Effect of EDTA on apical leakage of resin based root canal sealer

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ABSTRACT

Background: Cleaning root canal is not possible without using proper irrigation. The aim of this, in vitro, study was to investigate the application time of EDTA when it is used in combination with NaOCl as final irrigant on the apical leakage when AH26 root canal sealer.

Material and methods: Thirty two extracted human single-rooted premolar teeth were used. After instrumentation the teeth were randomly divided into four groups (n=8) according to final irrigation. In group I, irrigation was 5.25% NaOCl for 5 min, group II, irrigation was 5.25% NaOCl for 30 sec + 17% EDTA for 30 sec + 5.25% NaOCl for 30 sec, and same irrigation procedure of group II were performed for both groups III and IV except increasing the time of irrigation of 17% EDTA (1 min and 5 min respectively). The teeth in each group were obturated by lateral condensation with gutta percha and AH26 sealer. The crown cavities of all teeth were sealed with temporary filling. The teeth were stored in the incubator 100% humidity and 37º C for 48 hours. The teeth roots were covered with nail polish except 2-3 millimeters from the roots apices then were placed in 2% methylene blue dye and kept in incubator for 48 hours. After that the teeth were sectioned longitudinally and the dye penetration was measured.

Results: Statistical significant difference was found between groups (p<0.001). Group I scored the highest microleakage followed by group II and III and group IV had lest microleakage.

Conclusion: when AH26 epoxy resin based sealer is used in obturation of root canal system, it is better to use combination of NaOCl and EDTA as final irrigation, and the irrigation time for EDTA preferred to be not less than 5 min to improve the apical seal.

Keywords: EDTA, apical leakage, root canal sealer.

INTRODUCTION

The main objectives of root canal therapy are cleaning and shaping and then obturating the root canal system in three dimensions to prevent reinfection. Studies have shown that current methods of cleaning and shaping root canals produce a smear layer containing inorganic and organic substances, which include fragments of odontoblastic processes, microorganisms, and necrotic materials (1,2). Presence of this smear layer prevents penetration of intracanal medication into the irregularities of the root canal system and the dentinal tubules and also prevents complete adaptation of obturation materials to the prepared root canal surfaces (3,4). Also the smear layer can create a space between the inner wall of root canal and the obturating materials, thus preventing the complete locking and adherence of the root canal filling materials into the dentinal tubules (1).

Many investigations have demonstrated that removal of smear layer causes a better adherence and penetration of sealer into the dentinal tubules preventing apical/coronal microleakage (5,6).

EDTA (ethylenediaminetetraacetic acid) is the most common chelating agent used to remove smear layer. Numerous studies have reported that irrigation with 17% EDTA has a good cleaning effect on root canal walls (1,6,7). And because EDTA acts by dissolving the inorganic components of smear layer, its use in combination with NaOCl is important to remove the organic remnants of smear layer (8,9). The cleaning effect of EDTA is achieved after its application for few minutes. According to Goldberg and Spielberg (7), the optimal cleaning effect is only achieved after 15 minutes. In contrast McComb and Smith (1), were able to show a better effect when the chelator preparation was left in the root canal for 14 hours. Other study reported that a good cleaning efficacy of EDTA after working time between 1-5 minutes (7). In two recent studies, the use of 17% of EDTA for 5 minutes as a final irrigant show different signs of dentin erosion at coronal, middle, and apical thirds of the root (2,10). Nevertheless, no optimal working time for EDTA when it is used in combination with NaOCl has been described. So the purpose of this study was to investigate the better application time of EDTA when it is used in combination with NaOCl as final irrigant on the apical leakage of AH26 root canal sealer.
MATERIAL AND METHODS
Thirty two extracted human single-rooted premolars teeth were used in this investigation. The teeth chosen had single canal with no fracture or caries, and their roots were straight. The teeth were randomly divided into four groups of eight teeth. After preparing a conventional access opening preparation for each tooth, size 15 file was inserted into the root canal until the tip became visible at the apical foramen; this distance minus 1 mm was taken as the working length. The coronal portion of the canals were preflared using Gates Glidden drills (Produits Dentaires S.A, Switzerland) and the apical portion of the canals were prepared to a size 50 K-file (Dentsply Maillefer, Switzerland), alternately irrigating after each file with 2 ml of 5.25% sodium hypochlorite. The irrigants were delivered with a 27-gauge endodontic needle, which reached within 1 to 2 mm from the working length in each canal. Each canal was filled with an irrigant during instrumentation.

According to the final irrigation the teeth were divided into four groups:
Group I (control): 5ml of 5.25% NaOCl for 5 min.
Group II: 5ml of 5.25% NaOCl for 30 sec+5ml of 17% EDTA for 30 sec+5ml of 5.25% NaOCl for 30sec.
Group III: 5ml of 5.25% NaOCl for 30 sec+5ml of 17% EDTA for 1 min+5ml of 5.25% NaOCl for 30sec.
Group IV: 5ml of 5.25% NaOCl for 30 sec+5ml of 17% EDTA for 5 min+5ml of 5.25% NaOCl for 30sec.

