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## **Evaluation of shear bond strength of acrylic denture teeth to heat polymerized denture base resin after different surface treatments on the bonding surface of acrylic denture teeth - an in vitro study**

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**Abstract**--Present study aimed to improve the bond strength of denture teeth to acrylic resin denture base by chemical or mechanical modification on the bonding surface of denture teeth. Total 40

artificial acrylic resin central incisors and lateral incisors were divided into five groups: group I, 8 samples without modification (control group); group II, 8 samples (bonding surface of teeth were treated with monomer); group III, 8 samples (bonding surface of teeth were treated with monomer and the glaze layer removed with aluminum oxide stone bur); group IV, 8 samples (bonding surface of teeth were treated with acetone); and group V, 8 samples (acetone application followed by glaze layer removed with aluminum oxide stone bonding surface of acrylic resin teeth). They were mounted on wax blocks, and the blocks were acrylized. The bond strength values were obtained by subjecting the samples to shear compressive load under universal testing machine. The results were subjected to statistical analysis. The mean value of bond strength was highest for group E (modified by aluminum oxide abrasion prior to dichloromethane application), followed by group C (modified by aluminum oxide abrasion prior to monomer application), group D (modified by dichloromethane application), group B (modified by monomer application), and lastly group A (control group). Significantly improved bond strength values were obtained in modified groups as compared with the control group. Conclusion: Dichloromethane application followed by aluminum oxide abrasion provided the highest bond strength and is recommended to prevent debonding of the teeth from the denture base.

**Keywords**---Surface treatment, Acetone, Bond strength, Acrylic resin, Roughening.

## Introduction

The most common reason for the elderly group of the population to seek dental treatment is for the replacement of missing teeth either partial or complete.<sup>1</sup> Harold Vernon first introduced acrylic polymers as denture base materials in 1937.<sup>2</sup> Since 1940 the poly-methyl methacrylate artificial teeth have become popular to be used in artificial dental prosthesis.<sup>3</sup> Various materials like auto-polymerized resin, heat polymerized resin, light polymerized resin, etc. have been used to prepare dentures.<sup>1</sup> Routinely denture base material for dental prosthesis used is heat-cured poly-methyl methacrylate because of its properties such as better esthetics, low solubility, less toxicity, easy to repair.<sup>3</sup> It has remained in that position up to the present day, even though materials with superior properties have been available to the dental profession for some time now. The reason for acrylic resins continued popularity in dentistry is the simple processing equipment required and the relatively low cost of the fabrication process.<sup>4</sup> Conventional denture fabrication technique is remained same but the quality of acrylic denture teeth is improved a lot.

Bonding of acrylic teeth to denture base material is chemical. Major post-insertion complication of artificial prosthesis is de-bonding or fracture of acrylic denture teeth from denture base material and It remains a major problem in prosthodontics practice. It has been estimated that between 22% to 30% of

denture repairs involve tooth de-bonding, usually in the maxillary anterior region of the denture.<sup>5</sup> This detachment may be attributed to:

1. 1.A lesser ridge lap surface area available for bonding and the direction of the stresses encountered during function.<sup>6</sup>
2. Lack of free monomer in the acrylic resin dough at the packing stage.<sup>7</sup>
3. Incomplete elimination of wax residues on bonding surface of acrylic denture teeth area.<sup>8</sup>
4. Separating media over a bonding surface of acrylic denture teeth.<sup>8,9</sup>
5. Bond failure due to the crack propagation from areas of high-stress concentration.<sup>9</sup> 6.The type of tooth material (conventional acrylic teeth or cross-linked teeth).<sup>10,11</sup> 7.Different polymerizing processing methods applied to the base resins.<sup>1,12</sup>

