

# CORONAL SEALING ABILITY OF COPALITE VARNISH WITH DIFFERENT INTERMEDIATE RESTORATIONS AS AN INTRA-ORIFICE BARRIER IN ENDODONTICALLY TREATED TEETH. A COMPARATIVE IN-VITRO STUDY



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## ABSTRACT

### *Background*

Coronal restorations having an effect on the outcome of root canal treatment.

### *Objectives*

The aim of this study was to evaluate and compare sealing ability of three cement base materials with and without cavity varnish in the orifice of root canal systems after root-canal treatment.

### *Methods*

The palatal root of extracted human maxillary first molar teeth were selected, after preparation and obturation three millimeters of coronal gutta-percha were removed from the coronal aspect of the root canal and divided randomly into six groups (6 roots each). Root canal orifices were restored with conventional glass ionomer cement, zinc polycarboxylate cement and zinc phosphate cement bases with and without cavity varnish. All the specimens were thermocycled for 100 cycles at 7°C – 55°C for 60 sec in each bath. They were immersed in the 1% methylene blue solution for 7 days, and then sectioned into longitudinal sections. The extent of dye penetration was measured using stereomicroscope. Data were analyzed statistically.

### *Results*

All the materials leaked at the interface of restorative material-dentin wall. Glass ionomer cement with varnish sealed significantly better than the other groups.

### *Conclusion*

Placement of a suitable intra-orifice barrier, like conventional glass ionomer cement with a layer of copalite cavity varnish over it, may help minimize coronal microleakage in endodontically treated teeth.

**Keywords:** *Glass-ionomer; Zinc polycarboxylate; zinc phosphate; Copalite cavity varnish; Microleakage.*

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## INTRODUCTION

The aim of endodontic treatment is to eliminate microorganisms and their byproducts from the root canal system and to create a fluid-tight seal that prevents re-infection <sup>(1)</sup>.

Numerous studies have demonstrated that coronal leakage can jeopardize the prognosis of endodontic therapy, and it has been indicated in the literature as the major determinant of endodontic success or failure <sup>(2,3)</sup>.

Microleakage is defined as the clinically detectable passage of bacteria, fluids, molecules or ions between a cavity wall and the restorative materials applied to it and are the major problem in clinical dentistry <sup>(4)</sup>.

Microorganisms can penetrate through different temporary restorative materials and supposedly well obturated root canals. Various studies on coronal leakage have shown that canal obturation techniques and material; do not provide a hermetic seal at several different times after completion of endodontic therapy. Therefore, the importance of an immediate definitive coronal seal should be emphasized after obturation of the canal system <sup>(5,6)</sup>.

A coronal barrier in root-filled teeth is one of the most effective methods for prevention of coronal microleakage <sup>(7)</sup>. Application of an intra-orifice seal to prevent coronal microleakage has been widely accepted <sup>(8)</sup>. The restorative materials should provide a permanent, leak-proof seal. However, no leak-proof permanent restorative material is yet available. The apical seal may be adversely affected if coronal seal is lost or becomes defective <sup>(9)</sup>.

A Cooley Copalite dental cavity varnish is used to provide a barrier against irritants (from cements and other restorative materials) and to reduce the penetration of oral fluids into the underlying dentin at the tooth-restoration interface <sup>(10)</sup>.

Microleakage tests can provide much useful information about the performance of restorative materials. A variety of different techniques for assessing microleakage have been developed and utilized. These include the use of dyes, radioactive isotopes, air pressure, bacteria, neutron activation analysis, scanning electron microscopy (SEM) and other methods <sup>(11)</sup>. Commonly used methodology is dye penetration method, mainly because of its sensitivity and it is easy to perform.

The method is based on the supposition that the depth of dye penetration represents the gap between the root filling and the canal walls <sup>(12,13)</sup>.

The purpose of this study was to evaluate and compare the sealing ability of conventional glass ionomer cement, zinc polycarboxylate cement and zinc phosphate cement bases with and without the use of Copalite cavity varnish, as intra-orifice barrier to prevent coronal microleakage of endodontically treated teeth, using the Methylene blue dye leakage method.

