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Original Research Article

An influence of preheating composites on microleakage- An invitro study

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ABSTRACT

Background: Resin composites have become one of the widely used restorative materials in the field of dentistry. Resin composite Pre-heating is a recent innovative method that is clinically beneficial by improving handling and marginal adaptation of the resin to the tooth.

Aim: The study aims to determine the effect of temperature on the degree of microleakage in resin composite restorations.

Materials and Methods: In the present study, Class 1 cavity was prepared in 30 extracted non-carious human premolars and divided into two groups. Group A (n=15) - filled with nano-hybrid resin composite (3M^{TM} Filtek^{TM} Z350 XT Universal Composite) at room temperature. Group B (n=15) - filled with the same resin preheated and then checked for micro-leakage under SEM. Mann-Whitney test was used to compare the mean Marginal Leakage scores between the 2 groups.

Results: There was a statistically significant difference in the micro-leakage score between group A and group B. Group B showed minimal or no micro-leakage in comparison to Group A.

Conclusion: Preheating the resin composite has better adaptability to the walls thus reducing micro-leakage and postoperative sensitivity.

1. Introduction

Because of the growing patient desire for cosmetic restorations, the use of direct resin composites in general clinical practice has expanded during the last decade.[1] Also direct composite restorations are gaining popularity over traditional amalgam restorations because of the toxic effects of mercury.[2] When compared to traditional restorative materials such as silver amalgam, composite resins have superior physical and chemical properties, great operability, and good aesthetic performance.[3] Despite the aesthetic advantages of resin composite over amalgam, the major disadvantage of resin composite is polymerization shrinkage and factors influencing it include volumetric shrinkage and viscoelastic behavior.[4] The total shrinkage in a dental composite could be divided into Pre-gel (viscous to gel) and post-gel (gel to solidification) phases.[5,6] In the post-gel stage, the resin has partially set and cannot undergo plastic deformation to adjust for volumetric shrinkage. As a result, tensile stresses are formed at the resin-to-tooth interface, causing the material to be pulled away from the tooth surfaces.[7,8]

The cavity configuration, often known as the C-factor, is defined as the ratio of bonded to unbonded surface area. The shrinkage stresses in high C-factor cavities cannot be decreased by resin flow during light-induced polymerization of resin composite, resulting in the debonding of one or more walls. Using various adhesive solutions, it was discovered that the cavity's C-factor had a detrimental effect on the micro-tensile bond strength to dentin.[9] Thus, if clinically the C-factor can be decreased, the polymerization

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shrinkage may be decreased as well.

Composite restorations' clinical success is highly dependent on polymerization and degree of conversion. Also, composites including macrofilled, microfiiled, nanofilled or hybrid composites irrespective of its filler size are highly viscous and are very hard to adapt accurately to cavity preparations which may leave behind unwanted voids, hence, more flowable composites were introduced.[10]

The main disadvantage of flowable composite resins is their low strength in comparison to conventional composite resins, which is due to the low amount of filler content to achieve low viscosity and ease of handling.[11] To overcome this drawback the flowable composite liner in conjunction with ordinary composites is used. But later to avoid this extra step of placing flowable composite, traditional composites have been heated to reduce viscosity. In this method, conventional composites with higher durability could be used, while using lower viscosity to produce more intact interfaces with tooth tissues.[12] Therefore, this study was done to compare the micro-leakage between conventional composites and preheated composites.

2. Materials and Methods

1. This was an in vitro experimental study.
2. Preparation of sample.
3. Human premolar teeth extracted for periodontal and orthodontic purposes were collected for this study.

2.1. Inclusion criteria

Intact teeth without caries, cracks, fracture or restoration.

2.2. Exclusion criteria

1. Teeth with crown or root caries
2. Teeth with fractures
3. Teeth with cracks
4. Teeth with restorations
5. Teeth with fluorosis

Teeth were cleaned thoroughly, disinfected in 5% sodium hypochlorite solution for 1 hour, and stored in distilled water. Teeth were mounted in wax sheet by embedding the roots.

