***Received:* 08th May 2015 *Accepted:* 13th August 2015 *Conflicts of Interest:* None**

***Source of Support:* Nil**

Original Research

Effect of Eugenol Containing and Eugenol Free Temporary Restorations on Microleakage in Composite Restorations

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How to cite the article:
Vagarali HT, Patil J, Nanjannvar GS, Hugar S, Shanbhag R, Pande N. Effect of eugenol containing and eugenol free temporary restorations on microleakage in composite restorations. J Int Oral Health 2015;7(10):58-61.

Abstract:

Background: Eugenol has an adverse effect on dentin bonding agents and composite resins. The purpose of this study was to investigate the microleakage at the enamel and dentine margins in composite restorations pretreated with eugenol containing and eugenol free temporary restorations.

Materials and Methods: About a total of 40 freshly extracted caries-free human premolars were selected and randomly divided into four groups. Class V cavities were prepared using NSK Airotor, to a depth of 2 mm, width 2 mm, and length 5 mm. The cavities were parallel to cementoenamel junction (CEJ) and gingival surfaces of the cavities extended 0.5 mm below the CEJ and was restored with composite material (Charisma microfilled) in Group I, Type III zinc oxide-eugenol (ZOE) cement with P: L ratio (10:1 g) in Group II, Type III ZOE cement with P: L ratio (10:2 g) in Group III, and zinc phosphate cement with P: L ratio (2.85:1 g) and were stored in distilled water at 37°C for 1-week. After 1-week, temporary cement fillings were removed, and the teeth of Groups II, III, and IV were filled with composite material and stored in distilled water for 24 h. The specimens were thermocycled and subjected to dye penetration test and observed under stereomicroscope for microleakage.

Results: Results showed that specimens with higher P:L of Type III ZOE cement increased the microleakage at enamel and dentine margins.

Conclusion: Based on the results of this study, it was concluded that microleakage at dentin margins was higher than enamel margins and increased P: L ratio of Type III ZOE cement increased the microleakage at dentin and enamel margins.

***Key Words*:** Composite, eugenol, microleakage

Introduction

Composite restorative materials are the most frequently used direct, tooth-colored restorative materials (Xie J et al. 1993).[1] A clinical usage of these materials has increased substantially over the last few years due to improvements in its formulation, simplification of bonding procedures, increased esthetic demands by patients, and decline in amalgam usage.[2] Polymerization shrinkage still interferes with clinical success of composite restorations.[3-8]

In routine clinical practice, temporary restorations are required prior to permanent restorations due to lack of clinical time, as intermediate restorations of multiple carious teeth and pulp capping procedures. Materials based on zinc oxide-eugenol (ZOE) are extensively used for this purpose.[9] There is an evidence that eugenol contamination can alter adhesion of resin by interfering with the polymerization (Bausch JR et al. 1982).[10] Eugenol is a phenolic compound that is insoluble in water. Its chemical formulation is 2 methoxy-4 phenol. Phenolic hydrogen, which is part of its formulation, inhibits resin polymerization, and reduces its adhesive strength and microhardness (Kosales Leal JI et al. 2003).[11]

Other adverse effects of eugenol are softening of composite resin, decreased surface hardness, increased surface discoloration, and roughness (Woody TL 1992, Jung M et al. 1998).[12,13]

To achieve sound adhesion, the resin should have adequate flow. To achieve the highest flow, the surface energy of the substrate must be greater than the surface tension of the adhesive. Eugenol contamination on dentin may interfere with the spreading and penetration of the resin through the dentinal tubules. Remnants of provisional restorations could also reduce dentinal wetting.

Aims and objectives

- To determine the degree of microleakage in composite restorations pre-treated with ZOE temporary restorations
- To compare the effect of eugenol containing and eugenol free temporary restorations on microleakage in composite

restoration.

Materials and Methods

Collection and storage of test specimens

A total of 40 freshly extracted human premolars free of caries and/or enamel and dentin defects were collected. Teeth were scaled to remove the soft tissue tags and surface deposits and stored in 10% of formalin solution. Teeth were used within 45 days of collection.

Teeth were randomly divided into four groups of 10 each. Class V cavities were prepared using NSK Airotor with water coolant, to a depth of 2 mm, width 2 mm, and length 5 mm. The cavities were parallel to the cementoenamel junction (CEJ) and gingival surfaces of the cavities extended 0.5 mm below the CEJ. Round diamond points and straight diamond points were used to prepare the cavities. After preparation, cavities were thoroughly cleaned and air dried.

Restoration

Group I: Cut surfaces were etched with 20% orthophosphoric acid (GLUMA Etch20 Gel) for 10 s and rinsed. Bonding (GLUMA Comfort Bond Kulzer) agent was applied on the prepared surfaces and cured for 20 s. The composite material (Charisma microfilled) was filled and light cured for 40 s. Polishing was done with Rainbow Super-snap Composite Polishing Kit.

