Original Article

Evaluation of flexural strength of two commonly used provisionalization materials: An in-vitro study

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Abstract

Background: One of the established treatment modality for treating patients with partially edentulous spaces is the fixed partial dentures. Because these restorations are made indirectly in a dental laboratory, several days or weeks are usually required for their completion. Therefore provisional restoration is an essential step in fixed prosthodontics. Hence; we planned the present study to assess the flexural strength of two commonly used provisional restoration materials.**Materials & methods:** The present study included assessment of flexural strength of heat cure resin and auto polymerization resin materials when used as provisional restorative materials. Heat polymerizing PMMA & self polymerizing PMMA are most commonly used materials available in powder & liquid form. The materials were mixed according to the manufactures instructions. They were packed into the mold and allowed to bench cure for 20 minutes under a constant pressure of 500 gm. Universal force testing machine was used for testing the forces of the standard specimens. All the results were recorded and analyzed by SPSS software. **Results:**Significant results were obtained while comparing the mean elastic modulus in between the specimens of the two study groups. Maximum amount of elastic modulus found in specimens of group of heat polymerized resin was found to be 852.22 mPa while in the group of Auto polymerizing resins, the maximum amount of elastic modulus was found to be 423.25 mPa respectively.**Conclusion:** Heat polymerized resin materials have higher Elastic modulus in comparison with the Auto polymerizing resins materials.

Key words: Heat polymerization resin, Provisionalization, Prosthodontics

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INTRODUCTION

Fixed partial dentures have become a well-established treatment modality for many partially edentulous patients. Because these restorations are made indirectly in a dental laboratory, several days or weeks are usually required for their completion. Therefore provisional restoration is an essential step in fixed prosthodontics.[1] The word provisional means 'established for the time being'. During the prosthetic rehabilitation procedures, provisional restorations are commonly used to provide both pulpal and periodontal protection until the final restorations are placed. Such temporary restorations should have good marginal integrity, esthetics and sufficient durability to withstand the forces of mastication.[2] Material strength is important when selecting resins for provisional restorations. For patients with treatment plan which requires long-term use of provisional restorations like full mouth rehabilitation, improved mechanical properties are required. Materials commonly used to fabricate provisional restorations are polymethyl methacrylate (PMMA) resin, polyethyl methacrylate resin, bis-acryl composite (BAC) resin, and epimine.[3-5] Hence; we planned the present study to assess the flexural strength of two commonly used provisional restoration materials.

MATEIRALS & METHODS

The present study included assessment of flexural strength of heat cure resin and auto polymerization resin materials when used as provisional restorative materials. Heat polymerizing PMMA & self polymerizing PMMA are most commonly used materials available in powder & liquid form. Standard specimens of each material were produced from a mold fabricated by flasking acrylic sheets with the dimensions of length-25mm, breadth-10mm, thickness-2mm, in versity flask using dental stone as an investment material. The materials were mixed according to the manufactures instructions. They were packed into the mold and allowed to bench cure for 20 minutes under a constant pressure of 500 gm. The heat activated PMMA specimens were polymerized at 90 degree C for 2 hours. The cold mould seal was used as the separating medium. In this way 10 specimens of each material were fabricated. A Vernier calliper was used as a standard measuring device to measure the dimensions of each specimen. Storing of the specimens was done at room temperature for one day and then to simulate the oral environment the specimens were incubated in normal saline at 37 degree C for 5 days in an environmental machine. Universal force testing machine was used for testing the forces of the standard specimens. All the results were recorded and analyzed by SPSS software. Chi- square test was the used for the assessment of level of significance. P-value of less than 0.05 was considered as significant.

