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COMPARISON OF INTRA-PULPAL RISE IN TEMPERATURE DURING FABRICATION OF PROVISIONAL COMPLETE CORONAL COVERAGE RESTORATION BY DIRECT METHOD USING DIFFERENT AUTOPOLYMERIZING AND PHOTOPOLYMERIZING RESINS - AN IN VITRO STUDY

Periodontology

KEYWORDS: Provisional restoration, temperature rise in pulp chamber

Dr. Jasmeet Chandhok	Associate Professor, Swargiya Dadasaheb Kalmegh Smruti dental college and hospital, Nagpur
Dr. Deepika Chandhok	Associate Professor, Swargiya Dadasaheb Kalmegh Smruti dental college and hospital, Nagpur
Dr. Grishmi Niswade	Senior lecturer, Swargiya Dadasaheb Kalmegh Smruti dental college and hospital, Nagpur
Dr. Ganesh Bajaj	Professor, Swargiya Dadasaheb Kalmegh Smruti dental college and hospital, Nagpur
Dr. Arihant Bathiya	Post graduate student, Swargiya Dadasaheb Kalmegh Smruti dental college and hospital, Nagpur

ABSTRACT

Background

While fabrication of a vital tooth structure it is mandatory to give a provisional restoration to the patient for comfort, esthetics and function. In the mean time it is important to maintain the pulpal health of the tooth by saving it from the rise in temperature by fabrication of provisional restoration by direct method which is less time consuming and can be done chair side. This study is based on the comparison of the different materials and methods which are best suited for fabrication of provisional restoration by direct method. **Material and Methods** A heat transferring silicon compound was then inserted with the help of an instrument into the empty pulp chamber from of a freshly extracted mandibular 1st molar. A vacuum form matrix of 2 mm thickness was fabricated and the tooth was prepared for a full ceramic coronal restoration. The intra-pulpal rise in temperature caused due to five different temporary crown and bridge resin material over the prepared tooth was recorded. **Results** The results demonstrate that when no matrices were used the mean maximum temperature rise was seen with DPI which was 4.3200 C. The mean maximum temperature rise shown with use of any matrix was with DPI with use of Polypropylene matrices which was 3.8200 C and the mean minimum temperature which was produced by Protemp with the use of polyvinyl siloxane matrices which was 2.1800 C **Conclusion** The amount of heat generated during polymerization of resinous materials is proportional to the volume of material used; therefore higher temperatures should be expected when restoring multiple units and replacing missing teeth with provisional fixed partial dentures.

INTRODUCTION

The fabrication of provisional crowns or provisional fixed partial dentures is an essential and key step in successful prosthetic treatment. Provisional restorations are required before definitive restorations are inserted in order to protect the prepared tooth, to prevent tooth migration with resultant occlusal changes, to reduce dentinal sensitivity, and to restore function.

Several methods have been described for fabricating provisional restorations. Both, direct and indirect methods are used for the fabrication of these restorations. Due to its accuracy, and, pulpal irritation being a non- issue, the indirect method is preferred over the direct method. However, time constraints and inadequate laboratory support may, at times, force the clinician to use the direct technique.

The most commonly used material for making provisional restoration are the autopolymerizing resins. When fabricating direct provisional resin crowns, the first problem pertains to the presence of free monomer, which can be harmful to the pulp, especially when placed in direct contact with open dentinal tubules. Secondly, most of the materials used for provisional restorations introduce a rise in temperature during polymerization. Heat generated during polymerization of resin material can be transferred to the pulp. This can cause various histopathologic changes, such as burn reactions at the periphery of the pulp including formation of "blisters", ectopic odontoblasts and their destruction, protoplasmic coagulation, expansion of liquid in the dentinal tubules and pulp with increased outward flow from tubules. This process can affect the pulpal vessels and lead to vascular injuries ending in tissue necrosis[1].

It has been reported that a temperature rise of 5.6 ◦C can lead to a 15% loss of vitality in the pulp, and a 11 ◦C temperature rise will lead to a vitality loss of approximately 60%. In addition, a 16.6 ◦C temperature rise may cause 100% necrosis of the pulp2. Some authors found that the temperature increase produced by the materials ranged from 14.8 to 27.3 ◦C during the exothermic polymerization process of provisional materials[3].

The purpose of this in- vitro investigation was to compare thermal changes in the pulpal chamber generated by five materials during fabrication of provisional resin crowns by the direct method. Also, the effect of curing resin crowns in different matrices, such as a polyvinyl siloxane impression and a vacuum-formed polypropylene sheet, were evaluated in this study.

