



## **Comparative Evaluation of Temperature Rise inside Pulp Chamber Using Two Different Provisional Restorative Materials**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. Author SO conceived the basic idea of the work. Authors SZ and MN dealt with all the permissions and collected the data. Authors KM and MMR conducted the analysis with statistical support. Authors JS and MH constructed the results. Authors MH and MMR supervised throughout the project and in drafting of manuscript. All authors read and approved the final manuscript.*

### **Article Information**

DOI: 10.9734/JPRI/2022/v34i25A35953

### **Open Peer Review History:**

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/84107>

**Original Research Article**

**Received 01 January 2022**

**Accepted 06 March 2022**

**Published 19 March 2022**

### **ABSTRACT**

**Aim:** To compare the rise in temperature inside pulp chambers with two different provisional crown prosthesis materials.

**Study Design:** Comparative -in vitro.

**Place and Duration of Study:** Department of Prosthodontics, Liaquat Medical University Hospital from AUGUST 2019 TO DECEMBER 2019.

**Methodology:** The purpose of this study was to evaluate the mean rise in temperature during provisional restoration utilising Polymethyl methacrylate resin (PMMA) versus bis- glycidyl methacrylate resin (Bis-GMA) at in-vitro laboratory of Prosthodontic department, Liaquat University of Medical and Health, Jamshoro. A total number of 60 extracted maxillary central incisor teeth were selected using non probability consecutive sampling technique. Teeth were divided into two groups on the basis of fabrication material used. In group I; Poly-methyl methacrylate resin (PMMA) was used for provisional restoration and in group II; bis-glycidyl methacrylate (Bis-GMA) was used

for provisional restoration. Tooth preparations were performed following all the principles. Mean temperature rise was recorded and compared for both material over each tooth using radicular approach after placing the provisional restorations in impression mould.

**Results:** A total number of 60 teeth were selected, out of which 31 (51.67%) were right maxillary central incisor and 29 (48.33%) were left maxillary central incisor. On comparison of mean rise in pulp temperature between the PMMA group and Bis-GMA group, mean rise in temperature was significantly high in PMMA group;  $40.59 \pm 0.56^\circ\text{C}$  versus  $39.40 \pm 0.53^\circ\text{C}$  in Bis-GMA group ( $p$ -value  $< 0.0001$ ).

**Conclusion:** The mean rise in pulp temperature using Bis-GMA resin was significantly less as compared to the PMMA material. So Bis-GMA should be preferred over PMMA material for provisional restorations.

*Keywords: Bisacrylic composite resin; exothermic heat; polymethyl methacrylate resin; provisional restorations.*

## 1. INTRODUCTION

A interim prosthesis is a fixed or removable dental prosthesis designed to restore aesthetics, structure, and/or function for a short period of time, after which it will be replaced with a definitive dental prosthesis [1]. Any interim prosthesis must meet mechanical, biological, and aesthetic standards, and its fabrication must be done with caution because the materials and methods employed may affect the pulp's vitality [2]. One of the key goals of any restorative process is to retain pulp health or vitality.

Different dental procedures, such as cavity preparation, self-cure polymerization, acid-base setting of any restorative materials, or even tooth exposure to light from various light sources, such as quartz-tungsten-halogen (QTH) and light emitting diode (LED) used for curing restorative materials, can affect the temperature of the pulp [2]. The existence of free residual monomer, which may cause soft tissue trauma, and the exothermic heat created during polymerization of the materials pose two major challenges when fabricating provisional prostheses utilising the direct technique [3]. Provisional restorative materials are essentially self-curing in nature, and during polymerization, they emit exothermic heat, which can cause thermal pulp damage when used in a direct mode of manufacturing [4]. According to Stanley, a  $5.6^\circ\text{C}$  increase in the temperature of the pulp causes 15% of the pulps to lose vitality, an  $11.2^\circ\text{C}$  increase causes 60% of the pulps to lose vitality, and a  $16.8^\circ\text{C}$  increase produces irreversible pulpal necrosis in 100% of the pulps [5]. On the contrary, Khajuria et al. observed that PMMA has a higher temperature rise than bis-GMA; they reported a mean temperature of  $40.39 \pm 0.46^\circ\text{C}$  in the PMMA group vs  $39.46 \pm 0.26^\circ\text{C}$  in the Bis-GMA group [2].

The purpose of this study was to compare the temperature rise inside the pulp chamber when two distinct provisional restorative materials, PMMA Polymethyl methacrylate resin and bisglycidyl methacrylate resin, were used to directly fabricate provisional restorations for prepared teeth (Bis-GMA). This study will aid in the prevention of future by opting for material with less temperature rise during setting procedure.

## 2. MATERIALS AND METHODS

The study was conducted in an in-vitro laboratory of the Prosthodontic department, Liaquat University of Medical and Health, Jamshoro. Total 60 permanent teeth with sound morphology, usually extracted for aesthetic concerns or functional needs, where patients could not afford the orthodontic treatment were selected using non-probability consecutive sampling technique.

