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Comparative Evaluation & Effect of Food Simulating Liquids on Flexural Strength and Hardness of Three Different Composition Based Crown and Bridge Provisional Restorative Materials: An In-Vitro Study

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ABSTRACT

Background: Provisional restorations play a critical role in the success of fixed prosthodontic treatment. They are fabricated for use during the time period between the tooth preparation and cementation of a definitive restoration.[40] Provisional restoration should provide function, comfort, and esthetic for the prepared tooth structure. They are also useful for diagnostic purposes where the functional, occlusal and esthetic parameters are developed to identify an optimal treatment outcome before the completion of definitive procedures. Many provisional restorative materials are available in the market which is having different composition. The physical properties of these materials depend on the type, amount and size of the filler particles as well as the properties of the polymer matrix. The selection of provisional restorations should be based on the merits and demerits of a given material relative to the clinical requirement for specific treatments.

Keywords: Esthetic, Flexural Strength.

INTRODUCTION

In certain situations like treatment planning of oral rehabilitation, correcting changes in the occlusal plane, re-establishing occlusal vertical dimension, providing harmonious gingival contour we require to give provisional temporization for extended period of time. So, the study was conducted to evaluate the effect of food simulating liquids on provisional restoration at the end of one, two and three weeks. A fixed partial denture is subjected to a variety of forces during function. Flexural strength is an important property for longevity of prosthesis. A flexural strength test is essentially a test of a bar supported at each end, subjected to three-point flexure. The flexural strength test used in this study was an attempt to simulate the stress distribution in clinical situations, such as multiple unit fixed partial dentures. Hardness can be defined as the resistance against scratch of a material and typically measured under an indentation load. Surface hardness is used as an indicator for density. More dense material will have more resistant to wear and surface deterioration. When a provisional restoration is fabricated with a material having good wear resistance, the risk of perforation is greatly decreased, so structural integrity can be maintained for a long period of time. Softening of material favour the condition like bacterial adhesion, dental biofilm formation, gingival inflammation and bone resorption. In this study, Knoop Hardness Number test was determined because it was more reliable

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for acrylic resin, require relatively thin specimens compared to other microhardness test and less sensitive.

This Present study was conducted to evaluate the effect of food simulating liquids (Distilled water, 0.02N citric acid, Heptane and 10 % ethanol in aqueous solution) on Flexural strength (FS) and Knoop hardness number (KHN) of three different composition based provisional restorative materials (Protemp IV, Cooltemp, DPI) at the end of one week, two weeks and three weeks. The food-simulating liquids used for conditioning the provisional restorative materials were chosen according to FDA guidelines. This in vitro study was carried out in the Department of Prosthodontics and Crown & bridge, Ahmedabad Dental College & Hospital, Gandhinagar.

Aims & Objectives:

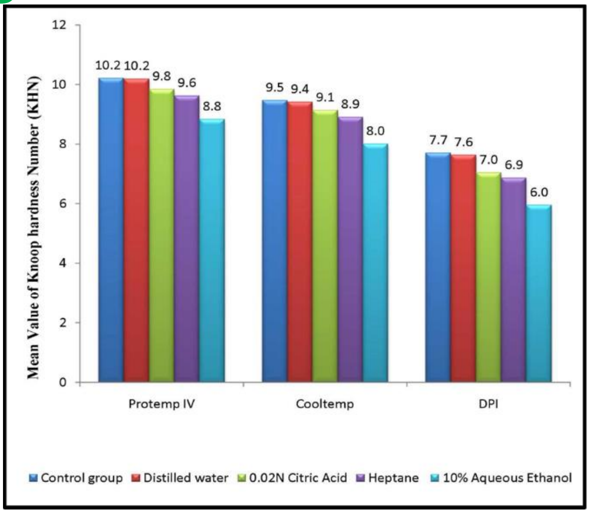
The aim of this study was to investigate Flexural strength (FS) and Knoop hardness number (KHN) of three different composition based provisional restorative materials (Protemp IV, Cooltemp and DPI tooth moulding powder) after immersion in food-simulating liquids (Distilled water, 0.02N Citric acid, Heptane and 10 % ethanol in aqueous solution) at the end of one week, two weeks and three weeks.

