

<p><b>Research Report</b></p>
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## The effectiveness of 2.5% NaOCl irrigation and 17% EDTA against the sealing ability of resin paste

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### ABSTRACT

**Background:** Root canal irrigation seeks the elimination of bacteria and its products from the root canal. If debris is left in the root canal, it can prohibit adaptation between obturation material and root canal wall. Therefore, it can decrease the sealing ability of obturation material. **Purpose:** To assess the effectiveness of 2.5% NaOCl and 17% EDTA on the apical sealing ability of resin obturation paste. **Methods:** The roots of 18 human mandibular premolar teeth were selected and the root canal was prepared using a conventional technique. Samples were irrigated with 2.5% NaOCl, and 17% EDTA, and sterile aquadest (Aqua Deastilata) as a control group. Samples were filled with gutta-percha and top seal. Samples were soaked in 2% methylene blue for 48 hours to measure the depth of microleakage. **Results:** The mean apical leakage after irrigation with 2.5% NaOCl; 17% EDTA; and sterile aquadest in the sequence were 0.92 mm; 3.6 mm; and 8.08 mm. **Conclusion:** 2.5% NaOCl has less depth of microleakage than 17% EDTA. However, the depth of microleakage cannot demonstrate the exact sealing ability of the resin paste due to some factors.

**Keywords:** irrigation solution; 2.5% NaOCl; 17% EDTA; sealing ability; resin paste

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### INTRODUCTION

Root canal irrigation is one of the important stages of root canal treatment. The irrigation procedure aims to clean the root canals, reducing friction between the instrument and the root canal dentine wall, dissolving organic and inorganic tissues, and increasing the antimicrobial effect of mechanical cleansing that has been done before<sup>1</sup>. The cleaning of the root canal is important if there is residual tissue that is still left behind (debris) that can reduce the adaptation of the filling material in the root canal wall. Poor adaptation of the filler can cause a lack of obturation density and can increase the possibility of treatment failure<sup>2</sup>.

Various irrigation materials are used to clean the root canals from organic debris, microorganisms, the remaining pulp tissue, smear layer, and endotoxins<sup>3</sup>. Material that can be used for irrigation includes hydrogen peroxidase (H<sub>2</sub>O<sub>2</sub>) 2.5%, NaOCl, 2.5%, EDTA 15%, Chlorhexidine, and aquadest (Aqua distilled). Root canal irrigation materials must have wettability, which increases the ability to dissolve tissue. Wettability of a liquid is affected by the contact angle between the liquid and solid material and the surface tension produced<sup>4</sup>. Sodium Hypochlorite (NaOCl) has been widely used as an irrigation solution since it was first introduced by

Walker in 1936. The concentration of Sodium Hypochlorite (NaOCl) solution used in root canal treatment varies from 0.5 - 5.25 %. NaOCl is an organic and fat solvent material<sup>5</sup>. NaOCl reduces surface tension thereby facilitating the release of debris from the root canal wall<sup>6</sup>. The wettability of NaOCl is reported to be smaller than MTAD and CHX4. Vivo study shows that a 2.5% sodium hypochlorite solution held for 5 minutes in the root canal can make the root canal sterile<sup>7</sup>. 2.5% NaOCl irrigation solution is commonly used in the Dental Conservation Clinics of Universitas Airlangga.

Another material commonly used as root canal irrigation is Ethylene Diamine Tetra Acetic Acid (EDTA). EDTA is a chelating agent or decalcification agent that can dissolve dentin and clean the smear layer. Some study reported that irrigation with 17% EDTA can have a good cleaning effect on the root canal wall<sup>8</sup>. EDTA containing surfactant agents are reported to have a low surface tension that can increase its wettability<sup>9</sup>.

After conducting the irrigation in the root canal, the following step is to sterilize the root canal and to conduct obturation of the root canal. The purpose of the obturation of the root canal is to eliminate things that can cause microleakage and isolate the root canal from irritants that cannot be cleaned at the cleaning and shaping stages<sup>10, 11</sup>.

Root canal obturation must obtain and maintain the hermetic seal in the root canal<sup>12</sup>. Sealing is very important to prevent bacteria from entering the root canal<sup>13</sup>.

Sealing ability is affected by root canal irrigation procedures because the complete cleaning of the smear layer by irrigation material can increase sealer adhesion in the wall of root canal dentin<sup>14</sup>. Sealer adhesion is the ability of the sealer to attach to the surface of the root canal dentin and provide bonding between dentin and gutta-percha<sup>15</sup>. One of the sealer materials, resin-based sealers, provides good adhesion to dentin, does not contain eugenol, low water solubility, and is easily manipulated<sup>16</sup>. Adhesion between resin-based sealer and dentin is the result of physicochemical interactions that cause adhesion between the filling material and root canal wall<sup>17</sup>. Adhesion is affected by the contact angle of the liquid material and the strength of the solid material surface. The lower the contact angle at the dentin surface, the more sealer adhesion will increase<sup>18</sup>. Sealer adhesion in the dentinal surface of the root canal wall determines the sealing ability of the obturation material<sup>19</sup>. The sealing ability is affected by root canal irrigation procedures because the complete cleaning of the smear layer by irrigation materials can increase sealer adhesion in the wall of root canal dentin. Failure of adhesion can result in microleakage or micro bearings between the root canal obturation material and the wall of the root canal dentine<sup>14</sup>.

