

# EVALUATION OF APICAL MICROLEAKAGE OF TEETH SEALED WITH FOUR DIFFERENT ROOT CANAL SEALERS

## AVALIAÇÃO DA MICROINFILTRAÇÃO APICAL EM DENTES OBTURADOS COM QUATRO DIFERENTES CIMENTOS ENDODÔNTICOS

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### ABSTRACT

**O**bjectives: to compare the apical sealing ability of four root canal sealers. Materials and methods: forty extracted human maxillary canines were instrumented 1 mm short of the anatomical apex and randomly assigned to four groups (n=10), according to the root canal sealer used for obturation: Endofill, AH Plus, EndoREZ and Epiphany. Root canals were obturated with gutta-percha points, except for the Epiphany group, in which resin points (Resilon) were used. The teeth were immersed in India ink for seven days and clarified using methyl salicylate. The extent of apical dye penetration was measured with a meausroscope in all aspects of the canal. Results: AH Plus (0.02 mm ± 0.07), Epiphany (0.00 mm ± 0.00) and EndoREZ (0.32 mm ± 0.62) did not differ statistically to each other (p>0.01). EndoFill presented the highest dye penetration mean (0.83 mm ± 0.73) and was statistically different from the other sealers (p<0.01). Conclusions: the resin-based root canal sealers presented lesser apical microleakage than the zinc oxide and eugenol based sealer. No statistical differences were observed among resin based sealers.

**Uniterms:** Dental leakage; Root canal obturation.

### RESUMO

**O**bjctivos: comparar a capacidade de selamento apical de quatro cimentos endodônticos. Métodos: quarenta caninos superiores humanos extraídos foram instrumentados 1 mm aquém do ápice anatômico e distribuídos aleatoriamente em quatro grupos (n=10), de acordo com o cimento endodôntico utilizado para a obturação: Endofill, AH Plus, EndoREZ e Epiphany. Os canais radiculares foram obturados pela técnica da condensação lateral com os cimentos e com cones de guta-percha, exceto o grupo do Epiphany, no qual os cones de resina (Resilon) foram utilizados. Os dentes foram imersos em nanquim por sete dias e submetidos ao processo de diafanização e, então, clarificados empregando-se o salicilato de metila. A extensão de penetração via apical do corante foi medida por meio de um microscópio de mensuração em todas as faces do terço apical. Resultados: AH Plus (0,02 mm ± 0,07), Epiphany (0,00 mm ± 0,00) e EndoREZ (0,32 mm ± 0,62) não diferiram estatisticamente entre si (p>0,01). EndoFill apresentou a maior média de penetração do corante (0,83 mm ± 0,73) e diferiu estatisticamente dos demais (p<0,01). Conclusões: os três cimentos resinosos apresentaram menor microinfiltração que o cimento à base de óxido de zinco e eugenol, porém, promoveram selamento apical semelhante entre si.

**Unitermos:** Infiltração dentária; Obturação do canal radicular.

## INTRODUCTION

Endodontic therapy consists of cleaning and shaping the root canal system, removing organic debris and sealing the intracanal space with permanent filling materials. The obturation must seal the pulp space both apically and laterally, thus preventing further apical irritation from either incomplete elimination of bacteria and their products or communication between apical tissues and oral cavity<sup>13,18</sup>.

Some authors have reported that the smear layer produced after root canal cleaning and shaping prevents the penetration of sealer into the dentinal tubules<sup>9,20</sup>. Studies have shown that smear layer acts as a passageway for microorganisms and as a medium for viable bacteria entrapped into dentinal tubules<sup>11,21</sup>.

Despite the undisputable improvements, until today no material fulfills all requirements and desirable properties to hermetically seal the root canal system. Apical leakage is still a frequent event in root-filled teeth, which raises concern regarding the quality of obturation provided by the currently available filling materials<sup>5,10</sup>.

There are several methods for evaluating the apical sealing of root canal sealers, such as bacterial penetration<sup>25</sup>, fluid transport<sup>34</sup>, clarification<sup>28</sup>, penetration of radioisotopes<sup>4,15</sup>, electrochemical methods<sup>6</sup> and gas chromatography<sup>12</sup>. Dye penetration tests, however, seem to be the most widely used<sup>27,29,33</sup>.

The purpose of this *in vitro* study was to compare, using a dye penetration test, the sealing ability of two commonly used root canal sealers (Grossman's sealer and AH Plus) and two recently introduced resin-based sealers (EndoREZ and Epiphany).

## MATERIAL AND METHODS

Forty human maxillary canines, extracted for unknown reasons and kept in 0.1% aqueous thymol solution under refrigeration, were used in this study. The teeth were washed under tap water for 24 hours prior to the experiment to eliminate traces of thymol. None of the teeth exhibited resorption, fractures or open apices on visual inspection. Canal length was established by introducing a size 10 K-file (Dentsply-Maillefer, Ballaigues, Switzerland) into each root canal until the tip of the instrument was visible at the apical foramen. Working length was established 1 mm short of the apex. The cervical portion of root canal was enlarged using a LA Axxess drill size 45/.06 (SybronEndo, Glendora, CA, USA) before instrumentation. The apical portion of all roots was enlarged at the working length up to a size 45/.06, using K<sup>3</sup> instruments (SybronEndo). Irrigation was performed with 1 mL of 1% sodium hypochlorite alternated with the same volume of 17% EDTA between instruments. A final flush with 10 mL EDTA solution followed by the same amount of distilled and deionized water was done and the canals were dried with paper points.