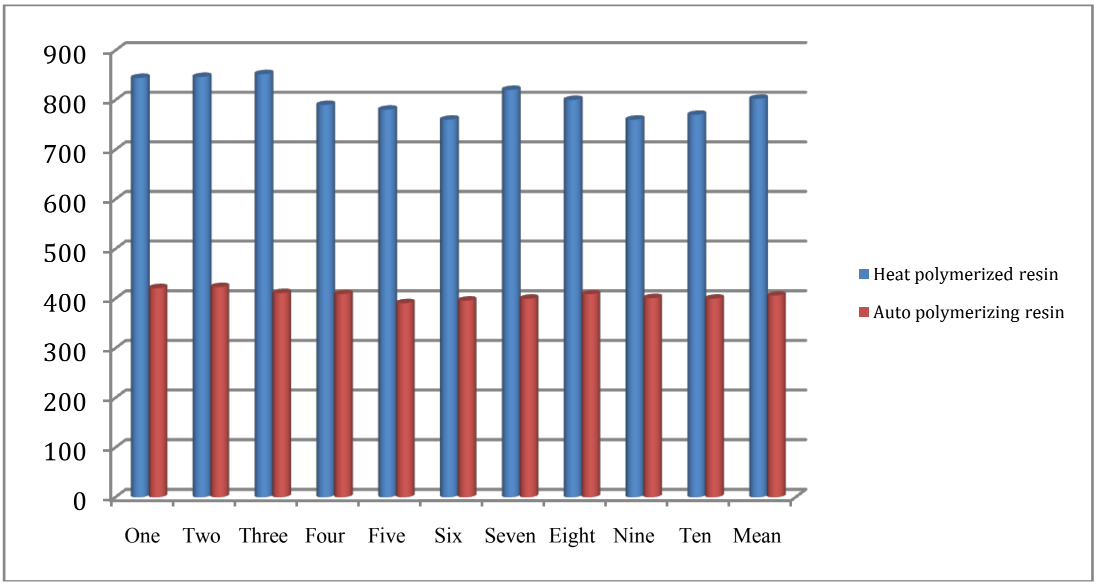
RESULTS

The mean elastic modulus was higher for the heat polymerized resin specimens and the results were found to be statistically significant (**Table 1, Graph 1**). Maximum amount of elastic modulus found in specimens of group of heat polymerized resin was found to be 852.22 mPa while in the group of Auto polymerizing resins, the maximum amount of elastic modulus was found to be 423.25 mPa respectively.

Table 1: Correlation of mean Elastic modulus (mPa) of all the specimens in both the study groups

Specimen number	Heat polymerized resin	Auto polymerizing resin	p-value
Mean Elastic modulus (mPa)	802.54	406.02	0.02*

*: Significant



Graph 1: Elastic modulus (mPa) of all the specimens in both the study groups

DISCUSSION

The use of fibers to reinforce a provisional restoration has an acceptable success rate mainly because of the advancements in fiber-reinforcing materials.[6] Reinforcement with fibers enhances the mechanical strength characteristics such as transverse strength, ultimate tensile strength, and impact strength.[7] Although laboratory flexural strength values under static loading may not reflect intraoral conditions; these values are nevertheless helpful as useful predictors of clinical performance.[8]Hence; we planned the present study to assess the flexural strength of two commonly used provisional restoration materials.

In the present study, we observed that the mean elastic modulus was significantly higher for the heat polymerized resin materials (**p-value < 0.05**) (**Table 1**). Kamble et al compare the flexural strength of polymethyl methacrylate (PMMA) and bis-acryl composite resin reinforced with polyethylene and glass fibers.Three groups of rectangular test specimens (n = 15) of each of the two resin/fiber reinforcement were prepared for flexural strength test and unreinforced group served as the control. Specimens were loaded in a universal testing machine until fracture. The mean flexural strengths (MPa) was compared by one way ANOVA test, followed by Scheffe analysis, using a significance level of 0.05. Flexural strength between fiber-reinforced resin groups were compared by independent samples t-test.For control groups, the flexural strength for PMMA (215.53 MPa) was significantly lower than for bis-acryl composite resin (240.09 MPa). Glass fiber reinforcement produced significantly higher flexural strength for both PMMA (267.01 MPa) and bis-acryl composite resin (305.65 MPa), but the polyethylene fibers showed no significant difference (PMMA resin-218.55 MPa and bis-acryl composite resin-241.66 MPa). Among the reinforced groups, silane impregnated glass fibers showed highest flexural strength for bis-acryl composite resin (305.65 MPa).Of two fiber reinforcement methods evaluated, glass fiber reinforcement for the PMMA resin and bis-acryl composite resin materials produced highest flexural strength.On the basis of this in-vitro study, the use of glass and polyethylene fibers may be an effective way to reinforce provisional restorative resins. When esthetics and space are of concern, glass fiber seems to be the most appropriate method for reinforcing provisional restorative resins.[9]

