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Original Article

Intrapulpal thermal changes during direct provisionalization using various autopolymerizing resins: Ex-vivo study

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ABSTRACT

Background: Resin materials used in the fabrication of direct provisional restoration exhibit an exothermic reaction and the extent of damage may also depend on the remaining dentine thickness. An ex-vivo study was envisaged to compare the time related temperature changes in the pulp chamber during the fabrication of fixed partial denture provisional restorations using direct technique. The effect of differently prepared teeth (with varying remaining dentine thickness) on the above mentioned temperature changes were also evaluated.

Methods: Thermal changes were calculated in pulp chamber of three differently prepared tooth having different amount of remaining dentinal thickness (45 samples) and control with no tooth media (15 samples), using three different types of autopolymerizing provisional restorative materials using Cr/Al thermocouple connected to digital thermometer.

Results: The data for the mean peak temperature rise was subjected to one way ANOVA analysis for relative comparison among subgroups within each main group and across the main groups. The results showed a statistically significant difference across both the subgroups and the main groups ($p < 0.001$). Then Turkey HSD test was applied to determine the significance of statistical difference between the means, within the groups. The differences in temperature rise were statistically significant for the three resins ($p < 0.001$).

Conclusion: Polymethylmethacrylate (DPI) showed the highest temperature rise value followed by polyethyl methacrylate (Tempron) and Bis-acrylate composite (CoolTemp). The maximum temperature rise was found on molar full veneer preparation followed by molar three quarter preparation and premolar three quarter preparation. Data and results from current study may assist clinicians to select an autopolymerizing provisional restorative resin when employing direct technique of fabricating provisional restorations for a specific tooth preparation which would cause minimal thermal trauma to pulpal tissue.

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Introduction

Fabrication of a successful crown or fixed partial denture requires the precise execution of many steps, from the initial visit for data collection and diagnosis through the post insertion visits. One of the intermediate steps is the fabrication of the interim prosthesis.[1] *An interim/provisional prosthesis is defined as "a fixed or removable dental prosthesis or maxillofacial prosthesis, designed to enhance esthetics, stabilization and/or function for a limited period of time, after which it is to be replaced by a definitive dental or maxillofacial prosthesis (GPT-8).*[2]

The fabrication of provisional restoration is a necessary procedure following extra coronal tooth preparation until the definitive prosthesis is placed.[3] The requirements of a provisional restoration are to provide pulpal protection, positional stability, maintenance of occlusal function, with minimal damage to tooth and supporting structures.[4–10] One of the important requirements of the temporization material is that it should be non irritating to pulp and other tissues i.e. should have low exothermicity. The most common materials employed for custom provisional fixed restorations are acrylic resins 5. Several types of acrylic resin materials are available for provisional restoration fabrication 5, 9: polymethyl methacrylate resins, polyethyl methacrylate resins, Bis-acrylate composites & other types or combinations of unfilled methacrylate resins.

There are **direct** (provisional restoration fabricated directly on the prepared teeth in the patient's mouth) and **indirect** (provisional restoration fabricated on the stone cast) ways of fabricating these restorations. The indirect method has been associated with superior fit[11,12] and pulp protection but its disadvantage is that an intermediate impression and stone cast are required to fabricate the provisional restoration. On the contrary direct provisional restoration fabrication method efficiently uses time and materials, and also inadequate or absence of in-house lab support has led to its continued use.[13,14] One of the disadvantages of direct method is the exposure of the tooth structure (pulp through remaining dentinal thickness) to the heat produced by polymerization of polymer based temporization materials **(Grajower R et al, 1979).**[15]

Probability of pulpal damage is more when the temperature increase exceeds the physiologic heat dissipation mechanisms of the dental periodontal system. Mechanisms of injury include protoplasm coagulation, expansion of the liquid in the dentinal tubules and pulp with increased outward flow from the tubules, vascular injuries and tissue necrosis.[16,17] According to **Zach and Cohen (1965),**[18] a temperature rise of 5.5 °C can lead to 15% loss of vitality in the pulp, an 11 °C rise causes about 60% and a 16.6 °C temperature rise causes 100% necrosis of the pulp.

The thickness of dentinal tissues remaining after the abutment preparations plays an important role as it affects the quantum of heat transferred to the pulp chamber during direct provisionalization.[19,20] Keeping this in view the present study was envisaged. An ex-vivo study was conducted to compare the temperature rise in the pulp chamber during direct provisionalization using various autopolymerizing resins and also to evaluate the effect of residual dentinal thickness of differently prepared teeth on the above mentioned temperature rise.

Materials and methodology

The study was divided into three main groups on the basis of provisional materials (Table 1; Fig. 5) and further sub divided into three subgroups on the basis of tooth preparation; each sub group had five readings. Making a total of 45 samples.

Study model was fabricated by replicating mandibular typodont model using autopolymerizing acrylic resin (tooth coloured and pink acrylic were used for demarcation of tooth area). Area 35, 36 & 37 of acrylic model was trimmed till base to facilitate the access of lead wires attached to thermocouples present in pulp chamber of prepared samples. Tooth sample preparation was done on extracted natural teeth numbers 35, 36 and 37 of an average size and form.[19] The mandibular second molar (37) was prepared to receive conventional three quarter crown mandibular second premolar (35) was prepared to receive conventional three quarter crown mandibular first molar (36) was prepared to receive conventional complete veneer metal crown. The roots of these extracted prepared teeth were sectioned 3 mm below cemento-enamel junction

Table 1 – Intergroup comparison of mean peak temperature achieved for different samples.

S. no.	Sample	Group	Mean	SD	F	p
1.	Control	Bis-acrylate composite (5)	13.76	0.15	6497.32	<0.001
		PEMA (5)	16.14	0.15		
		PMMA (5)	23.46	0.11		
2.	Premolar ¾ preparation	Bis-acrylate composite (5)	6.86	0.11	7899.88	<0.001
		PEMA (5)	6.98	0.08		
		PMMA (5)	14.14	0.11		
3.	Molar ¾ preparation	Bis-acrylate composite (5)	8.72	0.11	3753.63	<0.001
		PEMA (5)	10.76	0.13		
		PMMA (5)	15.14	0.11		
4.	Molar full veneer preparation	Bis-acrylate composite (5)	10.04	0.15	6370.54	<0.001
		PEMA (5)	12.02	0.08		
		PMMA (5)	18.66	0.13		

Temperature rise for various specimen in different groups.