Previous studies used 2.5% NaOCl as irrigation material with epoxy resin-based sealers. This procedure is said to increase the adaptation of root canal filling materials<sup>20</sup>.

Based on the various studies conducted above, the authors aim to conduct a study determining the effectiveness of 2.5% NaOCl irrigation materials and 17% EDTA on the resin paste sealing ability.

## MATERIALS AND METHODS

The study conducted was experimental laboratory research, with a post-test-only control group design. The study was conducted at the Microbiology Laboratory of the Faculty of Dental Medicine, Universitas Airlangga in June-September 2015. The sample in this study was a human permanent mandibular premolar that was extracted for orthodontic treatment purposes. The sample size was obtained using the *Lemeshow* formula, consisting of a minimum of 3 samples. However, in this study, 6 samples were used to make the data more accurate for each group. The sample group consisted of 3 groups, namely: Group I = sample were irrigated with 2.5% NaOCl; Group II = sample were irrigated with 17% EDTA; Group III = sample were irrigated with sterile aquadest (control group).

The study was started by soaking the sample in saline solution. The sample used was a permanent mandibular premolar tooth extracted for orthodontic treatment purpose, by previously emphasizing some criteria if the single root canal with apical tip had fully grown, straight root canal, no root canal stoppage, had never been restored, had no

fracture, and could be entered by needle K-file number 15. In this study, samples were obtained from the oral surgery clinic RSGMP Faculty of Dental Medicine, Universitas Airlangga.

Before root canal preparation was conducted, the crown was cut using a diamond disc bur under the cemento-enamel junction as high as 17 mm from the apex to equalize the root length. The sample was then planted in clay.

The working length is set to be 1 mm shorter than the tooth length, then the root canal preparation was carried out with a K-file with conventional techniques. Every change of equipment was done by recapitulation and irrigation. Recapitulation used was the master apical file (MAF) K-file no.30.

Irrigation was carried out according to the distribution of sample groups using an endodontic irrigation needle (C-K Endo) connected using a small hose with a compressor to equalize air pressure, which was 1 atmosphere (1033 kg / cm<sup>2</sup>). Irrigation was carried out with a 3-ml-volume solution and irrigated for 3 minutes. At the end of the preparation, the root canals were irrigated with 3 ml of sterile distilled water. After irrigation, the root canals were dried with paper points.

Root canal filling using top seal and *gutta-percha* used a single cone obturation technique and the coronal section was coated using nail polish. All samples were incubated at 37 ° C with 100% humidity for 3 days. After being incubated, the sample was soaked in 2% methylene blue for 2 days. The sample was washed under running water and dried using tissue at room temperature for 24 hours.

The sample-cutting was done by fissure bur and high-speed handpiece. After being cut, it would appear half of the root vertically. In the section that had been cut, apical leakage would be seen.

Assessment of the apical leakage was calculated in millimeters using a caliper and evaluated using a digital microscope. The calculation was repeated three times by three different observers, then the mean was obtained. Data analysis tests used in this study were the Kolmogorov Smirnov normality test, the one-way homogeneity test, the ANOVA difference test, and the *Tukey* HSD test.

## RESULTS

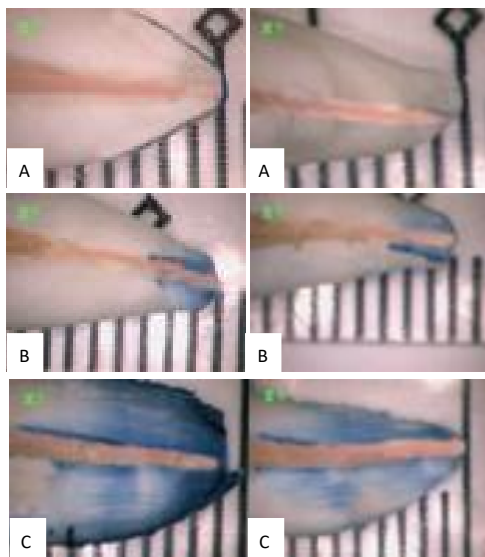
This study was conducted to determine the difference between the effectiveness of 2.5% NaOCl and 17% EDTA in the sealing ability of resin paste. The study consisted of three treatment groups, namely irrigation with 2.5% NaOCl, 17% EDTA, and sterile aquadest as a control. Each group consisted of 6 samples. The results of the apical leakage assessment from a digital microscope photo are shown in Figure 1. The mean and standard deviations of the results of the study are shown in Table 1.

Before conducting the difference-test between groups, each group was tested for its data distribution using the Kolmogorov-Smirnov test statistic. The results of the data distribution test in groups I, II, and III sequentially

**Table 1.** Mean and Standard Deviation of Influence of Root Canal Irrigation on Apical Leakage (mm)

Group	N	Mean	SD
I	6	0.92	0.67
II	6	3.6	0.79
III	6	8.08	1.46

Notes: I = irrigation group 2.5%NaOCl; II = irrigation group 17% EDTA; III = control group, aquadest irrigation.



