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# COMPARATIVE EVALUATION OF FLEXURAL STRENGTH OF COMMERCIALLY AVAILABLE TEMPORARY RESIN MATERIALS : AN IN-VITRO STUDY

Dental Science

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## ABSTRACT

**PURPOSE:** The purpose of this study was to evaluate and compare the flexural strength of commercially available temporary resin materials.

**MATERIAL AND METHODS:** 180 specimens of 2×2×25mm dimensions (According to ADA specification number 27) were made from 6 different temporary materials. 30 specimens from each group were prepared which included heat cure PMMA resin(group 1),self cure PMMA resin (group 2),CAD-CAM PMMA resin (group 3),bis-acryl resin (group 4),self cure PMMA resin reinforced with silanated glass fibers, bis-acryl resin reinforced with silanated glass fibers. All the specimens were stored in distilled water for a period of 7 days. A standard 3 point bending test was conducted on the specimens using universal testing machine. The Mean flexural strength of each group was calculated. Data was analysed statistically using unpaired "t" test ($p<.05$) ,Karl Pearson correlation coefficient among different groups and ANOVA-F test.

**RESULTS :** The CAD-CAM PMMA resin showed highest mean flexural strength while self cure PMMA resin showed lowest . The mean value for flexural strength in descending order are : CAD-CAM PMMA resin (group 3)=135.020, Bis-acryl resin reinforced with silanated glass fibers(group 6) =128.020 , Bis-acryl resin (group 4) =123.796 , self cure PMMA resin reinforced with glass fibers (group 5)= 99.243 , Heat cure PMMA resin (group 1) = 98.073 and self cure PMMA (group 2) =82.126 Mega Pascals respectively. There was no significant difference between group 1 & 5 , group 3 & 6 and group 4 & 6 .

**CONCLUSION:** CAD-CAM PMMA resin showed highest and self cure PMMA resin showed lowest flexural strength in six group

## KEYWORDS

## INTRODUCTION

Interim or temporary prosthesis given in fixed Prosthodontics serve the functional as well as esthetic purpose for the patient. The word "interim" means established for the time being. The clinicians get ample of time to prepare definitive prosthesis and patients are no more anxious of their missing teeth or sensitivity of prepared teeth[1].

Fixed Prosthodontic treatment , complete or partial coverage , natural tooth or dental implant abutments ,are indirectly fabricated in dental labs which may take days to weeks for its fabrication. Therefore ,temporary prosthesis serve the purpose of function and esthetics before definitive prosthesis is given to patient.

Temporaries significantly help in preserving the biological , mechanical and esthetic purpose for the patient. It protects the vital pulp from thermal or chemical insults after tooth preparation. Well contoured and polished temporaries maintains the gingival health and oral hygiene of patient[2].

Success of temporary restrorations is dependent on certain parameters like design and Fabrication of prosthesis but the strength of material is one of the significant factor which decides success of interim prosthesis. To withstand various occlusal forces while in function like chewing, swallowing or during speech are quite challenging .CAD/CAM technologies can fabricate temporary restoration which may solve this problem to certain extent using PMMA blocks cured under optimal condition. Bis-acryl composite resin also provide good strength, flexibility, and abrasion resistance, and are also commonly used in provisionalisation[3] .

## METHODOLOGY

The current study was conducted in the Department of Prosthodontics and Crown & Bridge, Subharti Dental College & Hospital, Meerut.
The aim of this study was to compare the Flexural strength of different provisional materials for fixed partial dentures.

## PREPARATION OF STANDARDIZED STEEL MOLD:

To achieve an accurate and uniform dimension of all the specimens, a standardized steel mold was prepared according to American Dental Association specification number 27 with dimensions of 2mm× 2mm×25mm (Figure 1)

## SELECTION OF SPECIMEN

The test specimens were fabricated using steel mold and were divided into 6 groups according to the materials used (Figure 2)

Group 1: Heat Cure Acrylic Resin specimens (DPI Tooth moulding powder for Crowns and Bridges.

Group 2: Self Cure Acrylic Resin specimens (DPI self cure tooth moulding powder for Crowns and Bridges)

Group 3: Milled PMMA using CAD-CAM specimens (Coritec ,Made in Germany)

Group 4: Bis-acryl Resin specimens ( ProTemp 4 3M ESPE.)

