Original Article

An *in-vitro* evaluation of flexural strength of direct and indirect provisionalization materials

S. Dagar, A. Pakhan, A.Tunkiwala
Departments of Prosthodontics Sharad Pawar dental college and hospital, Sawangi (Meghe), Wardha

For correspondence
Departments of Prosthodontics Sharad Pawar dental college and hospital, Sawangi (Meghe), Wardha, E–mail: sanjivdagar_55@yahoo.co.in

With the advent of newer provisional crown and bridge material it has become imperative to evaluate their strength and know the tissue response of these materials in order to select the appropriate one. This study takes a comparative view of two commonly used acrylic resin materials i.e. self polymerizing poly - methyl methacrylate (PMMA) and heat polymerizing poly - methyl methacrylate with a newly introduced composite resin Protemp-II, claiming better handling, strength and esthetics. To simulate the oral condition, the fracture resistance of selected materials was tested by three point bent test on Instron testing machine. The highest values for fracture resistance were displayed by heat polymerized PMMA followed by Protemp-II and self polymerized PMMA.

Key words: fixture, rollers, stress applicator pin.

INTRODUCTION

The word provisional means established for the time being, pending a permanent one. A provisional restoration must fulfill several functions. It should be functional and durable till the permanent restoration is cemented. To serve these functions a provisional restorative material must be strong enough to resist masticatory forces, especially in long-span restorations or areas of heavy occlusal stress.[1]

The provisional may be used as short term or long term restorations and in such cases the established clinical condition of tooth preparation, position and tissue need to be maintained. An ideal material should be easy to handle, high in strength and have good tissue compatibility.

Provisional restorative materials should have following requisites:[2]

- 1] Good marginal adaptation. 2] Provide occlusal compatibility & maintain tooth position. 3] Colour compatibility and stability. 4] Good strength and high elastic modulus. 5] Sufficient working and setting time.
- 6] Easy to trim and contour.

In the clinical situation, a fixed partial denture is subjected to a variety of forces when under load. These forces have been shown by three point bent test which analyze the stresses as, compressive at the point of application of load, and tensile & shear at the points of resistance to that load.[3]

Although all properties have equal importance, we have selected flexural strength and elastic modulus for our study purpose.

So this study aim's to evaluate the flexural strength of three provisionalisation materials under conditions that simulates the stresses act on them to those acting on a fixed partial denture.

The objective of this present study was to determine which material have better strength and clinical application of the results.

MATERIALS AND METHODS

The three materials used for the study are listed in [Table 1].

Heat polymerizing PMMA & self polymerizing PMMA are most commonly used materials available in powder & liquid form. Whereas Protemp-II is a Bis-acryl composite, available in three component systems Bis-GMA! Bisphenol -A – glycidil methacrylate. Standard specimens of each material were produced from a mold

Table 1: Materials used in the study

Serial No.	Trade name	Resin type	Manufacturer
1	Heat cure resin	Poly Methyl Methacrylate	DPI
2	Protemp-II	Composite resin	3-M
3	Auto polymerizing resin	PMMA	DPI

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 [Figure 1]. 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.[4] The heat activated PMMA specimens were polymerized at 90ú C for 2 hours. The cold mould seal was used as the separating medium. In this way 15 specimens of each material were fabricated. A Vernier caliper was used as a standard measuring device to measure the dimensions of each specimen [Figure 2].

The specimens were stored at room temperature for 24 hours and then to simulate the oral environment the specimens were incubated in normal saline at 37ú C for 5 days in an environmental machine [Figure 3]. The standard specimens were short in length according to the minimum requirement of Instron testing machine, so to overcome this problem a fixture was fabricated to conduct the three point bent test [Figure 4]. The dimensions of fixture were length 46mm, width 30mm, & thickness 30mm. On the top of the fixture two grooves were made at a distance of 5mm from the center on either side. A roller with diameter of 4.25mm was placed in each groove. A customized "T" shaped stress applicator pin with the dimension of length

Figure 3: Dental stone mold

Figure 1: Dental stone mold

Figure 4: Fixture used in the study

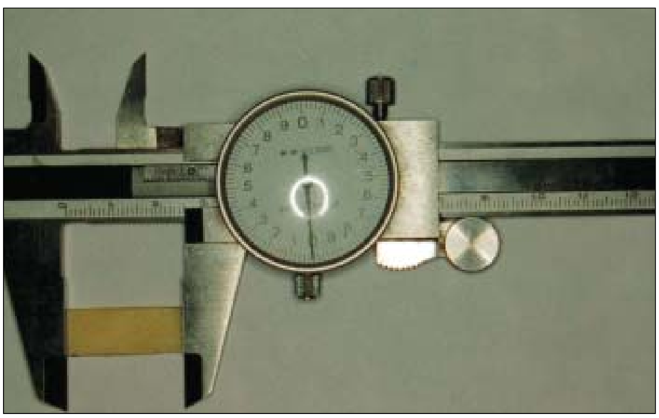

Figure 2: Vernier caliper

Figure 5: Specimen mounted on Instron testing machine

60mm & width 10mm was fabricated, by which stress can be applied in the center of specimen.

