Original Research Paper

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# Evaluvation of the Transverse Strength of Acrylic Denture Base Resins Repaired By Different Materials: An Invitro Study.

**Abstract:**

**Aims:** The aim of the study undertaken was to evaluate an effective method of denture repair, which will have considerable transverse and impact strength, quick to repair and can be effectively utilized by the general practitioner.

**Objectives: 1)** To evaluate the transverse strength of denture base resin repaired by different methods having 45° joint surface contours and compare it with denture base acrylic resin repaired by conventional methods.

2) To find out the best material for repair.

**Material and Methods:** For the purpose of this study, Heat cure resin (DPI), Autopolymerising resins (DPI) and Glass Fibers (interling), were taken from the market. The unrepaired conventional heat cure denture base resin (DPI heat cure) plates were used as control group. .

**Results:** 1) The mean transverse and impact strength of all the samples repaired by various methods showed significantly lower strength than control group (heat cure unrepaired samples used as control for transverse strength) 103.33MPa, although statistically significant.

2) Specimens repaired by self cure resin with glass fibers having 450 bevel joint showed the highest transverse strength.

**Key Words:** Denture base resins, Denture breakage, Transverse strength

## Introduction:

Complete edentulism can be defined as "the physical state of the jaw[s] following removal of all erupted teeth and the condition of the supporting structure available for reconstructive or replacement therapy".[1]

Glossary of Prosthodontic Term [Academy of Prosthodontic 2005] defines denture base as the part of denture that rests on the foundation tissue and to which teeth are attached.[13]

Fracture in denture mainly occurs because of flexural fatigue and impact forces. The most common factors of denture base fracture are alveolar resorption, warpage, inadequate relief, excessive relief, upper teeth set out side the ridge, incomplete polymerization of acrylic resin, previous repair and decreased inter arch space.[4] Clinical factors related to complete denture failure include: improperly contoured mandibular occlusal plane, high frenum attachment, occlusal scheme, occlusal forces, the denture foundation and denture base thickness.[5]

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Denture breakage is also prevalent among neuropsychiatric patients, especially those who also have neuromuscular disorders such as hemi paralytic muscular dystrophy and parkinsonian disease (Stipho HD 1987).[6]

Impact failure usually occurs out of the mouth as a result of sudden blow to the denture or accidental dropping while cleaning, coughing or sneezing (Jagger D.C. 1999)[3]. For this reason, the transverse and impact strength tests are selected as most relevant to evaluate the strength of repaired denture base resins.

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The present study investigates the commonly used material for repair i.e heat cure acrylic resins, auto polymerizing resins, glass fibers incorporated in auto polymerizing resins. This study is an effort to find the appropriate method which can provide the long lasting result and can prevent the recurrence of fracture.

## Aims and Objective:

### Aim :

The aim of the study undertaken was to evaluate an effective method of denture repair, which will have considerable transverse and impact strength, quick to repair and can be effectively utilized by the general practitioner.

### Objectives:

1. To evaluate the transverse strength of denture base resin repaired by different methods having 45° joint surface contours and compare it with denture base acrylic resin repaired by conventional methods
2. To find out the best material for repair

## Material and Methods:

This study was conducted in the Department of Prosthodontics, Jaipur Dental College, Jaipur (for preparation of test samples), Central Institute of Plastic Engineering & Technology (for testing and evaluation of the transverse strength) during the year 2017-18. For the purpose of this study, Heat cure resin (DPI), Autopolymerising resins (DPI) and Glass Fibers (interling), were taken from the market. The unrepaired conventional heat cure denture base resin (DPI heat cure) plates were used as control group.

The specimens of dimensions 65 mm long, 10.0±0.03 mm broad and 2.50±0.03 mm thick for transverse strength were used (As per ADA specification No. 12).15

The study was carried out in the following manner:

- Preparation of intact specimens
- Fracture of the specimens

Repair of specimens using different repair materials.

### 1. Preparation of Intact Specimens:

Metal Mold and Fabrication of Wax Patterns: The mold consisted of three plates, of which the middle plate had windows measuring 65mm x 10mm x 2.5mm. Wax patterns were fabricated using the metal mold. The final specimens were uniform in all dimensions. Distorted, damaged or broken patterns were discarded. A total of 60 wax patterns were prepared.