The teeth were divided into two groups based on the provisional material used. In group I; Poly-methyl methacrylate resin (PMMA) was used for provisional restoration. And in group II; bis-glycidyl methacrylate (Bis-GMA) was used for provisional restoration. Firstly a soft plaster slab was prepared to hold the tooth. Afterwards, access cavity was made into the pulp chamber through radicular approach to facilitate the insertion of thermal probe in order to assess the temperature rise in pulp chamber. Two impressions of each intact extracted tooth were taken using Heavy bodied- C silicone (Lab Putty) to make a mould. Teeth were prepared following principles of tooth preparation. Temporary crowns were fabricated for each tooth using two moulds, one with PMMA and other with Bis-GMA. Rise in mean temperature during the process of polymerisation was measured using

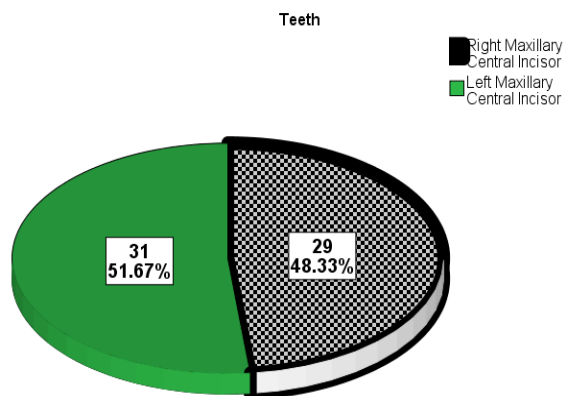
thermo-probe kept inside the pulp chamber via radicular approach connected to the digital thermometer. All the reading were noted on a pre-designed Proforma. The data collected and analysed using SPSS v23 software. Frequency and percentage were measured for qualitative variables such as side of tooth arch. Mean and standard deviation were used to present mean rise in temperature during restoration. Independent sample t-test was applied to compare rise in temperature between the groups. P-value  $\leq 0.05$  was taken as significant difference.

### 3. RESULTS

A total number of 60 teeth were selected, out of which 31 (51.67%) were right maxillary central incisor and 29 (48.33%) were left maxillary central incisor (Fig. 1). Mean rise in pulp chamber temperature was  $40.0 \pm 0.81^\circ\text{C}$ . Minimum temperature was  $38.90^\circ\text{C}$  and maximum temperature was  $41.30^\circ\text{C}$  (Table 1). On comparison of mean rise in pulp temperature between the PMMA and Bis-GMA group, temperature was significantly higher in PMMA group;  $40.59 \pm 0.56^\circ\text{C}$  versus  $39.40 \pm 0.53^\circ\text{C}$  in Bis-GMA group. This difference was statistically significant with p-value  $< 0.0001$  (Table 2).

**Table 1. Statistics of mean rise in temperature during provisional restorations**

<b>Mean</b>	40.0
<b>S.D.</b>	0.81
<b>Minimum</b>	37.90
<b>Maximum</b>	41.30



**Fig. 1. Frequency of teeth based on side of arch for Provisional Restoration**

### 4. DISCUSSION

Provisional fixed partial dentures are a critical part of fixed prosthesis treatments must be used to maintain the health and longevity of prepared tooth [6,7]. Since the introduction of chemical cured PMMA, they became the most frequently used interim fixed prostheses material [8]. Developments in Bis-GMA structure and filler content led to the development of other molecules such as: ethoxylated Bis-GMA, triethyleneglycol dimethacrylate (TEGDMA) and urethane methacrylates (UDMA) which found their way and have become popular for fabrication of interim fixed prostheses [9]. It has been observed that slight increases of pulpal temperature by all interim prosthesis can devitalize a considerable proportion of pulp cells, through various mechanisms. This temperature increase depends on the extent of polymerization, the size of restoration and thickness of intermediate dentin, and light curing (up to  $6^\circ\text{C}$  increase) [10,11]. This present *in vitro* study demonstrated that PMMA resin when used on incisor produced highest exothermic reaction. Throughout the study procedure, both the materials tested showed a rising trend in temperature due to the release of exothermic heat during polymerization [12]. Akova et al. and Usumez et al. investigated the effects of different matrices and application of desensitizer on rise in temperature and found no effects of matrix and desensitizer on the temperature rise [13,14]. Yondem et al. conducted a study to evaluate the temperature rise during polymerization of resin composite by various light polymerization units and found the temperature rise much below the critical temperature of  $5.5^\circ\text{C}$ . Hence, light cure or dual cure composites can also be suggested as provisional crown materials [15]. Malčić et al. stated that care should be taken while using blue phase light emitting diode light for polymerization of resins and suggested to use it at low power modes and with small duration of exposers [16]. Our study suggested that the type of resin used during direct fabrication of provisional restorations affects the intrapulpal temperature rise. The PMMA self curing resin produced a significantly higher exothermic heat release than the bisacrylic composite resin and should be avoided to reduces the chances of thermal injury to pulpal tissues.

**Table 2. Comparison of mean rise in temperature during provisional restoration using Polymethyl Methacrylate Resin (PMMA) versus bis-glycidyl methacrylate (Bis-GMA) material.**

Mean Rise in Temperature	PMMA Group	Bis-GMA Group	P-value
Mean	40.59	39.40	<0.0001
S.D.	0.56	0.53	

## 5. CONCLUSION

The mean rise in pulp temperature when Bis-GMA resin was used was much lower than when PMMA resin was used, implying that PMMA should be avoided in the case of vital teeth due to residual monomer and thermal injury. However, further research on use of other provisional restorative materials is needed as well.

## CONSENT

The written informed consent was taken from each patient prior to study. The confidentiality was maintained.

## ETHICAL APPROVAL

The ethical permission was sought from the Ethical Review Committee (ERC) of the Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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