MATERIALS AND METHODS

A freshly extracted mandibular 1st molar with normal morphology was selected for study. After thorough cleaning process it was sectioned at the root portion with a carborundum disk approximately 2 mm below the cementoenamel junction (CEJ) and perpendicular to the long axis of the tooth.

A heat transferring silicon compound was then inserted with the help of an instrument into the empty pulp chamber from its radicular portion. The pulp chamber was completely filled with the compound. This compound facilitated the transfer of heat from the walls of the pulpal chamber to the thermocouple. Then, with the help of a base former, an acrylic resin base was prepared for attachment of the extracted molar. With the use of auto polymerizing clear acrylic resin a base was poured into the base former.

After polymerization, clear acrylic resin base was removed and the block-out wax was eliminated. Two types of matrices were prepared over the unprepared tooth. A vacuum form polypropylene sheet of 2 mm thickness was used to prepare a matrix with the use of vacuum forming machine. After it hardened, the procedure was again repeated to get one more extra matrix with same thickness. This extra matrix was then again adapted to the tooth and over which auto polymerizing acrylic resin was poured. After setting of the acrylic resin it was removed and the vacuum formed matrix was separated from its inner surface. The inner surface of the acrylic resin was filled with polyvinyl siloxane and was kept back over the unprepared tooth surface. Two matrices with same thickness were ready to be used.

The tooth preparation was done with the help of a hand piece which was stabilized with the help of a jig that was attached to the vertical arm of the dental cast surveyor. With the help of diamond crown preparation points, the tooth was prepared for a full ceramic restoration with a 2 mm shoulder margin all over (Figure 1). The preparation was finished and kept ready for readings. The tooth was preheated in a water bath and set at 30°C before insertion of the resin. The water bath resulted in a baseline temperature in the pulpal chamber of approximately 30°C. Finally the thermocouple was attached to the base of the tooth with help of silicon agent and a radiograph was taken for detecting its location (Figure 2).

Three experiments were conducted for each system of provisional resin to evaluate the respective effects of two matrices and no matrix for thermal changes in the pulpal chamber. Measurements were repeated five times for each combination of resin and matrix material and five readings were averaged to determine the mean value in temperature rise. Temperature changes were recorded every 30 second interval, for a total of 10 minutes for poly methyl methacrylate resins (DPI , Dentek) , temperature changes were recorded every 2 seconds for 20 seconds when testing Urethane dimethacrylate ((Revotec LC resin), and every 30 seconds for total of 10 minutes for light cured methyl methacrylate resins Unifast LC). Temperature changes were recorded every 10 second interval, for a total of 2 minutes for bis acrylate resin (Protemp 3 Garant). All materials were manipulated according to the manufacturer's instructions and tested over the tooth for temperature changes. A total 65 temporary crown samples were made from all materials. After resin materials had been tested, the tooth was sectioned longitudinally. The thickness of residual dentin was recorded with Iwanson gauge and the average dentinal thickness was determined to be approximately 2.5 mm.

RESULTS

Five different temporary crown and bridge resin materials were used to fabricate temporary crowns over the prepared tooth. Light emitting diode (LED) was used to cure photopolymerizing resins. Observations were made with five readings of each individual matrix and total of 65 samples for all materials. Analysis of variance and student's paired and unpaired t- test were applied for statistical analysis and the following results were obtained.

The mean temperature rise with different materials along with their groups of matrices individually showing the means of maximum and minimum temperatures which were recorded, when 5 samples were taken for each group for individual material (Table 1). The results demonstrate that when no matrices were used the mean maximum temperature rise was seen with DPI which was 4.3200 C. The mean maximum temperature rise shown with use of any matrix was with DPI with use of Polypropylene matrices which was 3.8200 C and the mean minimum temperature which was produced by Protemp with the use of polyvinyl siloxane matrices which was 2.1800 C (Figure 3).

DISCUSSION

A provisional restoration must seal and insulate the prepared tooth surface from the oral environment to prevent sensitivity and further irritation to the pulp. It is because of the sectioning of dentinal tubules, a certain degree of pulp trauma is inevitable during tooth preparation[4].

Each tubule contains the cytoplasmic process of a cell body (the odontoblast), whose nucleus is in the pulp cavity. The environment around the exposed dentin should be carefully controlled; otherwise adverse effects on the pulp can be expected. In addition, in severe situations, leakage can cause irreversible pulpitis and the resulting need for root canal treatment5. For this reason provisional restorations are fabricated and temporarily fixed or luted to the prepared tooth.

