2023 till March 2023.

Materials and Methods: Forty specimens were fabricated according to standards of ADA No. 15. These specimens were divided into 4 groups as per bench curing time. In Group 1 specimens were not bench cured and were directly put in curing tank for processing. In Group 2 specimens were bench cured for 30 minutes, in Group 3 for 1 hour and in Group 4 for 2 hours. Processing in curing tank was carried out at 73°C for 90 minutes followed by 100°C for 30 minutes. Tensile load was applied at the junction of denture base and acrylic teeth. Analysis of data was done through SPSS software 21. Statistical significance was assessed by applying one way ANOVA and post hoc Tukey test. Cohesive, adhesive and mixed type of failure was assessed with naked eye. P-value less than 0.05 was considered as statistically significant.

Results: No statistical significant difference was found between any of the groups ($p > 0.05$). Tensile load value observed in newton was highest for group 3 but there was no statistical significant difference ($p > 0.05$). None of the groups showed cohesive failure above 80%.

Conclusion: Processing of denture base with or without bench curing did not affect strength of bond between denture base and acrylic teeth.

Key Words: Bench curing, denture base, acrylic teeth, tensile bond strength

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INTRODUCTION

Debonding of artificial (acrylic) teeth from denture base has always been a prime issue among different reasons of denture repair.¹ These problems have aroused since acrylic was considered as a material to replace artificial teeth.

Before this material was introduced several other materials have been used to provide artificial teeth.^{2,3} Acrylic resin has not been considered only for production of dentures but was also utilized for

fabrication of other restorative and substitute dental materials.⁴ Reason of this material to gain popularity because at the end of World War 2 raw material for vulcanize, which was used to produce denture was rarely available, this shortage made acrylic material as a popular choice.¹

Acrylic resin has this advantage that it can be molded to any shape either by pressing, applying heat or by involving in a chemical reaction. Thermal behaviour of the material to acquire any shape categorizes it as thermoplastic (reversible) and thermosetting (irreversible) material. Once the planned shape of the object comes in place then they remain stable. Stability of the material to remain in its shape makes it useful on permanent basis and can be an alternative to other materials.⁵

Acrylic resin is not only utilized for denture bases but teeth that are attached to denture base are also made up of acrylic resin. In broad terms two types of teeth are usually attached to denture bases namely resin based and porcelain based. Porcelain based teeth needs mechanical means such as pin and holes to attach to denture bases and resin gets attached through chemical means. Resin based teeth when needs to be attached to metallic bases needs special arrangements which can be costly and technique sensitive.⁶

¹. Department of Prosthodontics, Sir Syed College of Medical Sciences for Girls, Karachi.

². Department of Prosthodontics / Oral Medicine³ / Periodontology⁴, Dow Dental College, Dow University of Health Sciences, Karachi.

Correspondence: Dr. Kashif Aslam, Associate Professor of Prosthodontics, Dow Dental College, Dow University of Health Sciences, Karachi.

Contact No: 0300-3945654

Email: kashif.aslam@duhs.edu.pk

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As mentioned earlier that debonding is the most common factor observed for repairing of dentures and in order to alleviate this problem several factors have been studied to figure out the reason of debonding. Earlier studies have shown that wax and temperature on which it is removed could be the reason of debonding.^{7,8} Some studies have done mechanical alterations in acrylic teeth to improve bond strength.^{9,10} Some studies have propose the use of monomer between denture base and acrylic teeth.^{11,12} As per author's search there were some studies which have applied bench curing method before final processing of the denture.^{13,14} However, as per author's search, reason of bench curing was unknown therefore the purpose of this study is to find out the effect of bench curing on bond strength of denture base with acrylic teeth.

MATERIALS AND METHODS

In-vitro study which was experimental in nature was performed at Dental section of Sir Syed College of Medical Sciences and Dow Dental College of Dow University of Health Sciences, Karachi from February 2023 till March 2023. ADA Standards No 15¹⁵ were used to produce forty specimens. Cervical and incisal part of acrylic teeth were not covered with denture base so that holding of the tooth can be facilitated. Length of the denture base was 60mm, as per requirement of the universal testing machine, and central incisors were selected for every specimen (Fig 1). For every specimen acrylic teeth (Wellbite, Pakistan) was attached with modelling wax on a metal former (Fig 2). After attaching to a metal former they were invested into type 3 dental stone (Garreco, U.S.A). As per manufacturer's instructions Type 3 dental stone was mixed through hand mixing and poured into the drag part (first part) of the flask. Application of cold mold seal was done after type 3 dental stone got set with invested specimens in it. After this procedure, coup part of the flask was placed, filled with type 3 dental stone and covered with a lid (third part of flask). This procedure completes the investment and now left as per manufacturer's instructions so that the material gets set. After the investment material (type 3 dental stone) got set, flasks were put in dewaxing chamber (Manfredi, Italy) for 5 minutes.¹⁶ After dewaxing two halves of the flask were opened, metal former was removed and flushing with fresh boiling water was carried out (Fig 3). Reason of using fresh water for flushing so that wax is completely removed and mold is without of wax remnants.

After the investment got dry, plaster separating solution was applied on the entire investment material except the ridge lap area of the teeth. Denture base material (MR Dental, U.K) which is to be cured by heat was mixed according to the instructions of the manufacturer. During mixing when denture base material reached to dough stage, it was packed in the mold area of the

investment and covered with polyethylene sheet. The other half of the flask was then placed on it and the completed assembly was then transferred to bench press at 100 kp pressure for 5 minutes. Both the half of the flasks were again opened followed by removal of polyethylene sheet and excess material. Reassembled flasks were then transferred to spring clamp and were then put in a curing tank (Manfredi, Italy) for 0 minutes at 73°C followed by 100°C for 30 minutes¹⁵ (Group 1). In Group 2 reassembled flasks which were transferred to spring clamp were left on a bench for 30 minutes (bench curing) before putting them in curing tank. In Group 3, flasks were left for 1 hour and in Group 4 for 2 hours. All the groups had the same curing protocol as for group 1. After curing, all the groups had the same cooling protocols i.e. flasks were placed on a bench for 30 minutes and were then put under running tap water for 15 minutes⁵ followed by divesting and finishing of specimens.