The International Organization for Standardization (ISO) specification no. 22112 defines standards concerning the bond strength of artificial acrylic teeth to the denture base resins and the bond test method. One attempt to improve the bond of denture teeth to an acrylic base resin is mechanical modification of the base surfaces of denture teeth. Other methods are chemical treatments on the base surface of teeth.<sup>13</sup> The detachment may be due to a lesser ridge lap surface area of denture base available for bonding, inadequate thickness of acrylic resin in the anterior segment of denture base and the direction of the stresses encountered during function it leads to inadequate bonding of acrylic denture teeth. So, the fracture or de-bonding of acrylic resin teeth from maxillary denture specially in the anterior region is more common.<sup>14</sup>

There are two processes that affect the achievement of a bond between the acrylic denture teeth and denture base resin.<sup>6</sup>

- (i) The polymerizing denture base resin must come into physical contact with the denture tooth resin.
- (ii) The polymer network of denture base resin must react with the acrylic tooth polymer to form an interwoven polymer network.

However, after the invent of acrylic resin teeth, it soon replaced porcelain teeth because of their ability to chemically bind with denture base resins, but still bond failure prevails between acrylic denture teeth and denture base which causes inconvenience to the patient and embarrassment to the dentist.<sup>15</sup> If the problem of de-bonding teeth were solved, the elderly population would benefit by avoiding repeated repair of their dentures.<sup>1</sup> So, the purpose of this study was to evaluate bond strength between acrylic denture teeth to heat polymerized denture base resin with different surface treatments.

#### **Material and methods:**

1. Maxillary central and Lateral incisors acrylic denture teeth (Prestodent)

2. Modelling Wax (DPI, digital product of India.)
3. Heat Cure Poly-methyl methacrylate powder and liquid, Separating Media (Dental Products of India, Mumbai, India)
4. Dental Plaster (Asian chemicals, Rajkot, Gujarat, India)
5. Acetone (Labware chemical)
6. Petroleum jelly (vaseline)
7. Graph paper
8. Denture polishing cake and Sand paper of grit (samit products, new delhi)
9. Acrylizer (Unident dental equipment, India)
10. Universal Testing Machine (Unitest- 10, ACME Engineers, India)

Method:

1) Fabrication of stainless-steel triangular metal die and triangular wax blocks :  
A stainless-steel triangular metal die having each side of 3cm and length 4.5cm with 60° angulations was fabricated to obtain the wax-tooth assembly (fig1). Triangular wax blocks were fabricated using the same stainless- steel dimensions was prepared by using modeling wax (fig2). The blocks were checked using graph paper. Impression of wax blocks were made in the polyvinyl siloxane putty material to standardize the size of wax block and same size of blocks were fabricated by pouring molten wax in the poly vinyl siloxane mold. Final carving and polishing of wax blocks were done.

2) Angulation on the graph paper:

Equilateral triangle of each side 3cm with 60° angle was drawn on the graph paper and the lines were drawn on the both sides of the triangle at an angle of 130° to simulate forces of mandibular incisors in oral condition (fig3).

3) Teeth arrangement on wax block:

On the two opposite sides of triangular wax blocks central incisor were arranged at an angle of 90° by taking the guidance from the graph paper to simulate an oral condition in the mouth (fig 4).

4) Different surface treatments on the bonding surface of acrylic denture teeth:

Group 1: Control / Unmodified group.

Group 2: Bonding surface of acrylic denture teeth painted with monomer.

Group 3: Glaze is removed by roughening followed by application of monomer on the bonding surface of acrylic denture teeth.

Group 4: Bonding surface of acrylic denture teeth treated with acetone.

Group 5: Glaze is removed by roughening followed by application of acetone on the bonding surface of acrylic denture teeth.

5) Processing of Wax Blocks

Flasking, de-waxing (fig 5), packing, and de-flasking were done according to manufacturer's instructions. Acrylic blocks with mounted teeth were then finished, rechecked on graph paper, and stored in water (fig. 6).

