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### Comparative evaluation of flexural strength and elastic modulus of interim resin materials for fixed prosthodontics: An *in vitro* study

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#### Abstract

**Objective:** In the present study, three tooth colored, commercially available provisional restorative materials (Protemp 4, Cool Temp, Luxatemp Fluorescence) were chosen to test and compare the flexural strength and elastic modulus.

**Materials and methods:** 30 specimens (with a change in thickness of 0.5mm every 10) were fabricated for each material and stored in artificial saliva in separate plastic jars for 14 days. They were further tested for flexural strength by three-point bending test under a universal testing machine.

**Result:** The results obtained were statistically compared and it was found that the highest values of flexural strength and elastic modulus were exhibited by Protemp 4.

**Conclusion:** the present study concluded that Protemp 4 by 3M ESPE showed the highest flexural strength and elastic modulus; Cool Temp by Coltene showed the least flexural strength and Luxatemp Fluorescence showed the least elastic modulus amongst the three.

**Keywords:** elastic modulus, flexural strength, provisional restorative materials

#### 1. Introduction

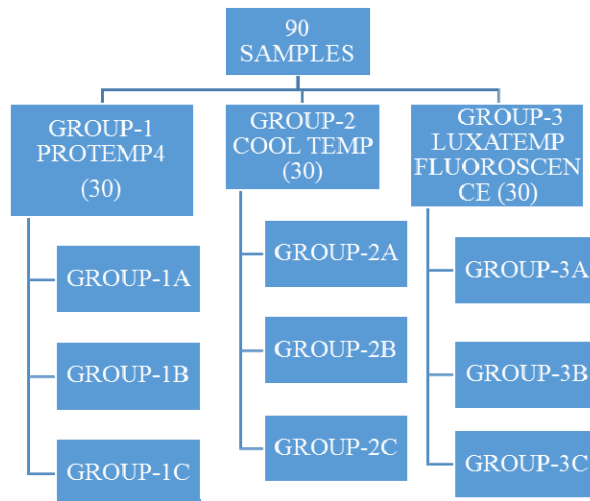
Interim prostheses are essential components of fixed prosthodontic treatment. These restorations should fulfill biological, mechanical and esthetic requirements to be considered successful. [1] The interim restorative materials should possess a number of ideal mechanical and physical properties, such as a high flexural strength, increased resistance to wear, high fracture strength, dimensional stability, minimal marginal gap formation and increased resistance to staining and discoloration. [2] One of the important aspects of provisional restorations is their flexural strength which plays a critical role in both functional as well as parafunctional conditions. Inadequate flexural strength may cause difficulty for both the patient and clinicians to keep the interim restorations intact. [3] The elastic modulus or modulus of elasticity is also an important factor in interim restorations as it describes the relative stiffness or rigidity of a material used for the fabrication of interim fixed prosthesis. Recent studies have evaluated flexural strength and elastic modulus of various materials, but very little emphasis has been laid on the impact of varying the thickness of restorations on the above two parameters. The purpose of the present *in-vitro* study is to assess the flexural strength and elastic modulus of three commonly used interim restorative materials using different thickness to cover a wider range of clinical applicability. The present *in-vitro* study was conducted in the Department of Prosthodontics, BRS Dental College & Hospital, Sultanpur, Panchkula.

#### 2. Materials and Methodology

A brass die was fabricated according to American National Standards Institute/ American Dental Association specification no. 27 (dimensions 25×2×2mm) [4], with change in thickness of 0.5mm (25×2×2mm, 25×2×2.5mm and 25×2×3mm) in order to simulate the oral conditions of a 3-unit bridge consisting of a pre-molar, 1<sup>st</sup> molar and a 2<sup>nd</sup> molar.

Materials required: Protemp 4 (3M ESPE), Cool Temp (Coltene), Luxatemp Fluorescence (DMG), Cold Mold Seal (DPI), paint brush, brass metal dies, dispensing gun, mixing tips,

pumice powder (neelkanth healthcare pvt. ltd.), sand paper (120 and 400 grit), Incubator (NSW India), artificial saliva (Wet Mouth-ICPA Health Products Ltd), specimen containers, Universal Testing Machine (series 7200, Dak System Inc.) Two coats of a separating media were applied on the metal dies and 90 Interim specimens (n=30 for each group) were fabricated using Prottemp 4, Luxatemp Fluorescence and Cool Temp.