Group II: Cavities prepared were filled with Type III ZOE cement with P:L ratio (10:1 g), recommended by the manufacturer (1 scoop of powder:1 drop of liquid).

Group III: Cavities prepared were filled with Type III ZOE cement with powder to liquid ratio 10:2 g one scoop of powder 2 drops of liquid.

Group IV: Cavities prepared were filled with Zn phosphate cement mixed at P:L ratio of 2.85:1 g as recommended by the manufacturer.

Teeth from all groups were stored in distilled water at 37°C for 1-week (Lab Hosp Humidor).

After 1-week, temporary cement fillings were removed with airotor and straight diamond point. The teeth of Groups II, III, and IV were filled with the composite material as described in - Group I and stored in distilled water for 24 h. All teeth were thermocycled in distilled water between 5°C and 55°C with 30 s dwell time and 2500 cycles.

The apices of the teeth were sealed with impression compound. Two coats of fingernail polish were applied on the roots and crowns of the teeth, so that only the restorations with a 2 mm peripheral margin of tooth remained exposed. The teeth were stained in 2% methylene blue dye for 2 h followed by a brief rinse with water. They were then embedded in autopolymerizing acrylic resin and sectioned longitudinally through the restorations with a thin diamond disk. The sectioned teeth were examined for microleakage using a stereomicroscope at ×40 magnification. The presence of microleakage was recorded using an ordinal scale where,

0 = No evidence of dye penetration.

1 = Dye penetration less than half the cavity depth.

2 = Dye penetration to the full cavity depth.

3 = Dye penetration to the axial wall and beyond as shown in the Figures 1,2 and 3.

Formula used for statistical analysis:

1. Mean

$$X = \frac{\sum X_i}{n} \qquad i = 1, 2, \ldots N$$

Where, X = variable, n = Sample size

2. Standard deviation (SD)

$$SD = \frac{\sum (X_i - X)^2}{\sqrt{N-1}}$$

Results

Table 1 shows the comparisons of microleakage between the control group and other groups at dentin and enamel margins (Mann–Whitney test).

Discussion

The present study was undertaken to evaluate the degree of microleakage in composite restorations influenced by ZOE temporary restorations. This study was based on the null hypothesis that, eugenol will have no effect on microleakage in composite restorations.

Results of this study showed that there was no statistically significant difference in microleakage between the control group, Group II (ZOE 1:1 concentration) and Group IV

Table 1: Comparisons of microleakage between control group and other groups at dentin and enamel margins (Mann–Whitney test).

Groups	Sample size	Mean		SD		*P* value	
		E	D	E	D	E	D
Group I	10	0.800	0.650	0.523	0.480	0.092	0.031
Group II	10	0.130	0.125	0.801	0.850	0.072	0.033
Group III	10	0.195	0.225	0.850	0.745	0.027	0.028
Group IV	10	0.115	0.125	0.366	0.786	0.676	1.0

SD: Standard deviation

(Zn phosphate 2.8:1 g concentration) at enamel and dentin margins.

This may be because acid etching and rinsing with water had effectively removed the smear layer and lesser concentration of free eugenol was available for diffusion into dentin in Group II, in which cement was mixed using 1:1 P:L ratio as recommended by the manufacturer.

However, microleakage in Group III (ZOE 1:2 concentration) was statistically significant at enamel and dentin margins when compared to Group II. This may be because a higher concentration of the eugenol from the freshly mixed cement had diffused deeper into dentin and interfered with polymerization of the resin.

Bond strength and micro leakage are the two important factors, which determine the clinical success of composite materials. Sazuki *et al*.[14] have stated that the bond strength and microleakage are inversely proportional, i.e. higher the bond strength lesser will be the microleakage.

Bonding agent applied on the etched enamel diffuses into microtubules by capillary attraction and undergoes *in situ* polymerization. Phenolic hydrogen, which is part of eugenol, present in microtubules inhibits resin polymerization and reduces the microhardness of resin composites. It also releases calcium from the dentin due to its complexing property, leading to softening of dentin.[15]

Inadequate polymerization coupled with softening of dentin lead to decreased shear bond strength and increased microleakage resulting in clinical complications such as hypersensitivity, secondary caries, fractured restoration, and surface discoloration.[10,16,17]

The results of this present study are in accordance with that of Peutzfeldt and Asmussen and Shiro Suzuki who used composite materials (Concise, Z-100 [3M]), containing Bis-GMA and GDMA. 66% volume of urethane dimethacrylate (UDMA) and TMPT as filler particles (0.014-0.4 μ). Etching of the surface was done with total etch technique. They found that use of microfilled resins offered greater resistance to wear and marginal deterioration. Composite used in a present study containing Bis-GMA and UDMA with 63% volume of filler particles (silica and zirconium), with etch and rinse technique did not make a significant difference in microleakage.[18-21]

In the present study, one type of bonding agent, composite material, and etching technique were tested in *in-vitro* conditions. The results obtained within the limitations of the study indicate that higher P:L ratios of ZOE cement cause more micro leakage, which rejects the hypothesis. Leakage was more at dentin margins than at enamel margins in all types of pretreated temporary restorations used in this study as shown in Graph 1.

