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# Effect of Temporary Cements on Microleakage of Composite Restorations: An *In vitro* Study

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**Abstract:** Cements such as zinc oxide eugenol have been frequently used as temporary restorations, but, the presence of eugenol in cement can negatively affect the seal of the permanent restorations like composite resin. To evaluate the microleakage of composite restorations following pre-treatment with ZOE temporary cements of different powder: liquid ratios and compare them with eugenol-free temporary cement. Class V cavities were prepared on the buccal surfaces of 32 freshly extracted human premolars. Teeth were divided into 4 groups of 8 each. Gr.1-Received no temporary restoration. Gr 2 and 3-Filled with Type III ZOE mixed at P: L ratio of 10 g: 1 g and 10 g: 2 g, respectively. Gr 4: Received eugenol-free cement (RelyX Temp NE). After one week storage in water, temporary fillings were removed and cavities were restored with composite resin (Z100). The restorations were finished , thermally stressed for 500 cycles at 5±56°C , subjected to dye penetration testing and observed under stereomicroscope at X40 magnification. Results were analyzed using Kruskal-Wallis and Mann-Whitney tests. At both enamel and dentin margins, the microleakage associated with group 3 was significantly more than group 1, 2 and 4. Pre-treatment of cavity with ZOE mixed at a P: L ratio of 10 g: 2 g significantly increased microleakage and is not recommended clinically.

**Key words:** ZOE temporary cement, composite restoration, microleakage, *in vitro* study

## INTRODUCTION

Materials containing eugenol have been used frequently in different combinations and for different purposes in restorative dentistry. The various formulation of zinc oxide eugenol (ZOE) cement are reflected in ADA specification No.30:

- Type I cement-used for temporary restoration.
- Type II cement-is intended for permanent cementation of restorations or appliances fabricated outside the mouth.
- Type III cement-is used for temporary restorations or thermal insulating base.
- Type IV cement-is used as a cavity liner.

ZOE also serves as root canal sealers, surgical dressings and impression materials. They have a sedative effect on teeth, are inexpensive, easily removed and can provide a good seal against leakage (Anusavice, 2004; Yap and Shah, 2002).

Both beneficial and harmful effects have been attributed to this substance. Concentration-dependent side effects of eugenol are for example; vasodilation, inhibition of cellular respiration, inhibition of prostaglandin-synthesis, cytotoxic and neurotoxic effects (Kielbassa and Attin, 1997; Anamura and Dohi, 1988; Brodin and Roed, 1984; Valle *et al.*, 1980; Meryon and Johnson, 1988; Markowitz and Moynihan, 1992).

In addition to the above mentioned side effects, the eugenol has been shown to adversely affect many of physical properties of resin, for example, eugenol softens composite resin, inhibits polymerization, decreases transverse bond strength, decreases surface hardness, increases surface discoloration, roughness and decreases shear bond strength of resin to resin. Eugenol has been shown to increase the gap width between the dentin bonding agent and the tooth (Woody and Davis, 1992; Civjan and Huget, 1973; Lingard and Davis, 1981; Paige and Hirsch, 1986; Reisbich and Brodsky, 1971; Schwartz and Davis, 1990).

ZOE temporary cements may be used due to the lapse of clinical time, as intermediate restoration of multiple carious teeth and as in indirect pulp capping procedures (Anusavice, 2004; Yap and Shah, 2002).

As clinical usage of composite resin for the restoration of posterior teeth has been increased substantially, it is important to determine the influence of ZOE temporary cements on microleakage of composite restoration.

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Although, many researches have shown that the eugenol present in ZOE cement has no effect on properties of resin composite (Ganss and Jung, 1998a, b; Powel and Huget, 1993), contradictory findings exist with regard to use of eugenol containing cements prior to composite restorations (Woody and Davis, 1992; Civjan and Huget, 1973; Lingard and Davis, 1981; Paige and Hirsch, 1986; Reisbich and Brodsky, 1971; Schwartz and Davis, 1990; Marshall and Marshall, 1982; Millstein and Nathanson, 1983; Terata and Nakashima, 1994; Hansen and Asmussen, 1987).

The aim of this study was to evaluate the microleakage of composite restorations following pre-treatment with ZOE temporary cements of different powder: liquid ratios and compare it with eugenol- free temporary cement. Specimens that received no temporary restoration were used as control. For each group, the difference between enamel and dentin microleakage was also compared.