**Flow Chart showing grouping of specimens (Group1- Prottemp, Group 2- Cool Temp, Group 3- Luxatemp Fluorescence)(2mm=A, 2.5mm=B and 3mm=C)**

The samples fabricated were then stored in artificial saliva, Wet Mouth (ICPA Health Products Ltd) at 37 °C for 14 days to simulate the oral environment. The specimens were placed on a universal testing machine for three-point bending test with a crosshead speed of 0.75 mm/min for evaluation of flexural strength and elastic modulus.<sup>[5]</sup>

**Statistical analysis and result evaluation:** The data collected from the evaluations was subjected to descriptive and inferential statistical analysis in the present study. The results were analysed by using SPSS version 18 (IBM Corporation, SPSS Inc., Chicago, IL, USA). Microsoft word and Excel were used to generate graphs, tables etc. Results on continuous measurements are presented as Mean & Standard deviation. Significance was assessed at 5% level of significance. Normality of the data was assessed using Shapiro-Wilk test. Test of significance like Kruskal-Wallis and Mann-Whitney U test is applied.

The results were found out to be Prottemp 4 by 3M ESPE showed the highest flexural strength and elastic modulus. Cool Temp by Coltene showed the least flexural strength and Luxatemp Fluorescence showed the least elastic modulus amongst the three.

### 3. Discussion

In the present study, three tooth colored, commercially available crown and bridge provisional restorative materials were chosen to test and compare the flexural strength and elastic modulus. Provisional restorations are essential elements of fixed prosthodontic treatment.<sup>[6]</sup> The parameters given due consideration in this study were flexural strength and elastic modulus as they are important from a clinical viewpoint. Flexural strength, also known as transverse strength or bending strength or modulus of rupture is a

measurement of the strength of a bar (supported at each end) under a static load. The flexural strength test is a combination of tensile and compressive strength tests and includes elements of proportional limit and elastic modulus measurements.<sup>[7]</sup> In a three point bending test, the maximum stress measured is called flexural strength. This test determines not only the strength of the material indicated but also the amount of distortion expected.<sup>[8]</sup> Elastic modulus is the relative stiffness or rigidity of a material.

In the present study, 30 specimens were fabricated for each material and stored in artificial saliva in separate plastic jars for 14 days. They were further tested for flexural strength and elastic modulus by three- point bending test under a universal testing machine. The results obtained were statistically compared and it was found that the highest value of flexural strength and elastic modulus were exhibited by Prottemp. Prottemp is a bis-acryl resin having a flexible cross-linked polymer structure which improves the strength and hardness of the material. Since it is hydrophobic, it ensures minimal water uptake and reduces the plasticizing action.<sup>[9]</sup> If the material is hydrophilic, it will not be suitable for use in the oral cavity. With many choices of materials available to use as interim restorations, it is important for clinicians to make their selection based upon the clinical needs for each situation. Direct comparison with the other studies is not possible because of difference in materials and methods. In the present study, it was observed that Prottemp 4 by 3M ESPE showed the highest flexural strength and elastic modulus on testing the specimens after fabrication and storage in artificial saliva for 14 days. Cool Temp by Coltene showed the least flexural strength and Luxatemp Fluorescence showed the least elastic modulus amongst the three. More studies to compare the flexural strength and elastic modulus of bis-acryl resin materials should be considered while choosing a compatible provisional restoration material.

There are some limitations in the present study. The present study was an in-vitro study, but provisional restorations are meant to function in the oral cavity. In clinical situations, immediate load is placed on the temporary restorations, whereas in this study load was applied after 14 days of storage in saliva. The number of samples can be increased in the future studies. The scope of the study is that further development in material science and properties of the materials can give better results. There are various complex compound forces (flexural, compressive and tensile) in the oral cavity, so to confirm the results of the present in-vitro study same materials can be compared in an in-vivo environment in the same region in order to simulate the actual oral environment.

### 4. Conclusion

In the present study, titled “Comparative evaluation of flexural strength and elastic modulus of interim resin materials for fixed prosthodontics: An *in-vitro* study” the following conclusion was drawn:

- Prottemp 4 by 3M ESPE showed the highest flexural strength and elastic modulus
- Cool Temp by Coltene showed the least flexural strength.
- While Luxatemp Fluorescence showed the least elastic modulus amongst the three.

### 5. References

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