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# A COMPARATIVE EVALUATION OF SHEAR BOND STRENGTH BETWEEN TREATED DENTURE BASE AND REPAIR RESIN: AN IN VITRO STUDY

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## ABSTRACT

**Statement of Problem:** Fracture of denture made with acrylic resin is frequent due to various reasons. Therefore, the purpose of the present study is to investigate the effect of various chemicals on shear bond strength between heat cure denture base and repair resin. **Materials and Method:** Seventy five samples of the heat cure denture base acrylic resin were fabricated. All samples were cleaned ultrasonically and were stored in water for seven days. The samples were roughened with acrylic trimmer and silicon carbide paper. In control group 15 samples were taken with no chemical treatment and the remaining 60 samples in experimental groups were treated with methyl methacrylate, chloroform, acetone and methylene chloride for 30 seconds respectively. Autopolymerizing repair resin was used for repair. Polymerization was done in the pressure pot under 52 psi pressure at 37 C for 10 minute. Shear bond strength test for all the samples was performed with a universal testing machine at 1.25mm/min speed using wooden jig. **Result:** Mechanical and chemical treatment of heat cure denture base increased the shear bond strength between heat cure resin and repair resin. ANOVA showed significant p value ($p<0.001$), student "t" test was also significant. **Conclusion:** Mechanical and Chemical treatment of heat cure denture base showed increase in shear bond strength remarkably with all tested materials.

**KEYWORDS:** Denture base, Shear bond strength, Fracture, repair resin.

## INTRODUCTION

Poly methl methacrylate denture base material is widely used in prosthodontics since its inception. Many attempts have been made to improve the properties but fracture of denture is the most common problem. Fracture is usually mechanical or accidental due to various reasons.[1] Several materials such as heat cure acrylic resin, auto-polymerized acrylic resin, visible light cure acrylic resin and microwave polymerized acrylic resin have been used to repair fractured acrylic resin denture base.[2] Repair must have adequate strength, dimensional accuracy, good colour matching, inexpensive and completed as rapidly as possible for convenience of the patient.[1]

Some of the dentures may tend to fracture even after repair has been done. Preparation of the broken piece to the joint plays a significant role in controlling the quality of the repair. Ware and Docking find that the transverse strength of smooth rounded edged repaired joints is superior to that of joints repaired with sharp edge and corner remaining.[1] Mechanical and chemical surface modifications of denture base materials improve bond strength. Mechanical modifications improve bond strength including grinding with burs, airborne abrasion particles, laser, butt, knife edge, round, lap, and ogee joint[3,4] or by reinforcing materials such as wires, mesh, carbon and glass fibres.[5,6,7] Adhesion of broken denture parts can be improved by applying some adherend to make the surface wet.[8,9] These adhered are chemicals and they are applied on the surface of broken denture base before repair. These chemicals etch the surface and may increase the bond strength of repair material.

A survey showed that 35.9% of the repairs arrived out were due to deboned or detached teeth. Around 29% were repairs to midline fractures, more commonly seen upper complete denture at a ratio of 2:1.[10] The recurrent rate of fracture has been reported to be as high as 19.5-21.3% in all denture fracture cases.[11] This reveals that repairing techniques for fractured dentures need to be further explored.

The purpose of the present study was to investigate the effect of chemical treatment of heat cure denture base on shear bond strength between heat cure denture base acrylic resin and repair resin.

## MATERIALS AND METHOD

Seventy five samples of heat cure denture base acrylic resin were fabricated measuring 15 mm in diameter and 3 mm in thickness using brass split ring. Seventy five Samples were divided into two groups: control group and four experimental group having 15 samples respectively.

### Manufacturing of brass split ring

Two brass split rings were designed and manufactured. One brass split ring having diameter of l5 mm and 3 mm thick was used to make wax patterns for fabricating heat cure denture base acrylic samples (figure 1). Another brass split ring having 6 mm diameter and 2mm thick was used to pack the autopolymerizing repair resin.

