Microleakage evaluation of intraorifice sealing materials in endodontically treated teeth

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Study design. Root-canal treatment was performed on 80 extracted human molars. Three millimeters of coronal gutta-percha was removed from the coronal aspect of the root canal and replaced with one of the 3 filling materials. After thermocycling (5°C to 55°C) and 5 days of immersion in dye, the teeth were cleared for stereomicroscope evaluation for evidence of dye penetration into the sealing material and along canal walls.

Results. All groups showed dye penetration into the root canal. Cavit sealed significantly better than the other groups (P < .01), preventing the coronal leakage in 90% of the specimens. Flow-It exhibited the highest leakage (65% of specimens) and did not differ significantly from the Vitremer group, which showed dye penetration in 55% of specimens.

Conclusion. Cavit sealed significantly better than Vitremer and Flow-It when used as intraorifice filling materials.


Several studies have shown that certain factors influence the outcome of endodontic treatment. They may include the preoperative status of the root canal, presence of the periapical lesion, previous root canal treatment, the root filling quality, and coronal restoration.1,2

The importance of the coronal leakage on the outcome of root canal treatment has been widely accepted.3-7 However, recent studies1,8-13 have not found the restoration to affect the outcome of endodontic treatment. Thus, the true outcome impact associated with microbial leakage has not been definitively established.

Microbial infection is one of the major factors associated with endodontic failure. Therefore, every effort should be made to prevent microbial contamination of the pulp space.13 The addition of a coronal seal for root canal fillings has been recommended.8

Roghanizad and Jones14 suggested placing a coronal seal in the orifice of the root canal immediately after root canal filling. They suggested the replacement of 3 mm of coronal gutta-percha by a restorative material. This method would offer enough bulk of material to seal the canal appropriately without limiting the thickness or compromising the retention of the final restoration.

The restorative materials should provide a permanent, leak-proof seal. However, no leak-proof permanent restorative material is yet available. Materials to
provide efficient intraorifice sealing have been studied. Roghanizad and Jones have shown that amalgam with 2 coats of cavity varnish sealed significantly better than Cavit and TERM. However, amalgam can cause discoloration on anterior teeth or interfere with the future bonding agents that are usually used for these teeth.

Pisano et al. found Cavit to be better than IRM and Super-EBA when used as intraorifice filling materials. To minimize leakage, bonded restorations have also been recommended.

Our study evaluated Cavit, Vitremer, and Flow-It as intraorifice filling materials for the prevention of coronal microleakage in the absence of coronal restoration immediately after completion of root canal treatment.

**MATERIAL AND METHODS**

Maxillary and mandibular human molar teeth were stored in deionized water with 1% thymol following extraction. After scraping the external surface, the teeth were kept under running water for 30 minutes, then kept in distilled water at room temperature. Prior to sample selection, all teeth were examined clinically by transillumination under 3.5× magnification for fractures or defects that would eliminate them from the study.

Eighty teeth were treated by the same dentist to reduce variability. The crowns were removed at the cementoenamel junction with a tapered fissure carbide bur at high speed under water spray. The instrumentation technique used for cleaning and shaping was performed as follows: the coronal two thirds of the canals were prepared sequentially with size 15 to 40 K-Flexofiles (Dentsply Maillefer Instruments, Ballaigues, Switzerland) followed by size 2 and 3 Gates Glidden burs (Dentsply Maillefer). The apical third of the root canal was instrumented up to size 35 for mesial and buccal canals and up to size 45 for distal and palatal canals. Finally, root canals were further instrumented with step-back technique enlargement in 1 mm increments to 3 sizes larger than the master apical file. Irrigation was carried out using 5 mL of a 5.25% NaOCl solution between files. After preparation, the root canals were irrigated with 5 mL 17% EDTA for 3 minutes to remove smear layer, followed by 5 mL 5.25% NaOCl. The final irrigation was done with 5 mL distilled water.

The root canals were dried using paper points and filled with laterally condensed gutta-percha (Dentsply Maillefer) and Roth R-801 sealer (Roth International Drug Co., Chicago, Ill) mixed according to manufacturers’ instructions. Gutta-percha master cones were fitted. The root filling technique was conducted while the teeth were maintained in moist saline-soaked gauze. Gutta-percha was cut with a heated instrument and vertically condensed right at the orifice opening of the canals. Three millimeters of the gutta-percha was then removed from the orifice of the canal with a size 5 hot plugger. Excess root canal sealer was removed with sterilized alcohol-wet cotton pellets. The teeth were randomly divided into 3 experimental groups of 20 teeth, for use by each orifice sealing material, and into negative and positive control groups, with 10 teeth each, as follows: (a) group I: zinc oxide and zinc sulphate hydrated temporary cement (Cavit, ESPE, Seefeld/Oberbay, West-Germany); (b) group II: a photo-cured plus chemically reacted glass-ionomer cement (Vitremer, 3M Co., St. Paul, Minn); (c) group III: a flowable composite (Flow-It, Jeneric/Pentron Inc., Wallingford, Conn); (d) group IV (negative control): intact teeth; and (e) group V (positive control): root-treated canals without intraorifice sealing.

