Efficacy of Different Endodontic Irrigation Protocols in Calcium Hydroxide Removal

Elka N. Radeva, Desislava M. Tsanova
Department of Conservative Dentistry, Faculty of Dental Medicine, Medical University, Sofia, Bulgaria

ABSTRACT:

Introduction: Calcium hydroxide is widely used in the field of endodontics as a temporary root canal filling. This medicament significantly increases pH and optimizes the treatment outcome. Its total removal before final obturation is very important. Otherwise it could affect the hermetic filling and respectively the endodontic success.

Aim: To evaluate the most effective irrigation protocol of calcium hydroxide removal from root canals.

Materials and methods: In this study 36 single root canal teeth were observed. They were randomly divided into three groups (n=10 each group) according to the technique applied for calcium hydroxide removal - manual irrigation, irrigation and Revo-S rotary instrumentation; and passive ultrasonic irrigation, and a control group (n=6) - irrigation with distilled water only. After calcium hydroxide removals following the procedures above, teeth were separated longitudinally in a buccal-lingual direction and remnants of medicaments were observed in the apical, middle and coronal part of each tooth. Then all of the specimens were observed using scanning electron microscopy and evaluated by a specified scale. The results have undergone statistical analysis.

Results: In the case of calcium hydroxide in the apex and in the middle with highest average is Revo-S, followed by Ultrasonic and irrigation. In the coronal part the highest average belongs to Revo-S, irrigation and Ultrasonic. In all groups the highest average is represented by control group.

Conclusion: There is not a universal technique for removal of intracanal medicaments and applying more than one protocol is required.

Key words: calcium hydroxide, conventional irrigation, irrigation protocols, passive ultrasonic irrigation

INTRODUCTION:

One of the main purposes in root canal treatment is to eliminate the infection from the root canal system and to prevent the tooth from reinfection. Many approaches are being applied in every day dental practice. One of them is the application of intracanal medications which affects the microbiota.

It has been assumed that the microorganisms in the root canals can be additionally reduced by the use of interappointment dressing. These dressings are in fact intracanal medicaments which have different mechanisms of action. Some authors describe that they help in elimination of unaffected microorganisms [1, 2, 3].

The aim of the dressings is to reduce the quantity of microorganisms that have survived through the chemomechanical preparation. These medicaments also lessen the inflammation, relieve the pain, eliminate the periapical exudation, protect the roots from resorption caused by inflammation and help to protect the root canal system from reinfection [4].

Calcium hydroxide is one of the most commonly used temporary medicaments in the root canal treatment. It is introduced in the field of endodontics by Herman as a direct pulp capping agent. It has been approved as antimicrobial medicament for more than 40 years and some authors claim that maybe this is the best interappointment medicament of choice against residual microflora [5, 6]. The mechanism of action due to its high pH which can be kept for a long time allows some authors to introduce the hypothesis for irreversible inactivation of bacterial enzymes [7]. There are three main mechanisms of action described in the literature that destroy the bacteria in the root canal system: First is Ca(OH)₂ activity based on its high pH, dissociation of ions and release of OH⁻ in water [8]. Second is the action of OH⁻ - they induce lipid peroxidation which results in a phospholipid destruction in the wall of microbial cells. The third mechanism is due to its interaction with bacterial DNA which causes segmentation of the two polynucleotide chains and gene loss. This process inhibits the replication of DNA and inactivates the function of the microorganisms. Calcium hydroxide detoxicates the endotoxin which has been produced from the microorganisms in the root canals [9]. Materials containing Ca(OH)₂ are water based with a cellulose type thickener which makes them hard to be removed from the root canal.

One of the methods for Ca(OH)₂ removal from the root canals which is described most in the literature is the file instrumentation combined with irrigation of NaOCl and EDTA [10].

Ultrasound irrigation is another method for removal of intracanal medicaments. There are two methods of ultrasonic irrigation described in the literature. The first one is a combination of ultrasonic instrumentation and irrigation. In the second method there is a lack of instrumentation and it is known as passive ultrasonic irrigation. The first method nowadays is rarely used because it does not allow the clin-
cian to control the dentin removal of the canal walls and the final shape of the prepared root canal [11, 12]. Passive ultrasonic irrigation (PUI) is more effective than irrigation with syringe in dentine debris removal from the canals. Unfortunately, it is not clear if PUI can remove the whole Ca(OH)\textsubscript{2} from the root canals.

In a perfect situation calcium hydroxide should be entirely removed from the root canals. Otherwise it might compromise the integrity of materials used for obturation of the root canals. For example, the thickness of the sealer can change the sealing ability of the root canal filling materials. Another outcome is that the bone strength of the root canal sealer can be reduced by Ca(OH)\textsubscript{2} remnants left on the root canal walls and interfere with the sealing ability of a silicon-based sealer [3, 13].

All of the above shows the need of more investigations in the field of Ca(OH)\textsubscript{2} application and its removal from the root canals.

**Aim:** The aim of this study is to investigate the effectiveness of different irrigation protocols used for removal of calcium hydroxide used as intracanal medicament.

**MATERIALS AND METHODS:**

In this study 36 single root canal teeth were observed. The length was standardized at 15 mm, and the root canals were shaped with Revo-S rotary instruments. The irrigation was made with 2ml 5.25% NaOCl and 1ml Smear Clear. All of the canals were dried and filled with Ca(OH)\textsubscript{2}. The teeth were divided into three groups (n=10) according to the technique applied for calcium hydroxide removal - manual irrigation, irrigation and reshape with Revo-S rotary instruments and passive ultrasonic irrigation (PUI), and a control group (n=6) – irrigation with distilled water. After calcium hydroxide removals following the procedures above, teeth were separated longitudinally in a buccal-lingual direction and remnants of medicaments were observed in apical, middle and coronal part of each tooth. Then all of the specimens were observed using scanning electron microscopy and evaluated by a specified scale as following: 0 – lack of Ca(OH)\textsubscript{2}; 1- less than \( \frac{1}{2} \) of the surface is covered with Ca(OH)\textsubscript{2}; 2- more than \( \frac{1}{2} \) of the surface is covered with Ca(OH)\textsubscript{2}; 3- the whole surface is covered with Ca(OH)\textsubscript{2}. The results have undergone statistical analysis.