1. To evaluate Flexural strength (FS) at the end of one week, two weeks and three weeks after immersion in food simulating liquids of three different composition based provisional restorative materials.
2. To evaluate knoop hardness number (KHN) at the end of one week, two weeks and three weeks after immersion in food simulating liquids of three different compositions based provisional restorative materials.
3. To compare the Flexural strength (FS) after immersion in food simulating liquids of three different composition based provisional restorative materials at the end of one, two and three weeks.
4. To compare the knoop hardness number (KHN) after immersion in food simulating liquids of three different composition based provisional restorative materials at the end of one, two and three weeks.

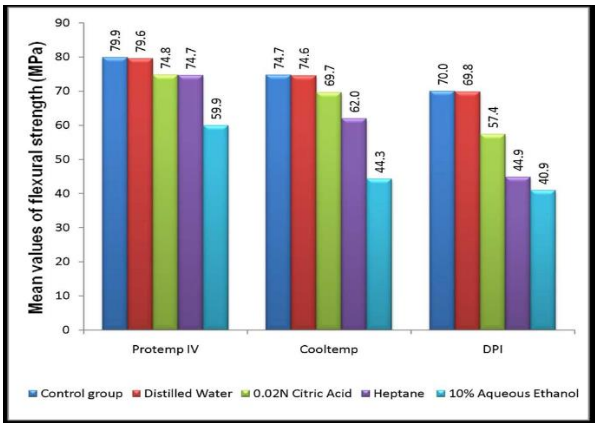
MATERIAL & METHOD

Table 1:The Composition of Provisional restorative materials used for study is detailed in the table given below:

PRODUCT NAME	manufacturer & type of resin	COMPOSITION	composition percentage (%)	LOT NO
Protemp IV	3M™ ESPE™ (Bis-GMA composites)	Catalvst paste		465324
		Ethanol,2,2'-[(1 -methylethylidene) bis (4,1-phenyleneoxy)] bis- diacetate	70 - 80%	
		Silane treated silica	5-15 %	
		Benzyl-phenyl-barbituric acid	5-15 %	
		Tert-butyl peroxy-3, 5,5-trimethylhexanoate	< 0.4 %	
		Base paste		
		Dimethacrylate	50-60%	
		Silane treated amorphous silica	20-30%	
		Polyurethane methacrylate	10-15%	
		Silane treated silica	5-10%	
Cooltemp	Coltene/Whaledent (Bisacryl composite)	Methacrylates		D53066
		Bariumglass silanized		
		Amorphous silica hydrophobed		
DPI	DPI (Self cure PMMA acrylic)	Powder		2344
		Poly (Methyl methacrylate)	< 99%	
		Benzyl peroxide	< 7%	
		Dibutyl Phthalate	< 22%	
		Liquid		
		Methyl Methacrylate	> 95%	
		N-dimethyl-p-toluidine		
		Hydroquinone	< 0.007%	



Graph 1: Mean value of Knoop Hardness Number of provisional restorative materials.



Graph 2: Mean value of Flexural Strength (Mpa) of provisional restorative materials.

The specimens were randomly divided into four test groups and one control group. Twenty five specimens were fabricated for each material for one cycle. The total number of specimens for one cycle was seventy five. A). The control specimens were stored at room temperature in air. B). The test groups were conditioned for one week, two weeks and three weeks in Distilled water, 0.02N citric acid, Heptane and 10% Ethanol aqueous solution at 37C in incubator (LTC, Ahmedabad).

At the end of the conditioning period, the specimens were washed under running water, air-dried. Specimen was used to determine the value of flexural strength at the end of first week, two weeks and three weeks. Each specimen was subjected to the three point bending test, at a cross head speed of 3 mm/min, at a 15 mm distance, with a universal testing apparatus (Instron 5500R) (Figure 14). The load was applied to the center of the specimen and continued till fracture occurred. Instron tester automatically displayed (with the help of ASTM C880 software) the Flexural strength value (Mpa) on the screen. The fractured specimens were used for the hardness test immediately after the flexural test was completed at the end of one week, two weeks and three weeks. The Knoop hardness number (KHN) was determined for each specimen using a digital micro-hardness tester (Shimadzu-HMV-2T) (Figure 15). Surface hardness was determined by loading each specimen for 15 sec with a force of 50 grams, after mounting it on the micro indenter. A diamond pyramid shaped indentation was used to obtained micro indentation on each specimen. Microhardness tester automatically displayed (with the help of Clemex CMT software version 41.032) digital Knoop hardness value (KHN) on the screen. Knoop Hardness Number was measured at three different locations on each specimen and the mean KHN was subsequently determined. For Statistical Analysis: Flexural strength and Knoop hardness number were calculated at the end of one week, two weeks and three weeks. Statistical analysis was carried out using one way analysis of variance (ANOVA), 3-way analysis of variance (ANOVA), and Tukey's post hoc test. Level of statistical significance was taken as P value < 0.05.