### 2. Fracturing of the Specimens and Preparing the Repair Site:

The samples were fractured using universal testing machine INSTRON under 1mm/min. The fractured specimen were placed back into the metal dies and 45 degree bevel was given on either side of the fractured end using a straight fissure carbide bur. The space between the fractured sample at the site of repair was kept 2 mm using vernier caliper.

### 3. Repair Procedure:

Subgroup A – Repair with Heat Polymerizing ResinFractured segments were repositioned into the master die. The space between the segments to be repaired was filled with molten wax. The specimens were invested using the conventional flasking procedure. Separating medium was applied on the dewaxed surface of the plaster index. The fracture surface was then conditioned with heat cure monomer. Heat polymerized resin was mixed and packed with acrylic resin and processed using conventional compression molding technique, after the flasks had cooled, the specimens were retrieved, finished and polished.

For heat cure repair, the gap between the parts was filled with wax and was invested using conventional flasking procedure. After dewaxing, separating medium was applied and the fractured surfaces were painted with monomer liquid and left for 3 minutes before mixing and packing,a total of 20 samples were repaired.

Subgroup B-Repair Using Auto Polymerizing Resin: Fractured segments were repositioned on the master die. The prepared site was conditioned with cold cure monomer. The repair space was filled with the free flowing mix, allowing for a slight excess to compensate for polymerization shrinkage and finishing. The repair resin was cured in a pressure pot at room temperature under 30 psi pressures for 30 min to reduce

porosities. The specimens were then recovered, excess resin trimmed and flushed with the adjacent segments. A total of 20 samples were repaired

Subgroup C – Repair with Unidirectional Glass Fiber Incorporated in Autopolymerizing Resin: When glass fibers were used for repair, a cavity

(1x5x30 mm) for transverse strength was prepared in the centre for each specimen. Specimens were repositioned in the similar fashion as mentioned above. Glass fibers (20 x 3 mm) were then placed in the cavity prepared in the specimen and the entire space was filled with autopolymerising acrylic resin. The samples were then cured in a pressure pot at a temperature of 37°C and pressure of 30 psi for 30 min. a total of 20 samples were repaired

In all 6 flasks were used for curing of the samples and a total of 60 samples were prepared including the unrepaired control group.

After being repaired the specimens were carefully restored to their original dimensions using sand paper and stored in 37°C distilled water for 48 hours before the test.

## 4. Evaluation of Transverse Test:

Instron Universal testing machine (Instron UTM, Model: 5569, U.K.), it has a load ranging from 2.5 N to 50 KN, with a digital data recording system. The software used was series 9software or Merlin software. The cross head speed could range from 0.01mm/min to 500mm/min.

The specimens were tested for transverse strength with a three point bending test using this Instron Universal testing machine at a cross head speed of 1mm / min and span length of 50mm. The load was applied to the centre of 2mm repaired area for the experimental groups and to the centre of control specimens until fracture occurred. The amount of deflection and the load at fracture were noted.

The transverse strength was calculated using the following formula:

Transverse strength (S) = 3 PL / 2bd2

Where,

P = Fracture load

L = Span length

b = Sample width

d = Sample thickness.

Fig1: Metal Dies

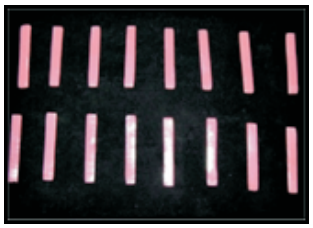


Fig2: Control Group

Fig3: Gap Filled By Wax

Fig4: Dewaxed Sample

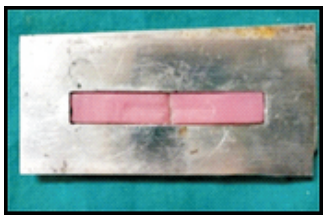


Fig5: Cavity Prepared For Glass Fiber

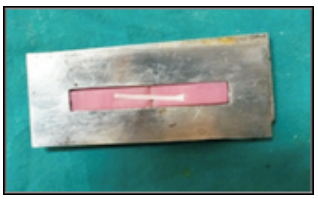


Fig6: Glass Fiber In Space

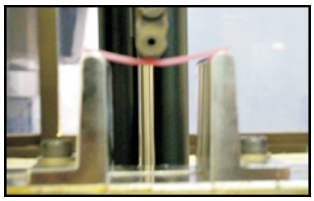


Fig7: Universal Testing Machine

## Results:

The present in-vitro study was conducted to evaluate and compare the transverse strength of DPI heat cure resin test specimens, which were repaired by autopolymerising resin,

heat cure resin and autopolymerising resin with glass fibers, Samples were given joint surface contour of 45 degree bevel joint.