## MATERIALS AND METHODS

Thirty two freshly extracted, non carious human premolars were selected for the study. After extracting the teeth, they were stored in 10% formalin solution. Class V cavities (mesiodistal width of 3 mm, occlusogingival height of 2 mm and a depth of 1.5 mm) were prepared on the buccal surface of each tooth using a high speed diamond bur with water coolant. The occlusal margins of the preparations were in enamel and the gingival margins were in dentin. A 45 degree bevel was placed on the occlusal margins of cavities using a flame shaped bur. The teeth were washed and randomly divided into four groups of 8 teeth.

The specimens in group 1 (control) received no temporary restoration.

Group 2 specimens were filled with Type III ZOE cement (Dentsply-Caulk, Milford, DE 19963) mixed powder: liquid (P: L) ratio of 10 g: 1 g (one spoon of powder one drop of liquid) (Fig. 1).

Specimens in group 3 were also filled with ZOE cement but a lower P: L ratio of 10 g: 2 g (one spoon of powder: 2 drops of liquid) (Fig. 2).

Group 4 specimens were covered with RelyX Temp NE cement (3M, ESPE AG,

D-82229 Seefeld Germany). RelyX Temp NE is zinc oxide non-eugenol temporary cement supplied in 2 tubes, base in one tube and catalyst in other tube, an equal length of contents of 2 tubes were mixed and placed in the cavities (Fig. 3).

Names, composition and the manufacturers of the materials used in this study are given in Table 1.

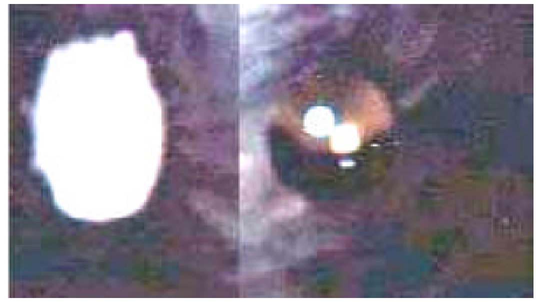

Fig. 1: One spoon of powder, one drop of liquid on glass slab

Fig. 2: One spoon of powder, two drops of liquid on glass slab

Fig. 3: Equal length of base paste and catalyst paste on glass slab

All temporarily restored specimens were then stored in distilled water at 37°C for 1 week. After 1 week

Table 1: Materials used and their composition

| Material | Main Components | Manufacturer |
|---|---|---|
| Zinc oxide Eugenol cement (Type III Cement) | Powder : Zinc Oxide Liquid: Eugenol | Dentsply-Caulk, Milford, DE 19963, RelyX Temp NE |
| RelyX Temp NE (Non-eugenol Zinc Oxide based cement) | Zinc Oxide | 3M, ESPE AG, D-82229 Seefeld Germany |
| Single Bond (One-bottle, total-etch adhesive) | Bis-GMA, HEMA, Dimethacrylates, Polyalkenoic acid copolymer, Initiator, Water, Ethanol | 3M, ESPE, Dental Product, Germany |
| Etchant gel (Total-Etch) | % 37 Phosphoric acid | Ivoclar , Vivadent |
| Resin composite Z100, B2 | Bis-GMA, TEGDMA, Zirconia/Silica | 3M, ESPE, Dental Product, Germany |

incubation time, the temporary materials were removed until the preparations were macroscopically free of material. The preparations were etched with 37% phosphoric acid gel (Total Etch, Ivoclar, Vivadent) for 15 sec for dentin and 30 sec. for enamel, rinsed for 15 sec and blot dried. A thin layer of Single Bond adhesive (3M, ESPE, Dental Product, Germany) was placed and light cured for 10 sec using a light curing unit (Kulzer curing light, Germany ). A composite resin (Z100; 3M Dental products, Germany) were placed in 2 increments, polymerized for 40 sec and immediately finished with a diamond finishing bur. Polishing was done using Sof-lex polishing disks. Ten strokes of each series of disc (coarse, medium, fine and superfine) were used.

The restorations were subsequently thermally stressed for 500 cycles with an exposure time of 10 sec at 5 and 65°C and a dwell time of 5 sec in a resting bath. In preparation for dye penetration testing, the teeth were sealed with utility wax at the apex of the roots and 2 coats of nail varnish, leaving the restorations and 1 mm beyond the margins exposed to dye. The restorations were then placed in 0.5% aqueous solution of basic fuchsin dye for 24 h at 37°C. After removal from the dye solution, the teeth were cleaned and sectioned longitudinally through the center of restorations in a buccolingual plane with a diamond sectioning disc. The sectioned restorations were examined for microleakage using stereomicroscope at X40 magnification. Microleakage at the enamel/dentin and restoration interfaces was scored using an original scale where 0 = no evidence of dye penetration; 1 = dye penetration to less than half the cavity depth; 2 = dye penetration to the full cavity depth and 3 = dye penetration to the axial wall and beyond. As each tooth was sectioned into 2, the section with greater dye penetration was scored.