The canals were then irrigated with 10 ml of sterile distilled water and dried with paper points and then obturated laterally using #50 gutta-percha as master cone and #25 gutta percha as accessory cones (Alpha-Dent, Inc USA). AH26 (Dentsply, DeTrey, Konstanz, Germany) was used as sealer in this experiment. The crown cavities of all teeth were sealed with temporary filling (Produits Dentaires, Switzerland). To ensure setting of the sealer in the all groups, the samples were kept the incubator (Fisher Scientific – model 5500- USA) at 100% humidity with 37ºC temperature for 48 hours. Then all surfaces of the teeth roots except for the 2-3 mm of apical root were sealed using two coats of nail polish. All teeth were placed in 2% methylene blue dye (C.I. 52115, England, product no. 26132) and kept in incubator for 48 hours. After removing the samples from the incubator, they were thoroughly washed with water and the nail polishes were removed from the surfaces. A diamond disk was used to make buccal and lingual grooves on the root surfaces. Using a spatula, the roots were separated into two parts and the gutta-percha and filling materials were removed from the canals. The linear dye penetration (maximum point) was measured in tenth of millimeters using a stereomicroscope (Hamilton by Altay) and graded scale. The data collected were statistically analyzed by One-way ANOVA and Post Hoc LSD tests.

RESULTS
The means and standard deviations of the four groups of the study have been shown both in figure 1 and table 1. One way ANOVA test shows statistical significant differences (p<0.001) between the tested groups as shows Table 2. Table 3 shows LSD test (post hoc analysis) between the tested groups of the study with their degree of significance. LSD test shows very high statistical significant differences (p<0.001) between the tested groups.

![Figure 1: Bar chart shows microleakage for the four differently treated groups](image)

Table 1: Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>3.9</td>
<td>0.46</td>
</tr>
<tr>
<td>Group II</td>
<td>3.1</td>
<td>0.28</td>
</tr>
<tr>
<td>Group III</td>
<td>2.4</td>
<td>0.33</td>
</tr>
<tr>
<td>Group IV</td>
<td>1.3</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Table2: One-way analysis of variance (ANOVA) of tested groups

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>28.631</td>
<td>3</td>
<td>9.544</td>
<td>76.84</td>
<td>.000</td>
</tr>
<tr>
<td>Within Groups</td>
<td>3.477</td>
<td>28</td>
<td>.124</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>32.107</td>
<td>31</td>
<td></td>
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</tbody>
</table>
EDTA removed smear layer, and this improved the adherence of AH26 resin based sealer and reduced the apical microleakage. When EDTA was not used as in group I, the smear layer impaired the adhesion of the AH26 sealer with dentin surface and the microleakage was increased. This agrees with other studies which found that the use of EDTA irrigation would improve the adhesion\(^{(6,13)}\), and reduce the microleakage of resin bonded sealers\(^{(5,6)}\).

There were very high statistical significant differences \(p<0.001\) when comparing between the other groups of the study (groups II, III, and IV), which means that when EDTA application time was increased the apical leakage was reduced. Considering the qualities of AH26, if the surface area of dentin exposed to this sealer is increased, the adhering and penetrating capacity of AH26 is improved and better seal is expected\(^{(13)}\). In this regard, increasing the irrigation time with 17% EDTA caused more erosion of dentinal wall and created a porous etched surface\(^{(12)}\), which improved the adherence of AH26. These findings agreed with other studies\(^{(9)}\), which showed that better results were obtained when working time of 17% EDTA is 5 minutes.

Since the irrigation time with EDTA used in the present study did not exceed 5 minutes, these results cannot be compared with other studies that suggested extended application time of EDTA for longer periods (15 minutes\(^{(7)}\) or 14 hours\(^{(4)}\)) for better chelating action. So further investigations with more extended application time for EDTA are required.

Under the condition of this study, we concluded that when resin based sealer is used in the obturation of the root canal system, it is better to use a combination of NaOCl and EDTA as final irrigation to reduce the microleakage, and the irrigation time for EDTA is preferred to be not less than 5 minutes to improve the apical seal.

### DISCUSSION

Achieving an adequate apical seal is an important goal in endodontics to prevent bacteria and their by-products from apical percolation. In this regard, removal of the smear layer is one of the factors that can affect coronal and apical microleakage and thus compromise the long term success of endodontic treatment\(^{(9)}\). NaOCl has the ability to dissolve organic debris, kill microbes, and destroy microbial byproducts\(^{(11)}\). EDTA is a chelating agent used to remove the inorganic debris of the smear layer\(^{(1,6,7)}\). This combination of irrigants has been shown to be effective in debriding and disinfecting root canals as well as other irrigants\(^{(9)}\). Also post EDTA irrigation with NaOCl is important because when EDTA dissolves the smear layer, the dentinal tubules will be left open for NaOCl to penetrate for better disinfection and dissolving of the remaining debris inside the exposed surface of the dentinal tubules\(^{(12)}\). Since the action of EDTA is time dependent, the present study used combination of (NaOCl and EDTA at different application times, then NaOCl as a final irrigation) to measure the apical leakage of AH26 root canal sealer.

The ability of root-canal sealers to adhere to dentin and gutta-percha is expected to result in superior sealing ability, which in turn should reduce leakage in clinical situations\(^{(5)}\). One of the advantages of resin-based sealers like AH26 is that they cannot only lock into open dentinal tubules but also adhere to the exposed dentinal surfaces. This characteristic of resin-based sealers is similar to the adherence capacity of composites to the dentin and enamel of teeth\(^{(15)}\). There was very high statistical significant difference \(p<0.001\) between group I when compared with other groups of the study (as shown in table 3), which means that when EDTA was used in combination with NaOCl the microleakage was reduced. This was because

### Table 3: Post Hoc LSD test between the differently treated groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Post Hoc LSD test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Group II</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Group IV</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>

* The connected lines identify the two analyzed groups with their significant value.

### REFERENCES

5. Farhad AR, Barekatain B, Koushi AR. The effect of three different root canal irrigant protocols for Restorative Dentistry 12