6) Testing of samples:

Prepared acrylic blocks were mounted on a specially designed fixture on the universal testing machine mounting table and shear load was applied at a cross-head speed of 0.5 mm /minute. During the testing, the fixture holding the acrylic resin-tooth sample was so aligned that the shearing blade was located on palatal surface of the acrylic incisor teeth so that it simulates the contacting lower incisor

surface on the palatal aspect of the maxillary tooth (fig. 7). While performing the test, care was taken that no significant bending/rotation of the mounted acrylic blocks in a fixture occurred during load application.

The samples were subjected to shear compressive load under universal testing machine, and the results obtained are listed in Table 1 and Graph 1.

The results of the study were statistically analyzed using following statistical tests.

#### Results:

1. Descriptive statistical analysis
2. One-way ANOVA test
3. Post HOC-Tuckey's test.

#### Discussion:

Although complete dentures cannot be considered a substitute for natural teeth, they have been and would probably remain, the staple treatment for edentulous patients. The use of complete dentures by edentulous patients is projected to increase over the next twodecades because of an increase in life expectancy.<sup>16</sup> Artificial teeth are often necessary for prosthodontic rehabilitation when natural teeth are lost.<sup>17</sup> Dentures – the mode of replacing teeth had become very popular since theintroduction of acrylic resins in removable prosthodontics since 1937.<sup>2</sup> Acrylic resins and porcelains have been used for the fabrication of artificial teeth; however, neither type completely accomplishes the requirements for an ideal prosthetic tooth. In particular, inferior wear resistance of acrylic resin artificial teeth is a significant limitation for complete denture therapy; namely, the denture cannot resist parafunctional movements and maintain proper occlusal relationships over time.<sup>17</sup> The group II in which monomer application was done prior to packing showed not more difference in bond strength value as compared with the control group. The increase in bond strength on monomer application was also reported by Vallittu et al<sup>18</sup>, Meng et al<sup>19</sup>, Patil et al<sup>7</sup>, Marra et al<sup>20</sup> and Saavedra et al.<sup>21</sup> Group III in which removal of the surface glaze was done prior to monomer application showed bond strength better than the control group and monomer application. Removing the glaze on bonding surface with an aluminum oxide stone bur was seen to significantly increase the bond strength between acrylic teeth and denture base resin, as reported by Bragaglia et al.<sup>22</sup> Group IV showed the highest bond strength, that is, acetone solvent application before packing. This result is in consonance with the findings of Sinasi Sarac et al<sup>23</sup>, Stoia et al<sup>24</sup>, and Kaura et al. Group E showed the second highest bond strength, that is, removal of surface glaze by aluminum oxide stone followed by application of dichloromethane before packing. Rached and Del-bel Cury<sup>25</sup> immersed the fractured sample in acetone for 30sec. Acetone dipping achieved the highest transverse strength when compared with acetone ± monomer association and no surface treatments.

#### Conclusion:

Within the limitations of this in-vitro study, the following conclusions were made. It was found that the modifications of the bonding surface of acrylic teeth improved the bond strength as compared with the unmodified surface. There was significant difference in the mean bond strength values after different surface treatments. The mean bond strength of the acetone group of central incisor was the highest and control group of central incisor was the lowest. Acetone group was significantly higher than monomer and control groups. There was significant difference in the mean bond strength values after different surface treatments. The mean bond strength of the acetone group of lateral incisor was the highest and control group of lateral incisors was the lowest. Acetone group was significantly higher than monomer and control groups. There was more of bond failure seen in the control group with no surface treatment done when compared to other groups. From the results obtained, it was clear that if we do some changes in the routine procedure of processing like surface treatment after dewaxing and before packing procedure, it shows improved bond strength of acrylic denture teeth to acrylic denture base resin. Acetone surface treated group had good bond strength values and more cohesive failure was noted. Adhesive failures were seen in the control groups. Within the limitations of this study, application of acetone bonding agent was proven to be more effective with simpler application technique and processing procedures.

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