DISCUSSION

In this study, three different composition based commercially available products of provisional restorative materials are selected (Protemp IV, Cooltemp and DPI) to evaluate the highest and lowest effect of Food simulating liquids on each group of material. This can help in selection of material having different composition to fulfill the clinical requirement. In present study results of flexural strength in control group of Protemp IV and Cooltemp suggest that both the group having more strength compare to DPI material. Similar conclusion given by Haselton DR et al[45] and said that methyl methacrylate is not resistant to flexural stress because it consists of linear, mono-functional, low-molecular-weight molecules, whereas materials containing Bis-GMA comprise multi-directional, flexible chains that provide high flexural resistance. Specimens fabricated from Protemp IV material shows less effect of Distilled water on flexural strength, may be due to Bis-GMA type of resin do not absorb water from its surface. Flexural strength of DPI materials after immersion distilled water shows maximum effect .Similar results were found in study done by the Tolga Akova et al. Results of Knoop hardness values showed that distilled water (Simulating saliva) group had a less effect on Protemp IV (Bis-GMA) and Cooltemp (bis-acryl) compared to DPI (PMMA) materials. Similar conclusion given by Ana M. Diaz-Arnold et al[41] and Tolga Akova et al. In present study specimen immersed in 10 % Ethanol aqueous solution shows that as the immersion time increased, the Knoop hardness number (KHN) is decreases. Among them specimen from DPI material was highly affected followed by Cooltemp because, ethanol has a more softening effect on PMMA resin followed by bis-acryl and Bis-GMA. The Similar results were observed by Adrian U.J. Yap et al and concluded that all provisional materials are susceptible to the softening effect of aqueous ethanol solutions. The result of present study shows that 0.02N citric acid and Heptane has less effect on all materials compared to 10 % Ethanol aqueous solution. But both the chemicals have highest effect on DPI followed by Cooltemp and Protemp IV. Heptane and 0.02N citric solutions have a mild effect on Cooltemp materials and least on Protemp IV. The highest effect of it seen on DPI materials at the end of third cycle. Result of Three-way ANOVA for flexural strength (FS) and knoop hardness number (KHN) materials showed that there is significant effect of the immersion period on flexural strength (FS) and knoop hardness number (KHN). Therefore, the oral simulating fluid should not be exposed to Provisional restorative materials for a long period of time.

Results of conducted study shown that different composition based provisional restorative materials are influenced by food simulating liquids. As the weekly immersion cycles increases the Flexural strength (FS) and Knoop hardness number (KHN) both decreases. The graphical representation of the same is mentioned below for interpretation.

CONCLUSION

Within the limitations of the present study and on the basis of results, the following conclusion were made,

All three provisional restorative materials showed that as the immersion time period in food simulating liquids increases, the value of Flexural strength (FS) and Knoop hardness number (KHN) decreases. At the end of three weeks both flexural strength and hardness of DPI provisional restorative materials are drastically reduced.

Protemp IV (Bis-GMA) provisional restorative materials showed the highest Flexural strength (FS) and Knoop hardness number (KHN) followed by Cooltemp (Bis-acryl) and DPI (PMMA) provisional restorative materials after immersion in food simulating liquids.

The two food simulating liquids (10% ethanol aqueous solution and Heptane) had the highest effect on the DPI followed by Cooltemp and Protemp IV.

The Knoop hardness number (KHN) of DPI material was least as compared to Protemp IV and Cooltemp.

Within the parameters of the study it can be concluded that Protemp IV provisional restorative materials may be considered as the material of choice for extended period of treatment planning and less susceptible to degradation by food simulating liquids. It showed highest Flexural strength (FS) and Knoop hardness number (KHN) compared to Cooltemp and DPI after immersion in food simulating liquids at the end of three weeks. Cooltemp provisional restorative material can be used for shorter period of temporization while, DPI material shoes least resistance to degradation by food simulating liquids.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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