2.3. Methodology

With a high-speed handpiece and a #245 carbide bur (MANI, INC), Class 1 preparations were performed in each tooth in the center groove. The cavity had a pulpal floor depth of 1.5mm, 4mm mesiodistal width, and 3mm width buccolingual (Figure 1A). Each tooth cavity was etched with an acid etchant (3M ESPE SCOTCHBOND ETCHANT) for 15 seconds and rinsed with saline and air-dried gently. A bonding agent (3M ESPE ADPER SINGLE BOND 2) was applied using an applicator tip and light-cured for 20 seconds (Figure 1B). The samples were then divided into two groups of 15 (n=15). Specimens in group A were restored with Nano-composite (3M™ Filtek™ Z350 XT Universal Restorative) (Figure 1C) in increments of 1mm with a Teflon-coated instrument using an oblique technique and light cured for 20 seconds and finished with a flame-shaped finishing bur. Specimens in group B were restored in a similar manner but with preheated resin composite, heated externally by a water bath (Figure 1D) to a temperature of 50°C to 55°C. The temperature in the water bath was maintained by laboratory thermometer. Teeth were then subjected to thermocycling, for 500 cycles at 5°C-55°C with a 30sec dwell time. To prevent dye penetration from other occlusal abnormalities, specimens were coated with two coats of fingernail varnish, leaving a 1 mm border around the cavity. The tooth was then placed in a solution of basic fuschin for 24 hours and then sectioned longitudinally (Figure 1E). The extent or absence of micro-leakage was determined by the amount of dye penetration along the resin composite-tooth interface visually with a Scanning Electron Microscope (Figure 1F).

Criteria for micro-leakage scoring[13]

Score - Definition

0 - Absence of infiltration

1 - Infiltration up to 1/3rd of the interface

2 - Infiltration up to 2/3rd of the interface

3 - Infiltration higher than 2/3rd of the interface

3. Results

Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp., was used to perform statistical analysis. Descriptive analysis of all the explanatory and outcome parameters was done using frequency and proportions for categorical variables, whereas in Mean & SD for continuous variables. Mann-Whitney test was used to compare the mean Marginal Leakage scores between 2 groups. The level of significance was set at P<0.05.

Group A showed 36.7% of Infiltration up to 1/3 of the interface, 30.0% of Infiltration up to 2/3 of the interface, and 33.3% of Infiltration higher than 2/3 of the interface, with almost an equal distribution of Marginal Leakage scores at different thirds of the tooth surfaces.

Group B showed 23.3% Absence of infiltration, 50.0% of Infiltration up to 1/3 of the interface, and 26.7% of Infiltration up to 2/3 of the interface, with more than 70% of the samples showing either no infiltration or infiltration up to $1/3^{rd}$ of the interface of the tooth samples. (Table 1)

Group B showed significantly lesser mean marginal leakage scores [1.03± 0.72] as compared to Group A [1.97 ± 0.85]. This difference in the mean marginal leakage scores was statistically significant at p<0.001 (Table 1).

Figure 2 shows the difference in the amount of micro-leakage between the unheated and the preheated composite

Table 1: Frequency distribution of Marginal Leakage scores in Group A & Group B

Parameter	Category	Group A		Group B	
		n	%	n	%
Marginal Leakage Scores	Absence of infiltration	0	0.0%	7	23.3%
	Infiltration up to 1/3 of the interface	11	36.7%	15	50.0%
	Infiltration up to 2/3 of the interface	9	30.0%	8	26.7%
	Infiltration higher that 2/3 of the interface	10	33.3%	0	0.0%

Table 2: Comparison of mean marginal leakage scores between 2 groups using mann whitney test

Parameter	Groups	N	Mean	SD	Mean Rank	U	p-value
Marginal Leakage Scores	Group A	30	1.97	0.85	38.62	3.816	<0.001*
	Group B	30	1.03	0.72	22.38		

