

Effect of Monomer Application for Different Time Periods on Bond Strength between Heat Cured Denture Base Resin and Acrylic Resin Teeth

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ABSTRACT

Aim: To find out the effect of monomer application for different time periods on tensile bond strength of heat cured denture base resin and acrylic resin teeth.

Methodology: Ninety specimens were fabricated as per ADA standards No 15 and were divided into 3 groups through purposive sampling technique. In Group 1 monomer was applied on acrylic resin teeth just before heat cured denture base material was packed. In Group 2 monomer was applied for 10 seconds and in Group 3 for 60 seconds. Universal testing machine applied tensile load between denture base and acrylic teeth. Visual observation was done to detect types of failure.

Result: Group 2 showed the highest value of tensile bond strength followed by Group 1 and 2 however there was no statistically significant ($p > 0.05$) difference between the groups.

Practical implication: Monomer application enhances bond strength between denture base and acrylic teeth but time period of its application which could provide maximum benefit is not very clear. Therefore this study is carried out so that the most effective time period of its application can be figured out.

Conclusion: Bond strength was not affected by monomer application for different time periods.

Keywords: Monomer, Time period, Denture base resin, Acrylic teeth

INTRODUCTION

In about 3000 B.C, dentistry began as a profession and in that period teeth made up of ivory or bones were attached to natural teeth¹. Some of the dentists in 17th century produced decay-proof porcelain dentures² followed by dentures made up of vulcanized rubber in 18th century which can precisely fit in oral cavity³. Polymerized acrylic resin as a denture base material was introduced in 1935 to support artificial teeth⁴. Use of polymer has also been seen in the production of preventive, restorative and auxiliary dental materials. Process by which these materials are formed are either addition or condensation reactions. In addition reactions, monomers are added one at a time and in condensation all the monomers become reactive at the same time⁵.

Polymerization of monomer resins attains a permanent shape when they reach to a solid state and therefore they are useful in dentistry. Synthetic polymer resins (plastics) can be permanently reshaped by irreversible deformation and remain dimensionally stable. The benefit of plastics is derived from their ability to be permanently shaped either by the application of heat and pressure or by a chemical reaction. Their thermal behaviour makes them classified as thermoplastic polymers where change is reversible or thermosetting polymers if the change is irreversible⁶.

Since 1940 polymethyl-methacrylate have been the material of choice for denture construction but earlier vulcanized rubber was most commonly used. At the end of World War II there was shortage of raw material for vulcanized rubber and then polymethyl-methacrylate (acrylic resin) became the popular material and since then has maintained its role in removable prosthodontics⁷.

Acrylic tooth getting debond from denture base has always been an issue and considered as a major reason of denture repair.⁸ In order to improve the bonding researchers have used various means such as use of different chemicals, mechanical modifications and different type of denture bases.⁹⁻¹⁰ Monomer application between denture base and acrylic teeth has been utilized¹¹ and has shown some promising results but as per author's search there has not been any standardization

Therefore the objective of this study is to figure out the effect of monomer application for different time periods on bond strength between heat cured denture base resin and acrylic resin teeth.

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MATERIALS AND METHODS

This experimental study was conducted at Sir Syed College of Medical Sciences and Dow Dental College during the period of October 2022 to December 2022. Ninety specimens were fabricated which were divided into three groups through purposive sampling technique¹². In Group 1 heat cure monomer (MR Dental, U.K) was applied on acrylic teeth just before denture base was packed. In Group 2 monomer was applied for 10 seconds and in Group 3 for 60 seconds.

All the specimens were fabricated as per design of ADA standards No.15¹³. A custom made metal former of 60mm in length was used for mounting acrylic teeth (Kaile, China) (Fig 1). Type 3 dental stone (Garreco, U.S.A) was mixed as per manufacturer's instructions and then mounted acrylic tooth with metal former was invested in it (Fig. 2). Type 3 dental stone present in drag part of the flask with invested metal former and acrylic tooth was left to get set. After setting, cold mould seal was applied on set plaster followed by placing the coup part of the flask. Coup part of the flask was then filled with type 3 dental stone followed by covering it with a lid. The completed investment procedure was again left to set as per recommended time of manufacturer.

Flasks were then transferred to fresh boiling water in a dewaxing tank (Manfredi, Italy) for 5 minutes¹⁴. After dewaxing, flasks were separated and metal former was removed. After removal of the metal former, wax residues were flushed with boiling water in order to avoid contamination of wax (Fig 3). After flushing with boiling water, investment was left to get dry followed by cold mould seal application. Application of cold mould seal was done to all the parts of the flask but not the ridge lap area of tooth.