The teeth were randomly assigned to four groups of 10 specimens each and the root canals were filled according to

the lateral condensation technique, as follows. In Group 1, the canals were obturated with Endofill, a zinc oxide and eugenol sealer (Dentsply Ind. e Com. Ltda, Petrópolis, RJ, Brazil). A size ISO 45 master gutta-percha cone (Dentsply Ind. e Com. Ltda, Petrópolis, RJ, Brazil) was coated with the sealer throughout its extension, including the apical portion, and placed into the root canal at the working length. Lateral condensation with size FF accessory gutta-percha points (Dentsply Ind. e Com. Ltda, Petrópolis, RJ, Brazil) and a size "C" finger spreader (Dentsply Ind. e Com. Ltda, Petrópolis, RJ, Brazil) was performed until the entire canal was sealed. Excess gutta-percha was removed with a heated instrument and the filling mass was compacted vertically with a manual plugger.

Canals in Group 2 were filled with EndoREZ, a UDMA resin-based root canal sealer with hydrophilic properties (Ultradent Products Inc., South Jordan, UT, USA), while canals in Group 3 were filled with AH Plus, an epoxy resin-based sealer (Dentsply De Trey GmbH, Konstanz, Germany), following the same technique used for Group 1. Canals in Group 4, after application of Epiphany dentin primer with a paper point, were filled with Epiphany resin-based sealer (Pentron Clinical Technologies, Wallingford, CT, USA) in the same manner as described for the other materials. However, instead of gutta-percha points, the resin points supplied with the root canal sealer in the same sizes of the previous groups were used.

Teeth were stored at 37°C, 100% air humidity for 72 hours to allow setting of the sealers. Thereafter, three layers of nail polish were applied to the tooth surface, except for the apical 2 mm, which remained exposed, in such a way that dye could penetrate the canal only via apical region.

Each group was separately immersed in India ink and stored at 37°C for 1 week, after which the teeth were thoroughly washed in running water and the nail polish was removed with a scalpel blade. Next, the teeth were demineralized in 5% hydrochloric acid, washed in tap water for 24 hours, dehydrated in ascending concentrations of ethanol at 50%, 70%, 80%, 96% and 100% for 4 hours each, and finally transferred to methyl salicylate for diaphanization.

The cleared teeth were analyzed by means of a measurement microscope (Measuroscope, Nikon, Japan). The extent of dye penetration was measured in millimeters in all aspects of the root canal by an experienced, calibrated examiner, from the apical stop to the maximum length of dye penetration.

Data were analyzed statistically using Kruskal-Wallis multiple comparison test. Multiple comparisons were performed using the Dunn's post test.

## RESULTS

Mean values and standard deviation of apical dye penetration for each root canal sealer are given in Table 1.

AH Plus, Epiphany and EndoREZ did not differ statistically to each other ( $p > 0.01$ ). EndoFill zinc oxide and eugenol sealer presented the highest dye penetration mean

and was statistically different from the other groups ( $p < 0.01$ ).

Apical dye penetration for each material is illustrated in Figure 1.

## DISCUSSION

Three-dimensional sealing of the root canal system is one of the main goals of endodontic treatment and is essential for prevention of canal re-infection and maintenance of healthy periapical tissues. For such purpose, several types of endodontic sealers have been developed and the evaluation of the apical sealing ability of these materials is extremely important<sup>26</sup>. Therefore, leakage studies that investigate the sealing properties of endodontic materials are still considered important and relevant<sup>7,19</sup>.

Different methods have been used to evaluate the sealing promoted by root canal sealers. Previous studies have shown the validity of using India ink penetration in cleared teeth for direct linear measurement of leakage<sup>9</sup>.

Apical leakage is increased in canals sealed with the presence of smear layer<sup>11</sup>.

Root canal microleakage is a complex subject because many variables may influence infiltration, such as root filling techniques, physical and chemical properties of sealers and presence or absence of smear layer<sup>2</sup>.