The Formula Used for Calculating Standard Deviation:11

Standard Deviation: It is the most frequently used measure of deviation. It is defined as root mean square deviation and is denoted by SD.

$$SD = \sqrt{\frac{\sum (\overline{X} - X)^2}{n-1}}$$

$\overline{X}$ = Mean

X = The values of the variables

□ = Sum of the values

n = Number of observations

Table 1: Mean and Standard Deviation for Transverse Strength (MPa) of Control Group and All The Repaired Groups

| | N | Mean | Std. Deviation | P-Value |
|---|---|---|---|---|
| Control Group | 60 | 103.33 | 24.31 | 0.0000 |
| Group I | 20 | 62.93 | 2.21 | |
| Group II | 20 | 80.63 | 2.18 | |
| Group III | 20 | 72.16 | 2.18 | |
| Total | 120 | 87.62 | 23.89 | |

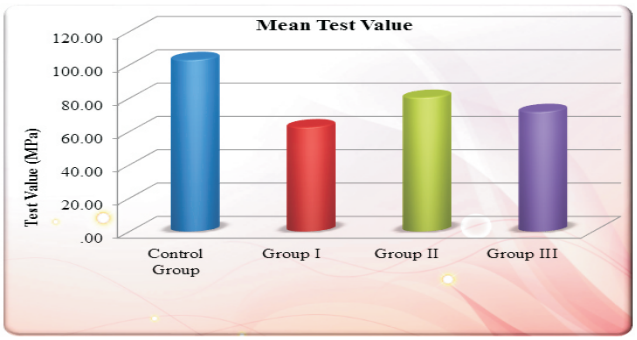
Table 1 Shows the mean value of different groups tested for transverse strength. Group 2 samples repaired with autopolymerising resins with glass fibers has the highest strength where as group 1 samples repaired with auto polymerizing resins has the lowest.

Table 2: Statistical Comparison (One way-ANOVA test) between the Mean Transverse Strength (MPa) of Samples Repaired by Heat Cure and the Samples Repaired by Cold Cure and Glass Fiber

| (I) Group Name | (J) Group Name | Mean Difference (I - J) | Std. Error | P-value |
|---|---|---|---|---|
| Control Group | Group I | 40.39867* | 4.49 | 0.0000 |
| | Group II | 22.69817* | 4.49 | 0.0000 |
| | Group III | 31.16817* | 4.49 | 0.0000 |
| Group I | Control Group | -40.39867* | 4.49 | 0.0000 |
| | Group II | -17.70050* | 5.50 | 0.0017 |
| | Group III | -9.23050 | 5.50 | 0.0962 |
| Group II | Control Group | -22.69817* | 4.49 | 0.0000 |
| | Group I | 17.70050* | 5.50 | 0.0017 |
| | Group III | 8.47000 | 5.50 | 0.1266 |
| Group III | Control Group | -31.16817* | 4.49 | 0.0000 |
| | Group I | 9.23050 | 5.50 | 0.0962 |
| | Group II | -8.47000 | 5.50 | 0.1266 |

*. The mean difference is significant at the 0.05 level.

- Control Group (heat cure): shows the highest value (103.33±24.31) and control group was find statistically significant ($p<0.01$) when compared with other groups.
- Group 1 (samples repaired with autopolymerising resins): has got the lowest value ( 62.93±2.21) it was found statistically significant ($p<0.01$) with group 2 and control group
- Group 2 (samples repaired with glass fibers and autopolymerizing resins) has got the value of (80.63±2.18) was found statistically significant with group 1 and control group.
- Group 3 (samples repaired with heat cure) has got the value of (72.16±2.18) was found statistically significant with control group only.