## RESULTS

The distribution of dye penetration scores at the enamel-restoration and dentin-restoration interfaces is shown in Table 2 and Fig. 4 and 5. Results of statistical analysis are shown in Table 3. Results of present study showed that specimens in group 3 had the highest

Table 2: Frequency distribution of dye penetration scores

| | Enamel margin | | | | Dentinal margin | | | |
|---|---|---|---|---|---|---|---|---|
| Treatment | 0 | 1 | 2 | 3 | 0 | 1 | 2 | 3 |
| Group 1 (Control) | 5 | 3 | 0 | 0 | 3 | 5 | 0 | 0 |
| Group-2 (ZOE thick mix) | 3 | 4 | 1 | 0 | 3 | 3 | 1 | 1 |
| Group-3 (ZOE thin mix) | 0 | 3 | 3 | 2 | 1 | 6 | 1 | 0 |
| Group-4 (Relyx cement) | 3 | 5 | 0 | 0 | 2 | 4 | 1 | 1 |

Table 3: Results of statistical analysis comparison between treatment groups

| | |
|---|---|
| Enamel margins | Group 3 > Group 1, 2 and 4 |
| Dentin margins | Group 3 > Group 1, 2 and 4 |
| **Comparison between Dentin and Enamel Microleakage** | |
| Group 1 | Dentin > Enamel* |
| Group 2 | NS ** |
| Group 3 | NS ** |
| Group 4 | Dentin > Enamel* |

*Indicates statistically significant differences in leakage score ( Results of- Kruskal-Wallis and Mann-Whitney tests- at significance level 0.05). ** NS- indicates no statistically significant differences

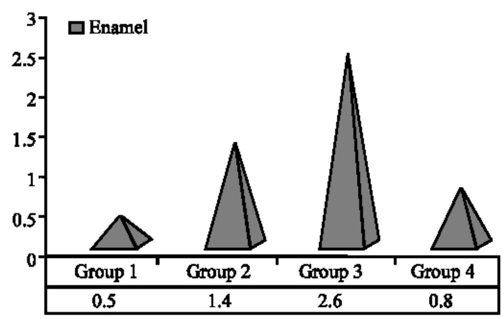


Fig. 4: Mean leakage scores for the various at enamel margin

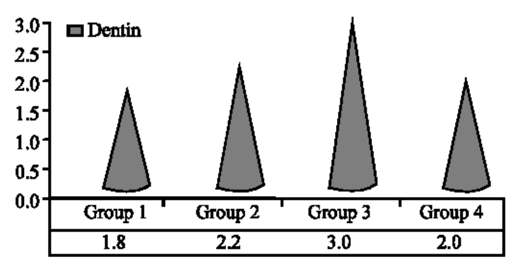


Fig. 5: Mean leakage scores for the various at dentin margin

amount of microleakage, while, the control group (gr.1) and group 4 had the least amount of microleakage at both enamel and dentin margins.

Ranking of mean leakage scores at the enamel margins from lowest to highest was as followings: group 1 < group 4 < group 2 < group 3. Ranking of mean leakage scores at the dentin margin from lowest to highest was as followings: group 4 < group 1 < group 2 < group 3. At both enamel and dentin margins, the microleakage associate with group 3 was significantly greater than groups 1, 2 and 4. For the control group (group 1) and group 4, leakage at the dentin margins was significantly greater than in enamel margins.

For the groups pre-treated with ZOE temporary restorations, no significant difference in dye penetration scores was observed between enamel and dentin.

## DISCUSSION

Microleakage at the tooth/restoration interface is a major factor influencing the longevity of dental restorations. Microleakage is defined as the clinically undetectable passage of bacteria, fluids molecules or ions between a cavity wall and the restorative materials applied to it. Microleakage may lead to marginal stain, breakdown of the marginal areas of restoration, secondary caries at the tooth/restoration interface and post operative sensitivity and pulp pathosis (Alani and Toh, 1997; Alavi, 2002; Retief, 1991; Edward and Bradley, 1992; Saboia and Pimenta, 2002). Prevention of microleakage along the margins of restorations is therefore a high priority.

In the present study, the effect of temporary cements on microleakage of composite restorations was evaluated and the results showed that the temporary cements containing greater amount of eugenol (group 3) had the highest amount of microleakage compare to control group (gr.1) and group filled with eugenol-free temporary cement (gr.4).