This comparative study was performed with the same specimen to standardize dentinal thickness that can be highly variable for different teeth before and after tooth preparation has been completed. Clinically, the amount of heat transferred to the pulp cannot be predicted. The elevations in temperature are dissipated by the periodontal ligament, and other organic structures, such as protoplasmic extensions of cells in dentinal tubules. Pulpal and osseous circulation is also effective in heat dissipation. Because of its insulating effect residual dentinal thickness is a critical factor in the protection of pulpal tissues from thermal injuries.

This study simulated the clinical situation of restoring a single tooth. The amount of heat generated during polymerization of resinous materials is proportional to the volume of material used; therefore higher temperatures should be expected when restoring multiple units and replacing missing teeth with provisional fixed partial dentures. The heat transferred to the pulp by different types of resins, different volumes of resin, and different types of matrices commonly used in the direct fabrication of extracoronal provisional restorations was done in some studies and they proved that there was more heat librated when more amount of material was used.[6]

Within the limitations of this study, the measured temperatures in this study were generally lower than the previous studies cited in the literature. 7,8 This can be explained by the differences in the test conditions. The heat rise generated during direct provisionalization is dependent on the ambient temperature and the amount of the resin used. In this study, the test apparatus was kept at 300C constantly before and during polymerization, which resulted in a 30 0C intrapulpal temperature, and a 1st molar was used with a standardized method that ensured the use of the same amount of resin each time. Different ambient temperatures and material volumes were used in previous studies. 9 In this study the tooth used was also a molar and the tests were carried out at room temperature. Therefore, direct comparative evaluation of the results of this study with previous findings is easy.

Even though the thermocouple records no significant temperature rise, damage to vital cells can occur. Therefore, some preventive methods such as cooling techniques using an air–water spray to dissipate the polymerization heat as well as to minimize the thermal trauma to the pulp, or the removal of the provisional restorations after initial polymerization, which allows the final polymerization to occur outside the mouth, may be used.[10]

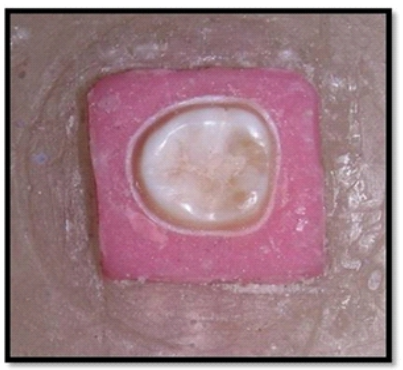


Figure 1: Tooth preparation done on mandibular 1st molar

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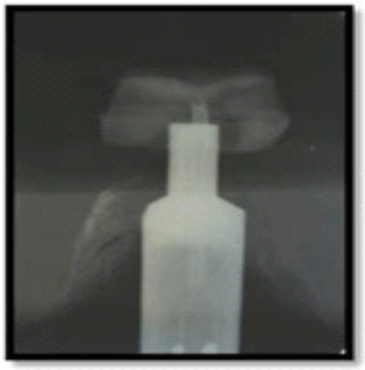


Figure 2: Radiographic view of prepared tooth with thermocouple inserted

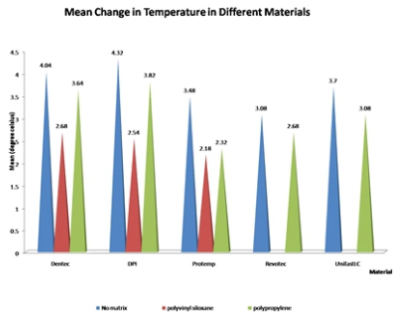


Figure 3: Mean change in temperature of temporization materials at varied time intervals in (deg celsius) using different matrices.

Table 1: Mean and standard deviation between 5 different materials along with their matrices group

MATERIAL	MATRICES	MEAN	NO OF SAMPLES	STANDARD. DEVIATION
DENTEK	No matrix	4.040	5	.1140
	Polyvinyl siloxane	2.680	5	.1095
	Polypropylene	3.640	5	.0894
DPI	No matrix	4.320	5	.1643
	Polyvinyl siloxane	2.540	5	.0548
	Polypropylene	3.820	5	.1304
PROTEMP	No matrix	3.480	5	.1095
	Polyvinyl siloxane	2.180	5	.1095
	Polypropylene	2.320	5	.1789
REVOTEC	No matrix	3.080	5	.1095
	Polypropylene	2.680	5	.0447
UNIFAST LC	No matrix	3.700	5	.0707
	Polypropylene	3.080	5	.0837

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