Gutta-percha was kept intact in the canal orifice for specimens in the positive control group. The teeth in the 3 experimental groups and positive control group were placed in 100% humidity at 37°C for 48 hours to allow the root canal sealer to set. The coronal root canal spaces were dried, and the restorative materials were placed following the respective manufacturers’ instructions. The materials were inserted and adapted in the prepared 3-mm deep cavity over the root canal filling. Excess material was removed.

Cavit was placed into the prepared root canal cavity over the gutta-percha by using a Mini 1 Goldstein Flexi-Thin 1 (Hu-Friedy, Rio de Janeiro, RJ, Brazil) and then condensed with the same instrument. The excess was removed with a moistened sterilized cotton pellet.

A Centrix syringe (Centrix Incorporated, Shelton, CT) was used to place the Vitremer. The primer was applied for 30 seconds to the dentin according to the manufacturer’s specifications, air-dried for 15 seconds, and polymerized for 20 seconds. Vitremer was mixed for 45 seconds in a powder-to-liquid ratio standard of 2.5:1. The cavity was filled by injecting the material directly into the cavity from the dispensing syringe, smoothed with a plastic instrument (Kit JON for composite, JON, São Paulo, SP, Brazil), and cured with a visible light activator for 40 seconds. Finally, a finish gloss was applied and polymerized for 20 seconds (3M Brazil, Campinas, SP, Brazil).

For the flowable composite Flow-It, the specimens were etched with 37% phosphoric acid for 15 seconds, washed for 10 seconds, then gently dried with cotton pellets. Next, 2 coats of Primer & Bond 2.1 (Dentsply Ind. & Co. Ltd., Rio de Janeiro, RJ, Brazil) were applied to the dentin by using a saturated disposable brush. One coat of adhesive was applied and after 20
seconds, the excess was removed by a quick (<5 seconds) air spray, and then cured with a visible light activator for 10 seconds. A second coat of adhesive was applied and the same procedure followed. The material was positioned and condensed until the cavity was filled, after which it was cured with a visible light activator for 40 seconds.

The teeth received 3 layers of nail polish, leaving only the area of canal’s orifice exposed to provide uniform control of any lateral or accessory canals. All surfaces of the negative control group were completely sealed with 3 layers of nail polish.

All specimens were then subjected to thermocycling between 5°C and 55°C for 750 cycles. The dwell times in each bath and the time intervals at room temperature between baths were 1 minute. Subsequently, the roots were immersed in Indian ink (Royal Talens, Apeldoorn, Holland) for 5 days. Afterward, they were rinsed in tap water, then dried, and the coatings were completely removed with a scalpel.

The teeth were decalcified in 5% hydrochloric acid for 72 hours with constant stirring followed by running water wash for 4 hours. The teeth were dehydrated for 1 hour in each of the 75%, 85%, and 95% ethyl alcohol and 2 hours in 100% ethyl alcohol, then cleared by immersion into methyl salicylate (Fisher Scientific Co., FairLawn, NJ). The 4 surfaces (buccal, lingual, mesial, and distal) of the cleared specimens were examined under a stereomicroscope at 15× magnification (Lambda Let 2, ATTO Instruments Co., Hong Kong) for evidence of dye penetration into the sealing material along the canal wall. The dye penetration was measured in millimeters. The canal that had the greatest depth of dye penetration was used as the final score for that tooth. The dye penetration was not measured along each barrier material because it was partially, or some cases, totally lost during immersion in 5% hydrochloric acid.

The extent of dye penetration was graded into 2 categories: (i) no leakage—if leakage was 3 mm and the dye never penetrated into the gutta-percha; and (ii) total leakage—if leakage was >3 mm and the dye penetrated the entire thickness of sealing material into the gutta-percha. The recorded results of dye penetration were subjected to statistical analysis using the chi-square test, and the Mantel-Haenszel test when necessary.