## MATERIALS AND METHODS

Ethical approval for the protocol of this study was obtained from the Research Ethical Committee, University of Sulaimani.

Thirty-six freshly extracted intact and carious human permanent maxillary first molar teeth were selected for this study. Teeth were stored in normal saline. X-rays were taken to assess the absence of anatomical anomalies in the canal system. The root canal was prepared by step back technique using K-file to a size of 60 numbers, using 2.5% solution of sodium hypochlorite as an irrigant. The canals were then dried with sterile absorbent point followed by obturation with gutta-percha points (Deadent, Korea) and ZOE sealer (DPI, India) using lateral condensation technique, then teeth were decoronated just apical to the cemento-enamel junction with a low-speed diamond disk. The palatal roots were separated at the furcation area.

Excess Gutta-percha and sealer were removed to terminate 3 mm apical to the level of decoronation as measured by periodontal probe. The prepared cavities were cleaned by irrigation with 3 ml of 17% solution of EDTA (Glyde, Dentsply Co.) followed by 3 ml of 5% NaOCl, a final flush was done with 3 ml of distilled water and dried with an air stream. Roots were randomly divided into six experimental groups, with six roots in each group, table 1.

### Experimental Groups

**Group-1:** Conventional glass ionomer cement base was mixed according to manufacturer instructions and condensed in the cavities, the excess was removed. Copalite cavity varnish (Cooley & Cooley Ltd) was applied over the entire cement base and adjacent cavity margin, and then dried with gentle air stream for 15 s. This was repeated

till 3 layers of cavity varnish was applied and dried.

**Group-2:** Conventional glass ionomer cement base was mixed, and condensed in the cavities as in group 1. Cavity varnish was not applied.

**Group-3:** Zinc polycarboxylate cement base was mixed according to manufacturer instructions and condensed in the cavities, the excess was removed. Cavity Varnish was applied as in group 1.

**Group-4:** Zinc polycarboxylate cement base was mixed and condensed in the cavities as in group 3. Cavity varnish was not applied.

**Group-5:** Zinc phosphate cement base was mixed according to manufacturer instructions and condensed in the cavities, the excess was removed. Cavity Varnish was applied as in group 1.

**Group-6:** Zinc phosphate cement base was mixed and condensed in the cavities as in group 5. Cavity varnish was not applied.

After placement of the test materials into access preparations, the specimens were stored in a

humidor at 37°C for 48 h. The specimens were then subjected to thermo cycling at 7°C and 55°C for 100 cycles. A complete cycle lasted for 2 min and consisted of 60 s at each bath. After thermo cycling, the root surfaces of teeth in these 4 groups were covered with 2 layers of nail varnish, except for the coronal 2 mm. All samples were immersed in 1% methylene blue dye for 7 days. The specimens were rinsed under running water to remove the superficial dye. Longitudinal sections were prepared with a diamond cutting disk, in bucco-lingual direction.

The sections were observed under a stereomicroscope at 1,6 X 10 magnification (Leica MS5 Switzerland) and the linear depth of dye penetration was measured on both sides of the filling material in all sectioned roots of all groups with caliper (Vernier Caliper 200xmm) . Linear measurements to the nearest 0.5 mm were considered as microleakage. The statistical analysis was done using SPSS version 17.1. The level of statistical significance was established at  $p < 0.05$ .

**Table 1. Experimental groups.**

Group	After root canal treatment
1	Conventional glass ionomer cement base with cavity varnish.
2	Conventional glass ionomer cement base without cavity varnish.
3	Zinc polycarboxylate cement base with cavity varnish.
4	Zinc polycarboxylate cement base without cavity varnish.
5	Zinc phosphate cement base with cavity varnish.
6	Zinc phosphate cement base without cavity varnish.

## RESULTS

The mean dye penetration and standard deviations recorded for each group are listed in table 2. The analysis of variance for microleakage for different cement base materials used in the study was found to be significant. All the materials leaked at the interface of restorative material-dentin wall, figure 1.

After 7 days of immersion in dye, the results showed variable leakage pattern in all the groups

and none of the material tested prevented microleakage completely.