Group 5: Self Cure specimens (DPI self cure tooth moulding powder for Crowns and Bridges) reinforced with silanated Glass fiber specimens (Silano 5ml Angelus)(Figures 3)

Group 6: Bis-acryl resin ( ProTemp 4 3M ESPE.) reinforced with silanated glass fiber specimens

## PREPARATION OF SPECIMENS

**Group I:** Consisted of Heat cure Polymethyl methacrylate specimens. The wax patterns were prepared in the standardized mold and were then invested in die stone. Dewaxing was done and a precise Gypsum mold was obtained . Specimens were prepared using polymer and monomer in the ratio of 3:1 by volume and were packed in the mold and bench cured for 30 minutes. Specimens were acrylised using short curing cycle . Bench cooling was done and the specimens were retrieved .

**Group 2:** Consisted of Self cure Polymethyl Methacrylate resin specimens which were prepared using polymer monomer in the ratio of 1.5:1 by volume . Resin was packed into the steel mold avoiding air bubble entrapment . Specimens were retrieved after curing and stored.

**Group 3:** Consisted of CAD-CAM Polymethyl Methacrylate resins specimens which were designed using CAD software and PMMA blocks were then milled in computer aided milling unit.

**Group 4:** Consisted of Bis-acryl resin specimen and were made by dispensing the material directly into the steel mold using auto syringe and mixing tip. Material was packed and the specimens were retrieved after setting of the material .

**Group 5:** Consisted of Self cure PMMA specimen reinforced with glass fibers (5% by weight ) . Each sample had 0.01gm glass fibers. Fibers were treated with a silane coupling agent for 5 minutes and then air dried. The material was then packed into the steel mold along with the premeasured glass fibers . After curing was complete specimens were retrieved from the mold .

**Group 6:** Bis-acryl resin specimen reinforced with glass fibers (5% by weight). All fibers were treated with coupling agent and air dried and were incorporated into the resin material same way as was done for Group 5

## SPECIMEN STORAGE AND TESTING

All the specimens were stored in distilled water for a period of 7 days at room temperature (Figure 4 ) and then tested on universal testing machine (UTM) for flexural strength (Figure 5).

## RESULTS

The data obtained for all the 180 specimens have been attached and represented in tables.

**Table 1**: Depicts Mean ,Standard deviation of flexural strength in Mega Pascals for Group 1-Group 6. Comparing all the six groups , it was observed that Group 3 shows higher flexural strength compared to other groups and Group 2 showed the lowest strength.

**Table 2** Depicts flexural strength (in MPa) between different pair of groups (unpaired “t” test) at .05 level of significance. All the groups showed significant p value <.05 except for Group 1& 5,Group 3 &6,Group 4&6 where p>.05).

**Table 3** Depicts comparison for flexural strength (in MPa) among different groups simultaneously at a time . This table represents the one way ANOVA –F test for comparing the significant difference in flexural strength (in MPa) among all six groups simultaneously at a time , which showed that flexural strength (in MPa) differ significantly among all groups at .05 level of significance (p<.05) .

**Table 4** Depicts Karl Pearsons correlation coefficient's among different groups for flexural strength (in MPa) which measures the linear relationship for flexural strength (in MPa) between different pair of groups.

## DISCUSSION

The present study was undertaken to evaluate the flexural strength of Heat cure PMMA resin (DPI Tooth moulding powder for Crowns and Bridges.), Self cure PMMA resin (DPI self cure tooth moulding powder for Crowns and Bridges) , Bis-acryl resin ( ProTemp 4 3M ESPE.) Milled PMMA resin (Coritec ,Made in Germany), and Self cure PMMA resin reinforced with glass fibers and Bis-acryl resin reinforced with glass fibers. For the purpose of this study 180 specimens were prepared with 30 specimen for each group . All these specimens were 25 mm in length , 2mm in height and 2mm in width . After finishing and polishing , specimens were stored in distilled water for the period of 7 days before testing to maintain uniformity among specimens.

The obtained data was interpreted and analysed statistically to evaluate the flexural strength of all six groups. All the values were expressed in the form of mean with standard deviation. Data obtained were subjected to statistical analysis for intergroup comparison using ANOVA-F test , Karl Pearson's Correlation and Unpaired “t” test.