### Preparation of wax patterns

Molten modelling wax was filled in brass split ring. After setting of the wax ring was refilled by additional molten wax to compensate the contraction. Then the ring was placed in cold water. After the wax is entirely hardened the brass split ring was opened and wax pattern retrieved and finished. Distorted patterns were discarded. Seventy-five such wax patterns were fabricated.

### Preparation of moulds for fabricating intact acrylic patterns

Fabricated wax patterns were invested in Hanau flask using Type III gypsum (Kalabhai). Eight wax patterns were invested at a time in a flask. After complete setting of the investment material, dewaxing was performed by immersing the flask in the boiling water for 4 minutes and clean the mould cavity by boiling water and detergent.

### Packing

Trevalon heat cure acrylic denture base material (Dentsply India private limited) was used for packing. The resin was mixed in 3:1 by volume ratio in a mixing jar and packed in dough stage. Excess material was removed by trial closure.

### Processing

For Processing, short curing cycle was followed; in which the resin was processed at $74^0$ C for 2hrs and then the temperature of the water bath was increased to $100^0$ C for 1 hour. Flask was removed from the water bath and bench cooled for overnight.

### Finishing of the samples

Samples were retrieved from the flask, finished, cleaned by ultrasonic cleaner and stored in water at room temperature for seven days before the surface treatments. All the samples made rough by acrylic trimmer and 600 grit silicon carbide paper. The entire prepared samples were checked by Vernier calliper for accurate dimension.

### Control Group

Fifteen samples were used in the control group with no chemical treatment.

### Experimental Group

Sixty samples were used in four experimental group and were chemically treated for thirty seconds with methyl methacrylate, acetone, chloroform and methylene chloride.

### Repair with auto-polymerizing resin

An auto-polymerizing brass split ring of 6mm diameter and 2mm thick was placed over the surface treated heat cure acrylic denture base sample. R R auto-polymerizing resin (Dentsply India private limited) was mixed and packed in the brass split ring in dough stage. Whole assembly was carried in the pressure pot for polymerization. In the pressure pot acrylic resin was polymerized under 32 psi pressure at 37 ºC for 10 minutes. Specimens were retrieved finished and stored in the distilled water for 24 hrs before testing.[2] All the specimens were tested in a shear bond testing machine with the help of wooden jig at25mm/min speed. (figure 2 & figure 3)

## RESULT

All the data recorded and analysed with the help of the statistical package for social scientists (SPSS) computer software versions 19. Group wise comparison showed (table 1) increase in shear bond strength values for all experimental groups. Methylene chloride group showed maximum shear bond strength 32.274 MPa while Methyl methacrylate group showed minimum shear bond strength 28.392 MPa. Analysis of variance revealed statistically significant differences amongst all groups ($p<0.001$) (table2). Intergroup comparison revealed control group had lower mean shear bond strength values as compared to all the experimental groups. Inter group comparison showed significant differences in all groups as p value $p<0.001$) except between control group and Methyl-methacrylate group and Chloroform and Methylene Chloride group when applied student “t” test (table 3).

**Table 1: Shear bond strength among various groups.**

| Group | N | Mean | SD | 95% Confidence Interval for Mean | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| | | | | Lower | Upper | | |
| Control | 15 | 28.265 | 0.898 | 27.768 | 28.763 | 26.860 | 30.260 |
| Methyl methacrylate | 15 | 28.392 | 0.724 | 27.991 | 28.793 | 27.200 | 29.920 |
| Acetone | 15 | 29.580 | 0.680 | 29.203 | 29.957 | 27.880 | 30.600 |
| Chloroform | 15 | 31.685 | 0.679 | 31.310 | 32.061 | 30.600 | 32.640 |
| Methylene Chloride | 15 | 32.274 | 0.775 | 31.846 | 32.704 | 30.600 | 33.320 |
| Total | 75 | 30.039 | 1.826 | 29.619 | 30.459 | 26.860 | 33.320 |

**Table 2: Analysis of Variance (ANOVA).**

| | Sum of squares | DF | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between groups | 206.667 | 4 | 51.667 | 90.503 | <0.001 |
| Within groups | 39.962 | 70 | 0.571 | | |
| Total | 246.629 | 74 | | | |