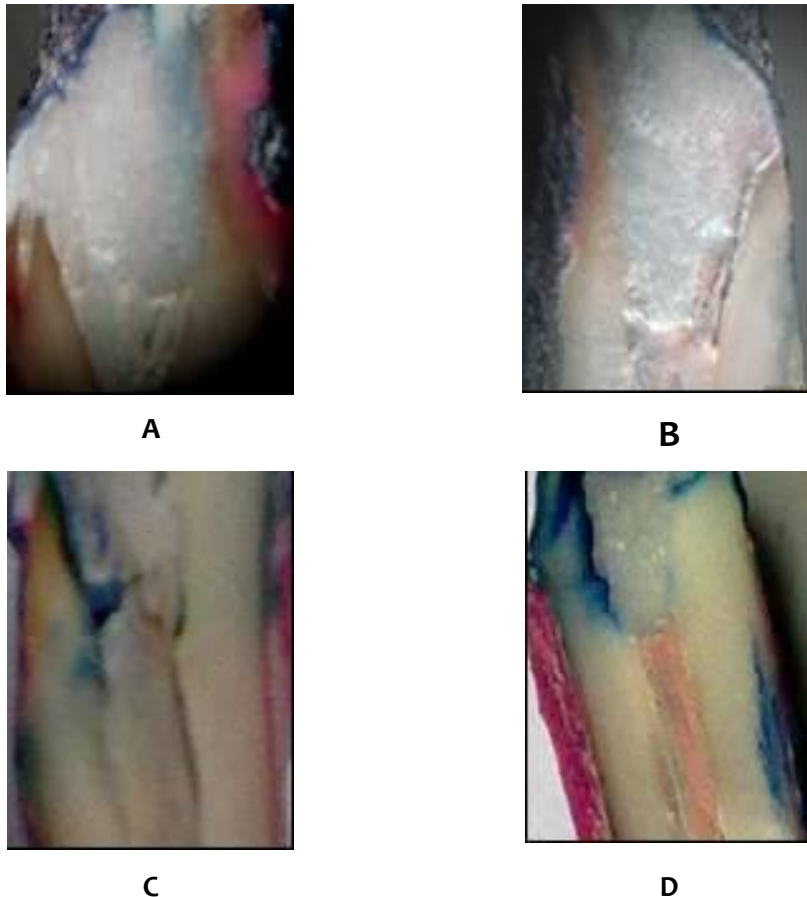
Microleakage was found to be maximum in group-4 (zinc polycarboxylate with no cavity varnish), followed by group-3 (zinc polycarboxylate with cavity varnish) and the least amount of microleakage was in group-1 (glass ionomer with varnish). Therein lies, the test materials can be summarized in the order of: Group-4(Maximum)>Group-3>Group-6>Group-5>Group-2>Group Group-1 (Minimum).

There was a significant difference ( $p < 0.05$ ) in the microleakage of Group-1(Conventional glass ionomer cement with cavity varnish) with all the other groups. With cavity varnish, there was no significant difference ( $p > 0.05$ ) in the

microleakage scores of zinc polycarboxylate cement with zinc phosphate cement. Whereas without cavity varnish zinc phosphate cement showed significantly ( $p < 0.05$ ) less microleakage than zinc polycarboxylate cement, table 2.

**Table 2. Mean leakage, standard deviation (SD) and analysis of variance for microleakage of tested materials used in this study.**

<b>Groups</b>	<b>t value</b>	<b>p value</b>	<b>significance</b>
<b>1:2</b>	3.64	0.0046	significant
<b>1:3</b>	10.1	0.0001	significant
<b>1:4</b>	6.74	0.0001	significant
<b>1:5</b>	6.98	0.0001	significant
<b>1:6</b>	5.58	0.0002	significant
<b>2:3</b>	2.36	0.04	significant
<b>2:4</b>	1.19	0.26	Not significant
<b>2:5</b>	0.988	0.35	Not significant
<b>2:6</b>	0.681	0.51	Not significant
<b>3:4</b>	1.58	0.14	Not significant
<b>3:5</b>	0.889	0.39	Not significant
<b>3:6</b>	2.12	0.06	Not significant
<b>4:5</b>	0.665	0.52	Not significant
<b>4:6</b>	2.24	0.049	significant
<b>5:6</b>	0.65	0.53	Not significant