Natarajan et al evaluated and compare the flexural strength of different provisional restorative materials reinforced with glass and polyethylene fibers. A total of 90 samples were prepared and divided into three groups based on the type of fiber reinforcement, unidirectional S-glass (Splint-It) and ultra-molecular weight polyethylene (Ribbond). Unreinforced samples served as control group. Again each group was subdivided into three subgroups based on type of provisional restorative resins, heats cure polymethyl methacrylate, self-cure poly methyl methacrylate and self-cure bis-acryl composite. Samples were loaded in a universal testing machine until fracture occurs. The mean flexural strengths (MPa) were subjected to the one-way ANOVA, followed by the Tukey-HSD test at a significance level of 0.001. The result shows all the fiber reinforced samples possessed greater strength than the control samples. In control samples, the heat cure poly methyl methacrylate resin (72.74 ± 2.28 MPa) had the greatest flexural strength, followed by self-cure bis-acryl composite (67.05 ± 2.35 MPa) and self-cure poly methyl methacrylate resin (52.88 ± 1.90 MPa). In both heat and self-cure poly methyl methacrylate resin, the polyethylene fiber reinforcement (96.00 ± 2.63 MPa, 86.17 ± 1.92 MPa) provides the greatest strength than glass fiber reinforcement (92.68 ± 1.58 MPa, 76.40 ± 2.11 MPa). In self-cure bis-acryl composite, the glass fiber (105.95 ± 3.07 MPa) shows better reinforcement than polyethylene fiber (99.41 ± 1.74 MPa).The fibers reinforcement increases the flexural strength of provisional restorative resins.[10]Hamza et al determined the fracture toughness and flexural strength of different types of provisional restoration resins reinforced with different commercially available fibers.A total of 105 specimens were prepared in this study for each test; compact tensile specimens for the fracture toughness test and rectangular specimens for the flexural strength test. The specimens were divided into 3 groups according to the type of resin used, Jet, Trim, or Temphase (n=35), and then each group was divided into 7 subgroups (n=5) according to the type of fiber reinforcement, Construct, Fibrestick, Ribbond normal, Ribbond THM, Ribbond triaxial, or Fibrenet. Unreinforced specimens served as the control. Specimens were loaded in a universal testing machine until fracture. The mean fracture toughness (MPa.m(1/2)) and mean flexural strength (MPa) were compared by 1-way analysis of variance, followed by the Tukey standardized range test (alpha=.05).Fibrestick and Construct reinforcements showed a significant increase (P<.0001) in mean fracture toughness over unreinforced controls for all resins tested. Fibrestick increased the polymethyl methacrylate from 1.25+/-0.06 MPa.m(1/2) to 2.74+/-0.12 MPa.m(1/2); polyethyl methacrylate from 0.67+/-0.07 MPa.m(1/2) to 1.64+/-0.13 MPa.m(1/2); and bis-acryl from 0.87+/-0.05 MPa.m(1/2) to 1.39+/-0.11 MPa.m(1/2). Construct increased polymethyl methacrylate to 2.59+/-0.28 MPa.m(1/2); polyethyl methacrylate to 1.53+/-0.22 MPa.m(1/2); and bis-acryl to 1.30+/-0.13 MPa.m(1/2); however, there was no significant difference between Fibrestick and Construct reinforcements in the degree of reinforcement. Similarly the mean flexural strength values were significantly increased by different combinations of fiber and resin (P<.0001).The addition of fibers to provisional resin increased both fracture toughness and flexural strength.[11]

Fahmy et al assessed the efficiency of reinforcing provisional restorations by adding a fine gauze metallic mesh or polyethylene fibers between the abutments spanning the pontic length.Forty-five resin fixed partial dentures (FPDs) were constructed using three provisional resins. The three resin groups were further divided into three subgroups depending on their reinforcement. Specimens were loaded compressively, and the load required to fracture the specimens was recorded in Newtons. Data were presented as means and standard deviation values. A regression model with two-way ANOVA was used in testing significance. Duncan's post hoc test was used for pairwise comparison (p < or = 0.05).Duralay resin and Duralay fiber-reinforced restorations showed the highest fracture-resistance values, followed by Protemp and Snap, which showed statistically similar values. Regarding the mesh-reinforced groups, Duralay had the highest modulus followed by Protemp and Snap. Reinforcements altered the modulus values of Duralay resin only. Mesh-reinforced Duralay resin showed the highest mean modulus, but no statistically significant difference was apparent between fiber-reinforced and control groups. As for Protemp and Snap resin subgroups, their moduli remained unchanged by reinforcements.Initially, Duralay resin had higher fracture resistance values than Protemp II and Snap. Fiber and mesh reinforcements increased the fracture resistance of Snap. No statistically significant difference was evident among the fracture resistances of the three mesh-reinforced resin FPD restorations.[12]

CONCLUSION

From the above results, the authors concluded that heat polymerized resin materials have higher Elastic modulus in comparison with the Auto polymerizing resins materials. However, future studies are required.

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