Finished specimens were then subjected to tensile load in a universal testing machine at a cross head speed of 1mm/min. Jigs of the machine held the specimens in such a way that a pull directly at the junction of denture base and tooth can be applied (Fig 4). Tensile load at which failure of the bond occurred was observed in Newton value. Nature of the failure i.e. cohesive, adhesive or mixed was visualized by the naked eye.

Forty specimens were fabricated for all the groups i.e. 10 specimens per group. Sample size was conducted by using power 95% (2-sided confidence interval) with a power of 80% and ratio of sample (1:1) having mean and standard deviation of heat cured denture base resin with 1 hour bench curing (19.09±4.67) and heat cured denture base resin without bench curing (12.41±3.97)¹⁷



Figure No. 1: Specimen (denture base and acrylic tooth)



Figure No. 2: Mounted specimen

Samples size estimation came out to be seven samples per group but was increased to 10 samples per group. Normality of data was checked with Shapiro-Wilk test and for homogeneity of variance, Levene's test was used. In order to find out that whether there is a

statistical significant difference, one way Anova was applied. Post hoc Tukey test was applied for multiple comparison within groups. p-value less than 0.05 was considered statistically significant.



Figure No. 3: After dewaxing



Figure No. 4: Universal testing machine.

INCLUSION CRITERIA:

1. Specimens with 60mm length of denture base resin
2. Specimens with 7mm width of denture base resin

EXCLUSION CRITERIA:

1. Specimens with cracks, notches and porosities
2. Specimens with teeth not perpendicular to denture base resin

RESULTS

Shapiro-Wilk test and Levene’s test revealed p-values above 0.05 which ensured that distribution of data and homogeneity of variance is normal.

Table No. 1: Mean and standard deviation for all the groups

Groups	No. of samples	Mean N /Std.dev.	p-value
Group 1	10	611.81±314	p>0.05
Group 2	10	679.74±172	
Group 3	10	698.1±254	
Group 4	10	465.73±210	

Table 1 shows mean and standard deviation of Newton values (N) for all the four groups. One way Anova and

post hoc Tukey test did not show any statistical significant difference (p>0.05). Table 2 shows number of cohesive, adhesive and mixed failures for all the four groups.

Table No. 2: Types of failure for all the groups

Groups	No. of samples	Cohesive	Adhesive	Mixed
Group 1	10	00	08	02
Group 2	10	02	06	02
Group 3	10	02	02	06
Group 4	10	02	08	00

DISCUSSION

Null hypothesis could not be rejected because there was no statistically significant difference. Highest value of bond strength was shown by group 3 but failed to show statistically significant difference from other groups. Also none of the groups showed cohesive failure above 80% which was a requirement of ADA standards No 15 to pass the test. Reason of not showing the difference could be absence of heat because during bench curing no heat was applied and if heat is not there active curing of material will not occur.

Wax removal can be done by different methods for different periods of time and temperature.^{17,18} Method to remove wax in this study is utilized as per Philips’ Science of Dental Materials.⁵ It was made sure that for every cycle of dewaxing and flushing, fresh water is used. It has come under observation that dewaxing chambers have contaminated water and using same water multiple times will not ensure complete elimination of wax and can affect bonding mechanism. Types of failure can be detected by various means^{11,19} and method of using naked eye in this study has also been utilized in the study of Mehtab et al¹¹. Though acrylic teeth and denture base are made up of same material but difference of colour provides a medium of comparison. Colour difference of denture base and acrylic tooth helps to distinguish their presence on each other.

Dentures when present in oral cavity are subjected to different types of forces and these forces becomes a point of great concern in area where teeth are attached. Some of the common types of forces which a denture is subjected to are shear, tensile and compressive. Different researchers’ have used different types of forces to evaluate bond strength between denture base and acrylic teeth.^{20,21} However in this study tensile force was used because as per recommendations of ADA standards no 15, evaluation of bond strength between denture base and artificial teeth is evaluated by applying tensile load between them.

In the study of Mohamed et al¹³ bench curing for 1 hour was applied to specimens which were cured with slow curing cycle but not with short curing cycle. Statistical significant difference was found and reasons of results not in accordance to this study could be the curing time

and temperature. In the study of Damade et al¹⁶ bench curing was applied for 1 hour to heat cured denture base resin but not with microwave cured denture base resin. They also found statistical significant difference which could be due to the difference of materials that were evaluated.

CONCLUSION

Bench curing for different time periods did not affect the strength of bond between denture base and acrylic teeth. None of bench curing regime could pass the bond test as per ADA standards no 15. Curing of the material is usually done as per manufacturer's instructions and if bench curing is not recommended then it might not be necessary. However one can state that time period taken by curing tank to reach the manufacturer's curing temperature and initiate curing can be regarded as bench curing time.

Author's Contribution:

Concept & Design of Study: Beenish Mehtab
 Drafting: Kashif Aslam, Saad ud din Siddiqui
 Data Analysis: Syed Kashif Abrar
 Revisiting Critically: Beenish Mehtab, Kashif Aslam
 Final Approval of version: Beenish Mehtab

Conflict of Interest: The study has no conflict of interest to declare by any author.

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