Manufacturer's instructions were followed to mix denture base material (MR Dental, U.K). After mixing, material was packed in the mould area of the investment. Before packing, monomer was applied with a brush on the ridge lap area of the tooth for time period as per groups division. After packing, denture base material was covered with polyethylene sheet (Fig. 4) followed by putting the other half of the flask. Completed flask was then transferred to bench press and was kept for 5 minutes at 100kp pressure to remove excess material. After excess material and polyethylene was removed, flasks were then transferred to spring clamp and placed in a curing tank (Manfredi, Italy) at 73°C for 90 minutes followed by 100°C for 30 minutes¹³. After curing flasks were allowed to cool for 30 minutes on bench followed by 15 minutes under running tap water¹⁵.

Tensile bond strength was tested for all the finished specimens (Fig. 5) in a Universal testing machine with a cross head speed of 1mm/min. Jigs of the machine held the specimens in such a way that a direct pull can be applied. Visual observation was done to observe the type of failure (cohesive, adhesive or mixed). One way ANOVA was applied to find out statistical significant difference between groups and post hoc Tukey test for multiple comparisons.

Fig 1: Metal former



Fig 2: Mounted specimens invested



Fig 3: After dewaxing



Fig 4: Covered with polyethylene sheet



Fig 5: Finished specimen



RESULTS

Group 2 showed the highest value of tensile bond strength followed by group 1 and 3 (Table 1). One way Anova and post hoc Tukey test did not show any statistical significance ($p > 0.05$) (Tables 2-3). Group 3 showed the highest number of cohesive failure followed by group 1 and 2 (Table 4).

Table 1: Mean and standard deviation for all the groups

Groups	No.	Mean±SD	p-value
1	30	326±22.194	0.118
2	30	336±22.588	
3	30	326±15.786	

Table 2: One way Anova

	Mean square	F	p-value
Between groups	913.900	2.190	0.118
Within groups	417.363		

Table 3: Post-hoc Tukey

(I) group	(J) group	Mean Difference (I-J)	p-value
Group 1	Group 2	-9.30000	0.188
	Group 3	.50000	0.995
Group 2	Group 1	9.30000	0.188
	Group 3	9.80000	0.157
Group 3	Group 1	-.50000	0.995
	Group 2	-9.80000	0.157

Table 4: Types of failure for all the groups

Groups	No.	Cohesive	Adhesive	Mixed
1	30	14	10	6
2	30	10	12	8
3	30	15	10	5

DISCUSSION

There was no statistically significant difference between all groups therefore null hypothesis cannot be rejected. Though Group 2 showed the highest bond strength but did not show any statistical significance. In all the groups, number of cohesive failure was more as compared to adhesive and mixed. Reason to focus more on cohesive failure because ADA standards no 15¹³ mentions that if more than 80% of the specimens shows cohesive failure, it is an indication that bond strength has passed the test.

Different researchers' have used different mediums to detect failure types^{16,17}. However method used in this study is visually which is also used in the study of Al Zaher et al¹⁷ Color difference of denture base resin and acrylic resin tooth can help to detect the presence of material on each other and in turn would help to find out the type of failure. Confirmation in regard to type of the failure can be done by other methods.

Denture base and teeth are not subjected to tensile load only when present in mouth. Other loads such as shear and compressive are equally acting on them at the same time. Researchers' have tested bond strength not only through tensile load but shear and compressive load has also been used¹⁸. However tensile load was used in this study because ADA standards no 15¹³ proposed it.

There is no standardization of wax removal and researchers' have used different methods for it^{19,20}. In this study method and time period for wax removal is done as per Colebeck et al¹⁴. Reason of using fresh water for each dewaxing procedure because water gets contaminated after each phase of dewaxing and if same water is used there are chances that wax residues might affect the bonding mechanism.

The study of Valittu et al²¹ showed that when monomer was applied for different time periods, cohesive failure got increased with increase in time period (180 seconds). In this study monomer application for 60 seconds showed the highest number of cohesive failure.

Though monomer application has shown some promising results^{22,23} but not in all the researches²⁴. Time period for which

monomer is applied and protocols that need to be addressed during its application are still in scarcity. Method through which continuous application of monomer can be applied for propose time periods needs more research. Continuous application of monomer can provide proper diffusivity and thus can enhance bond strength.

CONCLUSION

Effect of monomer application for different time periods did not have any effect on tensile bond strength between heat cured denture base resin and acrylic resin teeth. Application of monomer for 60 seconds showed the highest number of cohesive failure.

Conflict of interest: Nil

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