The specimen was placed on the rollers in such a way that the center of the specimen coincided with the center of the distance between the two rollers. This whole unit was then mounted on the lower jaw of the Instron testing machine. The stress applicator pin was fixed on the upper jaw of the Instron testing machine [Figure 5] & three point bent test was done for each specimen. The elastic modulus & force required to fracture each specimen were recorded.

[Table 2] shows the readings of elastic modulus in MPa & [Table 3] shows the readings of force required to fracture the specimen in kN with mean and standard deviation.

When load was applied on the specimen via "T" shaped pin [Figure 6].[4] C → Compressive stress acts on the upper surface of the specimen. T → Tensile stress acts on the under surface of the specimen.

S → Shear stress acts at the junction of the roller & specimen.

Table 2: Elastic modulus (MPa)

Specimen No.	Heat polymerized resin	Protemp-II	Auto polymerizing resin
1	847.739	320.136	402.718
2	854.359	302.108	420.383
3	883.503	320.136	370.674
4	781.005	395.262	515.069
5	714.519	285.421	356.668
6	823.902	401.231	419.133
7	699.955	311.413	431.923
8	808.019	417.683	369.704
9	827.879	408.552	416.935
10	839.795	321.014	409.526
11	759.821	398.413	407.342
12	701.279	401.139	412.869
13	690.687	312.007	411.918
14	844.387	398.875	409.715
15	835.471	319.053	413.159
Mean	800.821	354.194	411.212
SD	59.560	48.360	35.7009

Table 3: Force in kN required to fracture the specimen

Specimen No.	Heat polymerized resin	Protemp-II	Auto polymerizing resin
1	0.244	0.113	0.102
2	0.249	0.104	0.085
3	0.271	0.113	0.102
4	0.229	0.114	0.094
5	0.197	0.093	0.110
6	0.226	0.119	0.106
7	0.186	0.109	0.089
8	0.214	0.196	0.110
9	0.229	0.182	0.104
10	0.238	0.113	0.098
11	0.213	0.117	0.098
12	0.187	0.119	0.104
13	0.179	0.106	0.102
14	0.246	0.114	0.086
15	0.236	0.113	0.091
Mean	0.222	0.121	0.098
SD	0.024	0.028	0.008

RESULTS

According to the observations obtained during the study.

Highest force was required to fracture the heat polymerized PMMA specimens. Least force was required by autopolymerized PMMA specimens, while force required to fracture the Protemp-II specimens was more than autopolymerized PMMA specimens.

Elastic modulus of heat polymerized PMMA was highest followed by autopolymerized PMMA & Protemp-II.

DISCUSSION

The test used in this study was an attempt to stimulate the clinical situation where a combination of compressive, tensile & shear stresses acts [Figure 6]. Under the test conditions used, the heat polymerized PMMA demonstrated more than double the resistance to fracture as compared to the other two materials used in the study. Protemp –II produces no exothermic heat, had no residual monomer, easy to handle & produces less shrinkage. Thus it is ideally suited for direct technique.

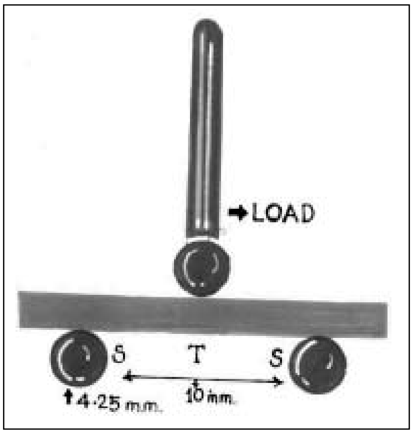

Figure 6: Diagrammatic representation of three point bent test

The flexural strength of a provisional resin is only one of a number of factors to be taken into account in selecting suitable materials for clinical use. This study has shown that under the test conditions used, the heat polymerized PMMA material would be expected to provide a greater flexural strength when used for provisional fixed partial dentures.

A method to test the flexural strength of three provisional resin materials that provided a simulation of the clinical condition of a fixed partial denture revealed the following-

In decreasing order the fracture resistance of the materials used was heat polymerized PMMA followed by Protemp-II & autopolymerized PMMA. So in posterior long span fixed partial denture & in full mouth rehabilitation cases, the material of choice is heat polymerizing PMMA. In anterior region either autopolymerizing PMMA or Protemp-II can be used. In certain surgical cases where an immediate provisional restoration is required Protemp-II is the material of choice.

This is based on *in-vitro* results & further *in-vivo* evaluation is required.

REFERENCES

1. Krug RS. Temporary crown and bridges. Dent Clin North Am 1975;19:313-20.
2. Rosenstiel SF, Land MF, Fujimoto J. Contemporary fixed Prosthodontics. 3^{ed}, The CV Mosby Co: St. Louis; 2001. p. 380.
3. Ebrashi MK, Craig RG, Peyton FA. Experimental stress analysis. Of dental restorations. Part VII. Structural design and stress analysis of fixed partial dentures. J Prosthet Dent 1970;23:177-86.
4. Osman YI, Owen CP. Flexural strength of provisional restorative materials. J Prosthet Dent 1993;70:94-6.