**Figure 1. Representative specimens for minimum and maximum coronal dye penetration from different group. A: glass ionomer without cavity varnish. B: glass ionomer with cavity varnish. C: zinc polycarboxylate without cavity varnish. D: zinc phosphate without cavity varnish.**

## DISCUSSION

Coronal seal is of critical importance for successful endodontic treatment, and obturated root canal is not an adequate barrier to leakage<sup>(14)</sup>. Coronal leakage can occur due to various factors; dissolution of cement by saliva, improperly placed restoration that results in fracture or dislodgement, lack of bond between tooth and restoration, coefficient of thermal expansion, and so on<sup>(15)</sup>. Many studies have shown that intracoronal barriers decrease coronal microleakage<sup>(16,17)</sup>.

Therein lies, the search for an ideal material or technique is necessary to act as an intracoronal barrier in prevention of coronal microleakage in endodontically treated teeth. Ex vivo evaluation of leakage may not correlate directly with clinical outcome<sup>(18)</sup>, most systems seem to be adequate for comparison of relative leakage, they do not simulate the type of microbial leakage that occurs clinically<sup>(19)</sup>, but the results may provide

information to the clinician in the selection of the material and technique to maximize the treatment outcome.

For consistency in the evaluations, palatal root of maxillary first molar were used in this study. Dye leakage assessment was done by using methylene blue dye, because it easily penetrates the water compartment of the tooth, does not react with the hard tissues and is readily detected under visible light<sup>(20)</sup>. The limitation of dye leakage studies is that they measure the degree of leakage in only one plane, making it impossible to evaluate the total amount of leakage.

Thermocycling is included in this ex-vivo study to closely reproduce the in-vivo conditions. The temperature fluctuation has shown to adversely affect the marginal seal of a restorative material<sup>(21)</sup>. The longitudinal sectioning method was selected and preferred over the other techniques, since it enables examination of the exposed filling

material and any dye penetration into the material and at the interface of the dentinal wall on one side. This technique provides more reliable information about the real leakage pattern than transverse sections or clearing<sup>(22)</sup>.

The most important criteria of an ideal intra-orifice material are sealing against coronal microleakage and bonding to tooth structure. In the present study both zinc polycarboxylate cement and zinc phosphate cement provided a less effective seal than conventional glass ionomer cement base, this corresponds to the study by Jeffery *et al.*<sup>(23)</sup>.

However, there is a real lack of technique standardization, as even when one and the same methodology is used, small variations may be included, which are able to interfere in the final outcome of the research. and the relationship of in vitro leakage measurements to the in vivo situation has not yet been established, the most reasonable way of testing the efficacy of coronal restoration is extrapolation of the data obtained from in vitro studies to clinical conditions and long term clinical evaluation of the results<sup>(24)</sup>.

The results of the present study may be explained by the difference in the thermal expansion coefficient between the tooth structure and the test materials. Such a difference may have caused an inadequate adhesion to the cavity walls. Glass ionomer cements are made primarily of alumina, silica and polyacrylic acid and self-curing materials that depend primarily on a chemical bond to tooth structure.

In this study, the cavity varnish used as a liner over the applied cement bases and adjacent cavity root dentin, was effective in reduction of dye penetration in all specimens. The only available explanation is that it seals the dentinal tubules, thus reducing the effects of micro-leakage. The cavity varnish is defined as natural gum (copal or resin) dissolved in an organic solvent such as acetone, chloroform, or ether. After the root dentin-cement interfaces is covered with a varnish, the solvent evaporates, leaving the solute as a thin layer or film, which is virtually insensitive to storage conditions<sup>(25)</sup>.

Under the conditions of this ex vivo study, we conclude that glass ionomer cement with cavity varnish did not completely resist dye leakage during a contact period of 7 days. In addition, our results show that glass ionomer with copalite cavity varnish provided an acceptable coronal seal

compared to zinc polycarboxylate cement and zinc phosphate cement, and it may be a good choice for intra-orifice barrier under a permanent restoration in endodontically treated teeth.

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