Results showed Group 1 had mean flexural strength of 98.0733 MPa, Group 2 had 82.1267 MPa , Group 3 had 135.0200 MPa , Group 4 had 123.7967 MPa, Group 5 had 99.2433 MPa and Group 6 had 128.0200 MPa ( Table 1 ). .CAD-CAM milled PMMA resin showed highest flexural strength and self cure PMMA showed the lowest . Statistical analysis showed a significant difference between all Groups( p< .05) except Heat cure PMMA & Self cure PMMA reinforced with glass fibers , CAD-CAM milled PMMA & Bis acrylic resin reinforced with glass fibers and Bis -acrylic resin & Bis-acrylic resin reinforced with glass fibers specimens (p>.05) shown in Table 2 . There was no significant difference in flexural strength of CAD-CAM milled PMMA specimens and Bis-acryl resin reinforced with silanated glass fibers specimens, **Ishiqa dureja**[4] found no significant difference of flexural strength of bis acryl resin and CAD-CAM based interim resins. . Since CAD/CAM PMMA blocks are industrially polymerized under optimum manufacturing ,that offer the interim restorations' efficient mechanical properties compared to manually fabricated temporaries. Moreover, better marginal fit of milled temporaries reduces risk of bacterial infiltration and hence protects the pulp from chemical or thermal insults .

In another study conducted by **Shruti et al**[5]**,** she summarized that milled PMMA had highest flexural strength whereas Rapid Prototyping based 3D printed and light cured micro hybrid filled composite had the highest microhardness. **Karaokutan.I et al**[6] stated that the CAD/CAM technique offers more advantages over direct technique.

Self cure PMMA with glass fibers showed significant improvement in flexural strength over non reinforced Self cure PMMA.A study of **K.singh et al**[7] stated that reinforcement of PMMA has advantages over non reinforced. 2% and 5% reinforcement of Glass Fibers improved flexural strength of the PMMA . 5% glass fibers showed statistically highly significant improvement.

Bis acryl resin specimen with or without glass fibers showed significant values of flexural strength over conventional PMMA (both Self cure and Heat cure PMMA. **Lang et al**[8] studied PMMA and composite temporary materials where he simulated the oral environment and found that composite based group with higher fracture strength..

However , reinforcement in Bis-acryl resin specimens showed marginal improvement in its flexural strength over non reinforced Bis-acryl resin specimens which was statistically non significant (p> .05) but overall it showed significantly higher flexural strength than Heat cure PMMA , Self cure PMMA with and without glass fibers. According to **Farahnaz et al**[9] it is so because methacrylate resins and Bis-acryl resin contain different monomer composition. The Bis-acryl resins contain multifunctional monomers (such as Bis-GMA or TEGDMA). It enhances the strength because it forms cross linking with other monomers. Additional inorganic fillers further improve strength and microhardness. Conventional methacrylate resins are mono functional, low molecular- weight, linear molecules which results in reduction in strength and rigidity. Besides ,it is important to polymerize conventional PMMA under pressure to avoid air bubble entrapment which could further reduce its fracture strength.

In contrary **Ankita et al**[10] concluded that there is a decrease in flexural strength of conventional PMMA resin and Bis-acryl resin, although flexural strength of Poly Methyl Methacrylate and Bis-Acrylic Resins was similar at 24 hours and 8 days time interval.

While comparing PMMA resin, the remaining monomer content and voids are lesser in Group1 (Heat cure PMMA resin) than in Group 2 (Self Cure PMMA resin) due to difference in polymerization techniques. Therefore Heat cure PMMA resin showed higher flexural strength over self cure PMMA resin.

## THERE ARE CERTAIN LIMITATIONS OF THE PRESENT STUDY:

1. The placement of glass fibers was manual , therefore the position of glass fibers may not be the constant for all specimens.
2. Being an in vitro study , true simulation to oral condition was not possible i.e composition and ph of saliva and temperature changes in oral cavity.

## CONCLUSION

Within the limitation of this study , it was concluded that:

1. CAD-CAM milled PMMA resin showed the highest mean flexural strength compared to Bis acryl resin and conventional resins (Heat cure PMMA & Self cure PMMA resins). Although it was non significant (p>.05) when compared with Bis acryl resin reinforced with silanated glass fibers.
2. Bis-acryl resin reinforced with silanated glass fibers improved the

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flexural strength but it was statistically non significant (p>.05) compared to non reinforced Bis acryl resins.

3. Silanated Glass fibers increased the flexural strength of Self cure acrylic resins significantly (p<.05) while comparing it with non reinforced self cure PMMA resin.
4. Heat cure PMMA resin showed higher flexural strength than Self cure PMMA resin (p<.05) , but it was non significant while compared with Self cure PMMA resin with silanated glass fibers (p>.05).
5. Bis-Acryl resin showed higher flexural strength than Heat cure PMMA resin and self cure PMMA resin with or without glass fibers which was statistically significant (p<.05).