The polymerization reaction of composite resins and resin bonding systems takes places by free radical additional polymerization. As with other phenolic compounds, eugenol is a free radical scavenger that inhibits the polymerization of resin materials (Yap and Shah, 2002). Eugenol release and diffusion through dentin has been observed from all ZOE mixtures. The presence of concentration of eugenol in the aqueous phase just beneath the ZOE cement and adjacent to the pulp has been found. It has been shown that the diffusion rate of eugenol is usually highest at one day and decreases rapidly after one week (Yap and Shah, 2002; Hume, 1984). A 1-week pretreatment time with temporary restorations was thus selected.

In the present study the composite resin was placed incrementally to minimize higher shrinkage rate that is associated with bulk polymerization, creating wider marginal gaps with greater microleakage and giving a worst-case scenario. Hansen and Asmussen (1987) found that there are markedly increased contractions gaps in dentin pretreated with ZOE filling materials (Alani and Toh, 1997).

The results of current study are in agreement with that of Yap and Shah (2002). ZOE mixed at P: L ratio of 10 g: 1 g did not influence microleakage of both enamel and dentin margins significantly. Acid etching with 37% phosphoric acid employed with single bond adhesive was effective in removing any residual cement and eugenol contaminated dentin. Pre-treatment with ZOE mixed at a P: L ratio of 10 g: 2 g resulted in significantly more enamel and dentin leakage compare to other groups, wetter ZOE mixtures have been shown to have significantly higher eugenol diffusion rates (Kielbassa and Attin, 1997). The greater amount and possible deeper penetration of eugenol associated with group 3 could cause inhibition of polymerization of the resin resulting in bond failure and microleakage.

For the control group and the group pretreated with non-eugenol cement (RelyX), leakage at the dentin margins was significantly greater than enamel margins. There was little or no observable microleakage at the enamel margins of these groups proving the effectiveness of the acid etching technique. No statistically significant differences in leakage was however, observed between enamel and dentin for both ZOE pre-treated groups.

RelyX Temp NE is zinc oxide non-eugenol temporary cement. This newly marketed cement can be used for temporary fixation of provisional restorations, crowns, bridges, inlays, onlays and core build up material.

Extremely low film thickness of this cement helps ensure an optimal fit and makes it an ideal partner for use with precision-fitting restorations. Strong adhesion offers high retention to the tooth, yet is removed easily for final cementation. This temporary cement will not inhibit the polymerization of composite resin. It is compatible with temporary crown and bridge materials, resin cements and composite resin core build-up materials. The manufacturers claim that this cement does not affect the polymerization of filling and luting composite. The result of this study showed the same thing.

The results of present investigation indicate that temporization with a cement, whether it contains eugenol or not increases microleakage at non-enamel margins. As demonstrated in Table 2 and 3, all the 3 groups that were treated with temporary cements leaked to some degree and leaked more at the non-enamel margins and the group that received no cement showed the least leakage. These findings imply that the cement itself rather than the eugenol was responsible for the leakage. Schwartz and Davis (1990), investigated the effects of eugenol on composite resin by comparing eugenol-contaminated specimens with specimens receiving no treatment, in their study the effects noted in the eugenol contaminated groups were attributed to the presence of eugenol which has been shown to have detrimental effect on resin, but, with development of new types of dentin bonding systems and total-etch technique, the removal of residual eugenol from the cavity is easier, although cleaning the cavity with a pumice water slurry prior to placement of resin composite may remove the residual cement, however, according to study done by Dilts (1986) inspite of cleaning the cavity with pumice slurry, still small amount of cement remained in the isolated area, which could interfere with resin polymerization.

RintaroTerata and Nakashima (1994) in have reported that even after removal of temporary cement with a dental probe, some traces remains on tooth surfaces and some of the ingredients probably penetrate the tooth surface. This residual cement and penetration may change the characteristics of tooth structure, for example, contact angle and dentin permeability and this could be the reason why after using the temporary cements the microleakage of composite restorations increased. The results of present study is in agreement with results of study conducted by Khamverdi and Shakib (1384) in who reported that use of temporary cements containing eugenol can significantly increase microleakage of composite restorations especially at gingival margins of Cl. V restorations. So, considering the results of present study and other similar above mentioned studies it can be stated that temporary cements containing higher amount of eugenol should not be used on the surfaces to be later restored with composite resin and bonding systems, however, a definite conclusion can not be drawn and with intervention of newer bonding systems more and more studies and researches should be done in future.

## CONCLUSION

Temporary restorations containing greater amount of eugenol significantly increased the microleakage and therefore is not recommended clinically. The central issue is thus not the use of ZOE temporary cements but the P: L ratio of ZOE cement used.

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