**Table 3: Intergroup Comparison.**

| S.No | Comparison | "t" | "p" |
|---|---|---|---|
| 1. | Control vs methyl methacrylate | -0.425 | 0.674 |
| 2. | Control vs Acetone | -4.519 | <0.001 |
| 3. | Control vs Choloroform | -11.766 | <0.001 |
| 4. | Control vs Methyl Chloride | -13.090 | <0.001 |
| 5. | Methyl methacrylate vs Acetone | -4.632 | <0.001 |
| 6. | Methyl methacrylate vs Choloform | -12.853 | <0.001 |
| 7. | Methyl methacrylate vs Methyl Chloride | -14.180 | <0.001 |
| 8. | Acteone vs Choloform | -8.488 | <0.001 |
| 9. | Acetone vs Methylene Chloride | -10.124 | <0.001 |
| 10. | Choloroform vs Methylene Chloride | -2.216 | 0.035 |

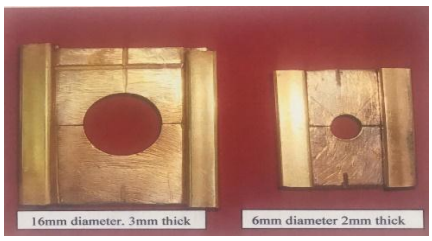


**Figure 1: Split mould.**

**Figure 2: Repaired samples.**

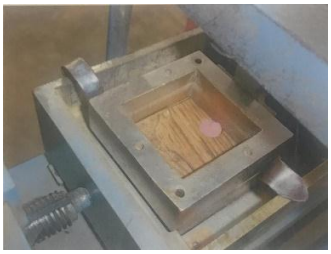

**Figure 3: Split shear bond testing.**

## DISCUSSION

Acrylic resin poly (methymethacrylate) denture base material is most commonly employed in the construction of dentures. Despite its popularity, these materials showed less flexural strength hence fracture of denture is very common problem. These broken dentures require repair, this repair must have sufficient strength so that it cannot fracture again at the joint interface. Presently, the Dental Practice Board, UK spends approximately seven million pounds annually to repair about 0.8 million dentures.[1]

Researchers have reported the influence of various factors like repair material, surface designing, repair surface treatment etc. to improve the repairing surfaces for fractured dentures. In the present study surface of heat polymerized denture base acrylic resin made rough in all the groups and kept as control group because very small number of studies are available to compare the shear bond strength for both mechanical and chemical treatment of repair surface using different chemicals. In this study auto polymerized repair resin was used because according to various studies auto polymerized repair resin is superior over the other types of repair resins.[12,13] Two mm space was used in this study because it helps to minimize the bulk of repaired material used, resulting in smaller dimensional changes and reduced any colour differences between the denture base and repair material.[14]

In the present study results showed that mean value of shear bond strength of control group was lowest 28.265MPa, mean value of shear bond strength in all experimental groups increased remarkably high after chemical treatment except with methyl methacrylate. These results are in accordance with previous studies of Shen chaiayi et al., George et al.[15,16] Methyl methacrylate showed least increase in shear bond strength may be because 30 sec time is not sufficient for methyl methacrylate.[17]

Denture repair relies on the phenomenon of adhesion. Adhesion can be improved by applying some adherents to make the surface wet. In this study methyl methacrylate, acetone, chloroform and methylene chloride were used. These chemicals are commonly used in industries and available in market. When these adherents applied on the broken surfaces of denture, they etch the surface by changing surface morphology, dissolve the surface and micro debris or increase the electron density to create more efficient site by better adhesion and wettability.[18,19] These agents evaporate quickly and do not interfere polymerization of autopolymerized resin.

Methylene chloride, chloroform, acetone and methyl methacrylate are hazardous to health, when they are used in moderate to high amount. These chemicals were used in this study for only 30 seconds and washed properly moreover they are volatile also, so that they cannot be injurious to health. It is advised to use these chemicals cautiously.

## CONCLUSION

It is observed, analyzed and concluded from the present study that

1) Shear bond strength was increased after chemical treatment.

2) Methylene chloride can be used as a regular etchant during fracture repair procedure.

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