**Table 1--Mean ,Standard deviation(SD)., Median, Maximum & Minimum scores of Flexural Strength (in Mpa) for six groups**

| S.NO. | HEAT CURE PMMA (GROUP 1) | SELF CURE PMMA (GROUP 2) | CAD CAM MILLED PMMA (GROUP 3) | BIS ACRYLIC RESIN (GROUP 4) | SELF CURE PMMA WITH GLASS FIBERS (GROUP 5) | BIS ACRYLIC WITH GLASS FIBER (GROUP 6) |
|---|---|---|---|---|---|---|
| MEAN | 98.0733 | 82.1267 | 135.0200 | 123.7967 | 99.2433 | 128.0200 |
| S.D. | 12.1636 | 11.8964 | 13.9758 | 9.7967 | 15.8512 | 19.6274 |
| MEDIAN | 99.15 | 80.25 | 138.5 | 120.4 | 99.4 | 130.65 |
| MAXIMUM | 135 | 106.9 | 157.5 | 146.6 | 146.6 | 155.9 |
| MINIMUM | 59.1 | 56.3 | 101.3 | 112.5 | 75.9 | 87.2 |

**Table 2—Comparsion for Flexural strength (in Mpa) between different pair of groups ( by unpaired"t" test)**

| S.NO. | PAIR OF GROUPS | P- VALUE (BY UNPAIRED"t" TEST/INDEPENDENT "t" TEST | SIGNIFICANCE |
|---|---|---|---|
| 1 | GROUP 1 & GROUP 5 | .7498 (P>.05) | NOT SIGNIFICANT |
| 2 | GROUP 3 & GROUP 6 | .1176 (P>.05) | NOT SIGNIFICANT |
| 3 | GROUP 4 & GROUP 6 | .2976 (P>.05) | NOT SIGNIFICANT |

**Table 3—Comparsion for flexural strength (in mpa) among different groups simultenously at a time**

| SOURCE OF VARIATION | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| BETWEEN GROUPS | 65081.091 | 5 | 13016.22 | 64.1579 | 1.07E-37 | 2.266062 |
| WITHIN GROUPS | 35300.777 | 174 | 202.88 | | P<.05 (SIG.) | |
| Total | 100381.868 | 179 | | | | |

where, S.S= sum of square of all observations , d.f.= degres of freedom of parameters, MS= mean sum of squares of observations, F-ratio=MS. (between groups)/MS. (within groups)

**Table 4---Karl Pearsons correlation Coefficient's among different groups for flexural strength (in Mpa)**

| | HEAT CURE PMMA | SELF CURE PMMA | CAD CAM MILLED PMMA | BIS ACRYLIC RESIN | SELF CURE PMMA WITH GLASS FIBERS | BIS ACRYLIC WITH GLASS FIBER |
|---|---|---|---|---|---|---|
| Heat cure pmma | 1 | | | | | |
| Self cure pmma | 0.252101 (+ VE) | 1 | | | | |
| CAD-CAM milled pmma | -0.01401 (-VE) | 0.083044 (+ VE) | 1 | | | |
| Bis acrylic resin | -0.27646 (-VE) | 0.085269 (+ VE) | -0.07226 (-VE) | 1 | | |
| Self cure pmma with glass fibers | 0.045006 (+ VE) | -0.33262 (-VE) | -0.33523 (-VE) | 0.471035 (+ VE) | 1 | |
| Bis-acrylic with glass fiber | 0.325219 (+ VE) | 0.306699 (+ VE) | -0.15226 (-VE) | -0.26629 (-VE) | -0.07157 (-VE) | 1 |

**Graph 1 :The line diagram of average flexural strength (in Mpa) in six groups**

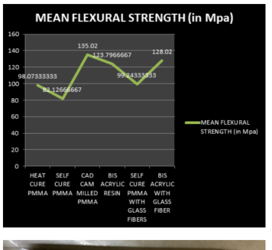


**Figure 1:customized steel mold**

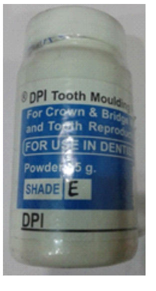

**Figure 2:Self cure PMMA,CAD-CAM PMMA,heat cure PMMA, Bis-acryl resin**

**Figure 3:glass fibers**

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**Figure 4: specimens stored in distilled water**


**Figure 5:specimen tested on UTM**

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