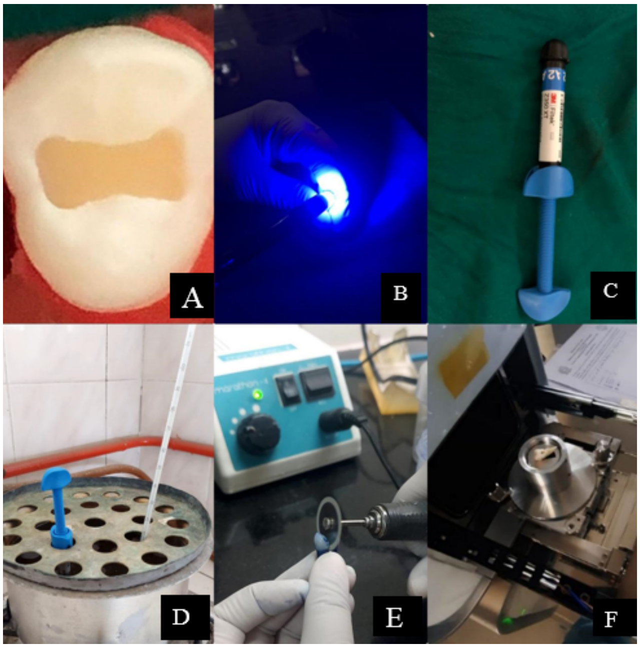

Figure 1: A: Cavity preparation; **B:** Etching and bonding; **C:** Composite used; **D:** Waterbath to heat composite; **E:** Sectioning; **F:** SEM

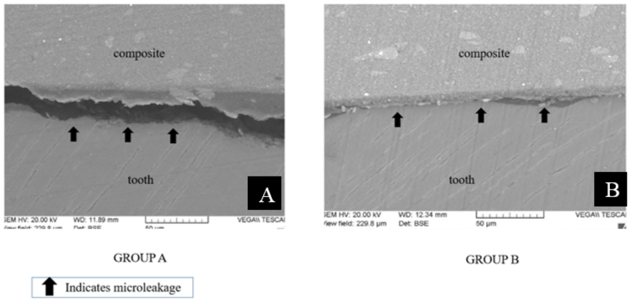

Figure 2: A: SEM sample of group A (unheated composite); **B:** SEM sample of group B (preheated composite)Indicates dye penetration that is microleakage between tooth and composite interface

under a scanning electron microscope. Figure 2A shows an increase in the micro-leakage between the tooth and the composite indicating results of Group A when compared to Figure 2B indicating results of Group B.

4. Discussion

This invitro study aimed to evaluate the marginal fit that is to see the marginal micro-leakage when the composite is preheated and compared it with conventional unheated composite. For the observation Scanning Electron Microscope was used as it is nondestructive to the samples and SEM images shows the extent of dye penetration into the tooth micro-structure. Thermocycling was done because it is the method of exposing dental materials and teeth to temperature ranges similar to those occurring in the oral cavity which may cause adverse consequences as a result of different thermal expansion coefficients between the tooth structure and the dental materials.[14] The teeth were sectioned longitudinally through the center of the restoration; therefore, the micro-leakage at interface of composite and tooth could be seen and evaluated as two-dimensional under SEM.[15] 3M™ Filtek™ Universal Restorative nano-composites were used because it is the composite that is approved by the FDA for preheating.[16] The study resulted in reduced or no microleakage between the tooth composite interface in group of preheated composite probably because of lower viscosity of preheated composite resulted in the better adaptability of composite to the tooth when compared to the unheated composite group which is difficult to adapt to tooth because of its higher viscosity.

Studies have shown that after placing a 60°C preheated composite resin, the pulp temperature rises by only 0.8°C, whereas 20 seconds of light curing raises the temperature by 5°C.[17] Daronch et al. discovered that after removing composites from the heating device, 50% of the temperature achieved is lost after 2 minutes and nearly 90% is lost after 5 minutes.[18]

From the results of the study done by Nivea Regina et al., showed preheated treatment of composite in the range between 50°C to 55^0C showed optimum restoration tooth interface with the least or no microleakage compared to the conventional unheated composite resin. So preheated composite samples showed better marginal adaptation compared to those at room temperature.[19] According to the findings, preheating composite resins improves the degree of conversion, stiffness, marginal adaptability, and micro-hardness. Flexural strength is unaffected, polymerization shrinkage is hampered, and the results of micro-leakage are uncertain.[1] More study with larger sample size and similar experimental settings, however, is required to establish the therapeutic significance of preheating.

5. Conclusion

Considering the limitations of the study like increasing sample size, using standardized preheating devices and other types of composite resin the present study revealed that preheating the composite resin to 50 to 55^{0}C showed a reduction in micro-leakage compared to unheated composite resin. Preheating lowered the viscosity of the resin composite materials where it eases its introduction to the cavity by increasing its flowability.

Thus in a clinical scenario, composites can be warmed to mimic flowable composites in achieving better adaptability to the cavity walls by reducing viscosity and thereby reducing micro leakage, without losing its mechanical properties as to a flowable composite which has lesser filler particles.

6. Source of Funding

None.

7. Conflict of Interest

None.

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