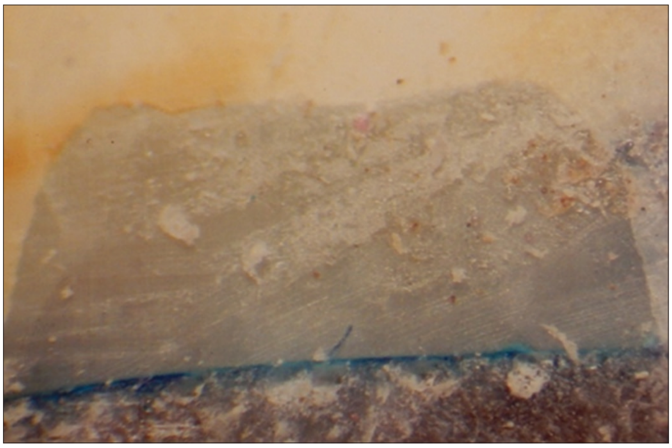


Figure 1: Stereomicroscopic image of microleakage (Grade I).

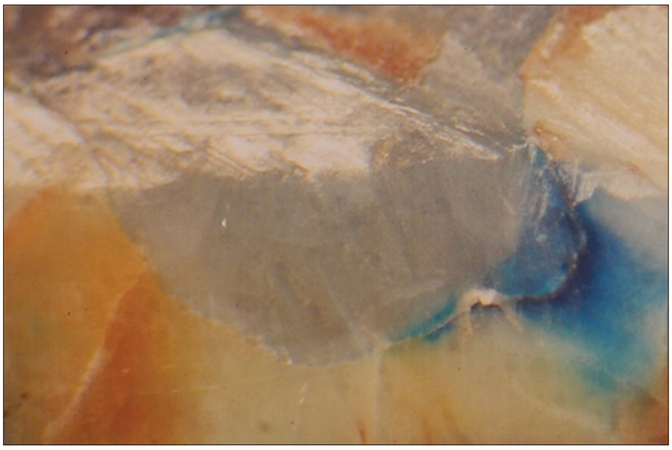


Figure 2: Stereomicroscopic image of microleakage (Grade II).

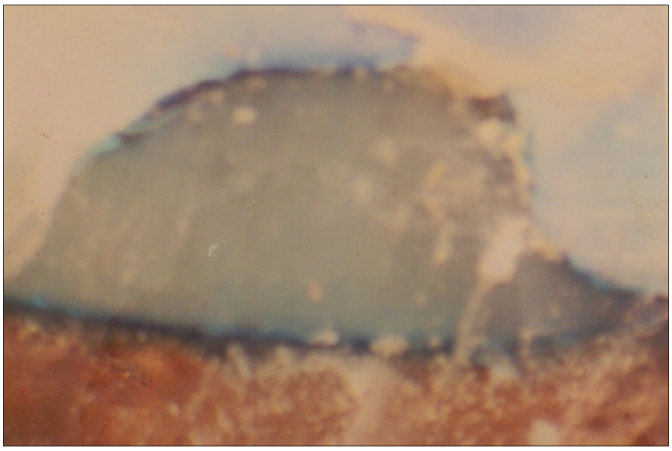
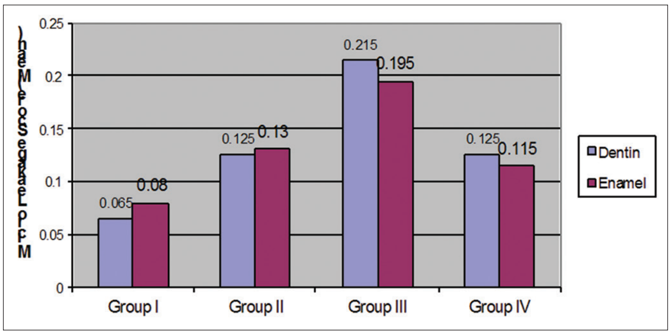


Figure 3: Stereomicroscopic image of microleakage (Grade III).

Conclusion

Based on the results of this study the following conclusions were drawn:



Graph 1: Microleakage of all groups at enamel and dentin margins.

- Microleakage at dentin margins was higher than enamel margins
- Increased P:L ratio of Type III ZOE cement increased the microleakage at dentin and enamel margins.

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