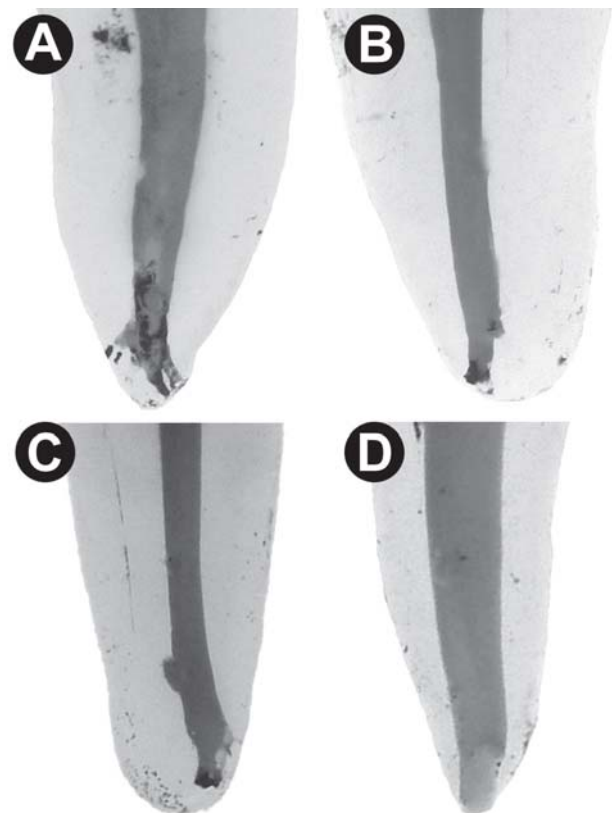
The smear layer resulting from root canal instrumentation acts as a physical barrier interfering with the adaptation and penetration of the sealer into the dentinal tubules, which might contribute for increasing microleakage occurrence<sup>20</sup>. Use of chemically active, adhesive root canal sealers may play an important role in minimizing apical leakage<sup>2</sup>. In this study, the smear layer was removed from the specimens with 17% EDTA. By doing so, the surface contact between the intracanal walls and the filling material is increased and apical seal may be improved<sup>3,20</sup>.

Although predictable clinical results have been reported with the use of gutta-percha points and epoxy resin-based root canal sealers<sup>3,14,19</sup>, there is an increasing interest in the use of methacrylate resin-based sealers (containing urethane dimethacrylate – UDMA)<sup>7</sup> because these materials can be used with dentin adhesives for bonding to intraradicular dentin<sup>24</sup>. Moreover, hydrophilic methacrylate resin monomers may be incorporated into root canal sealers to improve resin penetration into dentinal tubules after removal of the endodontic smear layer<sup>30</sup>. This fact may explain the

low microleakage results of EndoREZ, which is a UDMA resin-based root canal sealer.

Epoxy resin-based root canal sealers have also shown good physicochemical properties as well as excellent apical sealing<sup>8</sup>. Studies have demonstrated that resin endodontic sealers, such as AH Plus, have lasting dimensional stability and satisfactory apical sealing ability<sup>5</sup>. The remarkably low microleakage means of AH Plus in this study are consistent with these findings.

In addition to 17% EDTA, Epiphany Primer was applied to the dentin walls of the root canals that were to be filled with Resilon points. Epiphany primer is a self-etching primer that contains sulfonic acid terminated functional monomer, HEMA, water and polymerization initiator. Dentin preparation with the application of these chemical agents may prevent shrinkage of the resin filling away from the dentin walls and improve the sealing of the roots filled with Resilon points<sup>25</sup>. This might have contributed to the lack of apical dye penetration in the root canals obturated with Epiphany. The excellent sealing ability demonstrated by this root canal sealer in this study may also be attributed to the “monoblock” design that is created by the Resilon/Epiphany system, i.e., the Resilon points adhere to the Epiphany sealer, which, in turn, present adherence to the dentin walls<sup>25</sup>. Recent reports attest that this adhesion to the dentine walls is not flawless when examined both under SEM or TEM, a fact also observed with AH Plus sealer<sup>31</sup>.



**FIGURE 1-** Apical region of clarified teeth showing dye penetration. A) EndoFill; B) AH Plus; C) EndoREZ; D) Epiphany

**TABLE 1-** Mean values and standard deviation of apical dye penetration for each root canal sealer, in millimeters

Groups	Means and SD
EndoFill	0.83 ± 0.73
EndoREZ	0.32 ± 0.62
AH Plus	0.02 ± 0.07
Epiphany	0.00 ± 0.00

In the present study, Epiphany, EndoREZ and AH Plus presented dye penetration means close to each other. These findings may possibly be attributed to the fact that all these sealers have resin components in their formulations, which improve their adherence to the intracanal dentin walls<sup>26</sup> and is an important factor for leakage prevention<sup>1</sup>.

Zinc oxide-eugenol-based sealers have had their use standardized in Endodontics over time. They are the most widely known and clinically employed root canal sealers and have been used as controls in several *in vitro* investigations for comparison to other endodontic sealers<sup>16,23,32</sup>. Previous studies have reported that zinc oxide eugenol based sealers have poor adhesive properties to dentin and is highly permeable<sup>17,22</sup>. Accordingly, in this study, the zinc oxide-eugenol-based sealer had the highest microleakage means of all tested materials. Zmener et al. (2005)<sup>35</sup> compared the microleakage of Grossman's cement with a UDMA- based endodontic sealer, and found greater infiltration for the Grossman's cement. Similar results were obtained in our study.

## CONCLUSIONS

According to the methodology proposed and based on the results of this study, it may be concluded that the resin-based root canal sealers presented lesser apical microleakage than the zinc oxide-eugenol-based sealer, but promoted similar apical sealing among each other.

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