**Figure 1.** Results of the apical leakage assessment. Note: A. Irrigation of 2.5% NaOCl; B. 17% EDTA Irrigation; C. Aquadest sterile irrigation (control).

obtained  $p = 0.551$ ;  $0.652$ ; and  $0.419$ . This showed that all three groups have normal data distribution because of the value of  $p > 0.05$ .

Then the *One-way* test was conducted to determine the homogeneity of the sample. The results obtained are  $p = 0.251$  ( $p > 0.05$ ). This meant that the sample could be said to be homogeneous. The next test was the ANOVA test to find out the differences between the three treatment groups. The results obtained were  $p = 0,000$  ( $p < 0.05$ ). Therefore, in this study, it could be said that there were differences in the three treatment groups. To assess the existence of significant differences between the groups, a Tukey HSD statistical test was performed. The test results can be seen in Table 2.

## DISCUSSION

From the analysis of statistical tests, the results showed that the depth of apical leakage of 2.5% NaOCl irrigation was smaller than aqua dest irrigation. The depth of apical leakage of 17% EDTA irrigation was smaller than aqua dest

**Table 2.** Tukey HSD Test Results on Comparative Effects of Root Canal Irrigation Material on Apical Leakage ( $\alpha = 0.05$ )

Group	I	II	III
I		0.001*	0.000*
II			0.001*
III			

Notes: I = irrigation group 2.5%NaOCl; II = irrigation group 17% EDTA; III = control group, aquadest irrigation; \* = there were significant differences between the two groups.



**Figure 2.** Photograph of a microscope on the surface of the dentin in 1/3 middle of apical. Note: A. The surface of the dentin is normal in the tubules, without erosion; B. The root canal wall has changed, severe erosion occurs and dentinal destruction is seen.

irrigation. Whereas the depth of apical leakage with 2.5% NaOCl irrigation was smaller than 17% EDTA irrigation and aquadest.

The apical leakage produced by 2.5% NaOCl was the smallest compared to 17% EDTA and aqua dest. Even though it was the smallest, there was still a leakage. This was because NaOCl only dissolved organic particles, therefore the inorganic particles were still left behind and inhibited perfect sealing. In previous studies<sup>21</sup> NaOCl was also an irrigation material which caused the smallest apical leakage compared to the CHX irrigation mixture. The results of this study followed the theory that had been presented<sup>6</sup>, saying that NaOCl could dissolve organic substances presented in the root canal system such as remaining pulp and necrotic tissue. The action mechanism of NaOCl in dissolving organic and fat converted fatty acids into fatty acid salts and glycerol (alcohol) which would reduce the surface tension thereby facilitating the release of debris from the root canal wall. The leakage on the apical might also be caused by a lack of irrigation duration. In the study, the duration was 3 minutes. Whilst *in vivo* studies showed that 2.5% NaOCl solution held for 5 minutes in the root canal was able to make the root canal sterile<sup>7</sup>.

The depth of apical leakage with EDTA 17% irrigation was quite deep when compared to 2.5% NaOCl, but smaller than aquadest. This could be caused by the fact that EDTA only dissolved inorganic particles so that organic particles were still left behind in the root canal. Besides, EDTA also dissolved dentin, causing erosion of the peritubular and

intratubular dentin so that it triggered the irregularity in the structure of the dentine and thereby reducing the density and adaptation between the sealer and the dentin<sup>22</sup>. This theory was also proven in previous studies<sup>23</sup> which said that EDTA caused erosion of the dentine through the process of demineralization and excessive opening of the dentine tubules (Figure 2). This results in decreased sealing of the root canal obturation material created bacterial filtration and tissue fluid percolation.

In the control group, aquadest irrigation was used. The apical leaks caused was 8x NaOCl and 2x EDTA, with an average of 8.08 mm. This was because Aquadest had no active substances and only could wet the root canals so that the clean power was not optimal and caused the deepest apical leakage depth among other irrigation materials.

The depth of the apical leak caused after irrigation was unable to fully demonstrate the sealing ability of the resin paste. This was caused by several factors. Firstly, the parameter used was the measurement of apical leakage depth, which was a 2-dimensional parameter. While the dimensions of the root canal on a tooth were 3 dimensions. Also, the root canal fields were measured only on one side. Supposedly, the other side of the root canal was also investigated to improve accuracy. The parameters used must have high precision so that the measurements produced were accurate.

Secondly, the factor from the anatomical variation of the root canal. Anatomic and morphological variations of root canals that were difficult to be controlled by operators became one of the factors that caused difficulty in knowing the sealing ability of the resin paste. A bent root canal could cause an uneven filling in the root canal in the apical region. Thirdly, the contraction trait of root canal paste made from acrylic resin. The nature of these contractions could cause the filling of the root canal to be less dense so that it could cause apical leakage.

Based on the results and discussion in this study, therefore it can be concluded that there are differences in the effectiveness of 2.5% NaOCl irrigation materials and 17% EDTA in the resin paste sealing ability.

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