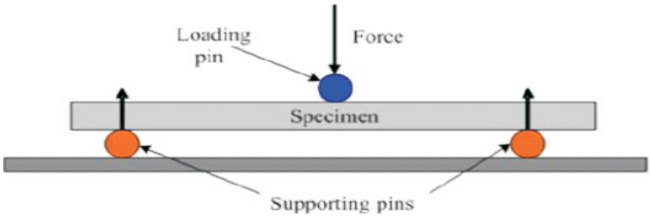

Graph 1: Shows the Mean Test Value of All The 3 Groups Including the Control Group

## Discussion:

Transverse strength is a collective measurement of tensile, compressive and shear strengths simultaneously. This transverse strength represents the type of loading born by a denture in the mouth. The higher the value of transverse strength of denture base acrylic, superior the clinical performance.12

3-Point

Flexure Test




In the present study, the method that recommended by ADA specification No. 12 to test the transverse strength. The transverse strength was determined using INSTRON Universal testing machine, specimen were fractured at rate of 1 mm /min form the middle.

Repair of complete dentures ranges from simple to complex procedures. They may involve the replacement of a single

tooth or of several teeth and/or the uniting of two or more pieces of a fractured denture base (Sharry J.J. 1974)2. The choice of repair material depends upon the following factors (Rached R.N. 2004)7.

1) Length of time required for making the repair.
2) Strength obtained with the repair material.
3) Degree which dimensional accuracy is maintained during the repair.

With due consideration to above mentioned facts, This study was conducted to evaluate and compare the transverse strength of acrylic resin test specimen which were repaired by autopolymerising resin, heat cure resin and autopolymerising resin & glass fibers with joint surface contour 45 degree bevel.9 DPI heat cure unrepaired resin was used as control group.

The 45-degree angulation given to the joint surface is preferred clinically. The geometry of 45-degree bevel increases the interfacial bond area and shifts the interfacial stress pattern more towards a shear stress and away from the more damaging tensile stress during repair (Ward et al.1992)8. Since it is easier clinically to prepare and finish a beveled joint than other types of joints, these most commonly used repair surface designs were used in this study.

The present study showed highest transverse strength value for Group 2 (cold cure with glass fibers having 450 bevel joint ) followed by Group 3 (Heat cure having 450 bevel joint) and least value was observed for the Group 1 (Cold cure having 450 bevel joint). (Table 1). The reason for getting the lowest value repaired by cold cure acrylic resin is that chemically cured material do not exhibit the same degree of polymerization as heat cured; hence, they cause a higher level of excess monomer to be present in the finished samples, which is primarily the reason for their poor mechanical and physical properties i.e. low transverse strength. The mean transverse strength (Table I) for control Group (Heat Cure unrepaired samples used as control for transverse strength) was found to be highest 103.33 MPa.

Transverse strength of Group 1 (cold cure having 450 bevel joint design) 62.93 MPa showed 60.90 %of the control group. The transverse strength of Group 2 (cold cure with glass fibers having 450 bevel joint design) was found to be 80.26 MPa, 77.67% which is of the control.Group 3 (heat cure having 450 bevel design ) was found to be 72.16 MPa, 69.83 % of control group.

The mean transverse strength in all the tested groups was significantly lower after repair. This is in accordance with the finding of Stipho (1998)10 who conducted a study to repair the acrylic resin dentures base with glass fibers. There was 25% increase in transverse strength after reinforcement with glass fibers in comparison to the non-reinforced samples while only Group 3 (Heat cure having 450 bevel design) showed higher transverse strength than Group 1 possibly due to repaired with heat cure denture base material.

## Conclusion:

Within the limits of the present study and on the basis of results obtained, it may be concluded that:-

1. Self cure resin produced the lowest strength after repair.
2. Fractured specimen repaired by heat cure method showed 30-40% higher values of transverse strength as compared to cold cure Groups.
3. Test specimens of all the Groups repaired by various materials and methods except control Group showed statistically significant variations in the transverse strength values.
4. Irrespective of the method of repair, the transverse strength of the test specimens decreased after repair.
5. The transverse strength values after repair were highest with autopolymerising resin with glass fibers having 450 bevel joint. e the dentures are necessary to reduce the chances of denture fracture. Furthermore, clinician should play a leading role in selection of appropriate material and prosthetic design for each patient.

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