RESULTS

The degree of dye penetration for each group is presented in Table I. There was no dye penetration for teeth in the negative control group, whereas the positive control group showed dye penetration in all specimens. Cavit sealed significantly better than the other groups (P < .01), showing coronal leakage in only 10% of the specimens. Flow-It exhibited the highest leakage, in 65% of specimens, which did not differ significantly from the Vitremer group with leakage in 55% of the specimens. All groups showed a statistically significant better seal (P < .01) than the positive control group, independent of the intraorifice sealing material used.

DISCUSSION

In this study, extracted molars were endodontically treated, and a thickness of 3.0 mm of intracanal gutta-percha filling was removed and replaced with a restorative material. Thermal cycling was made to expose the restorative materials to simulated clinical conditions that normally lead to stress on marginal sealing. For this, a temperature range of 5°C to 55°C was used, which according to Ziskind et al., represents the normal extremes of the oral environment.

Indian ink (pH 7.5) was used as a microleakage marker, because it permits an adequate visualization after decalcification and clearing of the specimens. Indian ink is a neutral suspension of carbon particles (pH 7.5-8.5), most of which are about 10 μm in size. In theory, due to the particle size, the ink should not enter into the tubules or small deficiencies around restorations and root fillings. Nevertheless, the range of particle sizes within the ink suspension makes their penetration possible into cracks where microleakage may occur.

The great majority of microleakage studies have examined linear dye penetration along a filling material. However, it is important to note that such studies
can only give information about the length of a gap in a sealing material/filled root canal. In this study, the volume of void (or the leaking material) could not be substantiated. Studies using quantitative volumetric data would be more reliable to compare various kinds of filling materials.23

In the present study, all samples in the positive control group, where gutta-percha was not replaced by 3.0 mm of another material, presented extensive dye penetration. Although the presence of dye penetration in vitro may not have clinical relevancy on the outcome of root canal treatment, the latter should be considered as an indicator of the potential for leakage.26 Therefore, the use of a more effective sealing material on top of the gutta-percha filling may reduce short-term microleakage inside the root canal.

Cavit is a premanipulated material composed of a single paste free of eugenol, which hardens when exposed to moisture. It is widely used as a temporary restorative material in endodontics and has outstanding sealing properties when compared with other materials for the same purpose.27,28 In this study, the excellent results obtained by Cavit as an intraorifice sealing material agree with previous findings.15 Gilles et al.29 have observed that Cavit presents reduced linear dimensional alterations when compared with zinc oxide and eugenol, providing better adaptation of the material to the cavity walls and consequently better protection during the ingestion of hot or cold foods.

Vitremer produced poor results, agreeing with Attin et al.30 and Zaia et al.18 The authors have reported that their results may be explained by the polymerization contraction and by the difference in the thermal expansion coefficient between the tooth structure and the modified ionomer. Such a difference may have caused an inadequate adhesion to the cavity walls or may have ruptured the union at the tooth/restoration interface by an eventual dehydration with consequent microleakage.

In the present study, Flow-It exhibited the highest leakage rate. It is possible that eugenol content of the root canal sealer used might have had an interaction with this material. Researchers have found that residual eugenol may change the characteristics of the tooth structure and may reduce bond strength to composite.31-33 However, other researchers have found no influence of eugenol-containing cements on dentin surface cleaned mechanically and with chemical substances.34-38

The result achieved with the resin composite Flow-It disagree with those obtained by Ferdianakis,39 who tested the resin flow Revolution against the resin Herceulite associated with resin XRV/Heliomolar (on its top) and obtained good results by using a horizontal layer arrangement in shallow cavities. The association of shallow cavity and horizontal layer arrangement may have caused a better adaptation of the material to the cavity and decreased contraction during polymerization in the study of Ferdianakis.39

The preparation and placement of 3.0 mm of Cavit, Vitremer, or flowable composite Flow-It into the root canal orifice is certainly feasible; however, the use of an intraorifice seal does not preclude the placement of an interim temporary or permanent restoration in the remaining coronal tooth structure.15 It is also important to use such a barrier on the top of the remaining apical section of gutta-percha in tooth with post placement.

This method for an immediate coronal seal in the orifice of the root canal immediately after root-canal therapy may prevent a short-term microleakage and provide a more logical choice for the placement of an adequate seal.

CONCLUSIONS

The results showed that Cavit sealed significantly better than Vitremer and Flow-It when used as intraorifice filling materials.

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REFERENCES

10. Helling I, Biulla-Shenkman S, Turetzky A, Horwitz J, Sela J. The outcome of teeth with periapical periodontitis treated with non-


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