The following methods were applied:

1. **Variation analysis** – for assessment of the characteristics of the central tendency and scattering data.
2. **Graphical analysis** – for visualization of the results.
3. **Nonparametric Shapiro-Wilk test** - for verification of normality data distribution.
4. **Nonparametric Kruskal-Wallis test** – for verification of hypotheses for difference between several unrelated samples.
5. **Nonparametric Mann Whitney test** – for verification of hypotheses for difference between two unrelated excerpts - Checks hypotheses of difference between two unrelated samples.

**RESULTS:**

Statistical results about Ca(OH)\textsubscript{2} removal show that:

- In the apical part - significantly highest average belongs to the teeth treated with Revo-S followed by Ultrasonic (PUI) and then Irrigation only.
- In the middle part - with significantly highest average is the group irrigated and reshaped with Revo-S followed by Ultrasonic and Irrigation. There is no statistically significant difference between last two groups.
- In coronal part - highest average belongs to the group of teeth treated with Revo-S followed by Irrigation and Ultrasonic (Fig.1-2, Table 1).

**Table 1.** Comparative analysis for the Ca(OH)\textsubscript{2} effect on the groups of investigated methods and control group according to the different locations.

<table>
<thead>
<tr>
<th>Location</th>
<th>Revo-S</th>
<th>Ultrasonic</th>
<th>Irrigation</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>( \bar{X} )</td>
<td>SD</td>
<td>n</td>
</tr>
<tr>
<td>Apex</td>
<td>10</td>
<td>2.80\textsuperscript{a}</td>
<td>0.30</td>
<td>10</td>
</tr>
<tr>
<td>Middle</td>
<td>10</td>
<td>1.40\textsuperscript{a}</td>
<td>0.37</td>
<td>10</td>
</tr>
<tr>
<td>Coronal</td>
<td>10</td>
<td>1.40\textsuperscript{a}</td>
<td>0.37</td>
<td>10</td>
</tr>
</tbody>
</table>

* - identical letters horizontals mean lack of significant difference and different - the existence of such (p <0.05)
DISCUSSION

In a study which was conducted to evaluate the antimicrobial activity of Calcium hydroxide and other intracanal medications on various microorganisms it was found that Ca(OH)₂ has better activity than antibiotical medications. This can be explained with its high pH 11-12.5 and the bactericide effect of the OH⁻. In spite of its high antimicrobial effectiveness, there are resistant species such as E. faecalis, calcium hydroxide which is the reason for the lack of success in many endodontically treated teeth [14].

Calcium hydroxide should be entirely removed from the root canals. Otherwise it might compromise the integrity of materials used for obturation of the root canals.

Capar et al. (2014) investigated the effect of different irrigation methods on calcium hydroxide removal and they found that in the NaOCl irrigated groups, PUI removed significantly more Ca(OH)₂ medicament than the other techniques. In the EDTA/NaOCl irrigated groups, the SAF and PUI removed significantly more Ca(OH)₂ than the other techniques. The use of the SAF system with the combination of EDTA and NaOCl enhanced Ca(OH)₂ removal when compared with the use of only NaOCl irrigation with the SAF. Continuous PUI and SAF were more effective than EndoVac, and conventional syringe irrigation in the removal of the Ca(OH)₂ medicament from an artificial standardized groove in the apical part of the root canal [15].

According to investigations comparing the efficacy and cleaning effect of different irrigation techniques based on scanning electron microscopy the best is the sonic irrigation technique which removes most of the smear layer [2, 16]. Second is the passive ultrasonic irrigation and the third is the manual irrigation with endodontic files and solutions [17]. In our study best results in Ca(OH)₂ removal from the apical and in the middle part of the root canals is achieved with Revo-S and irrigation, followed by PUI and conventional irrigation.

Many authors have the opinion that there is no existing technique which could fully remove the temporary medication from the root canal and in spite of the vehiculum in all of the experimental groups can be found remnants.
from the temporary root canal medicament [18]. According to Da Silva et al., 2011 [19] the vehiculum is not important because the dentin surface stays smeary the same way after passive and active ultrasonic irrigation. We achieve similar results to these in our SEM investigations. No matter what kind of technique for Ca(OH)$_2$ removal we use there are always remnants left in each part of the root canals. Only the quantity of the remnants is different depending on the protocol used for medicament cleaning.

Other investigators who compare different irrigation protocols reach the conclusion that none of the irrigants or a combination between them could totally remove Ca(OH)$_2$ but chelators such as citric acid and EDTA give better results [20]. Others claim that Canal Brush and Ultrasound do not have maximum effectiveness but they show better results than rotary instrumentation and irrigation techniques [21]. The effects of NaOCl, 17% EDTA, 10% citric acid, 7% maleic acid have been observed as individual techniques or applied together with different mechanical preparation of the root canals (manual and rotary instrumentation, ultrasonic irrigation etc.). The results are different: 17% EDTA and 7% maleic acid effectively remove Ca(OH)$_2$ aqua destillata and Apexcal while 7% maleic acid has better efficacy in Metapex removal compared to EDTA. 17% EDTA and 0.2% chitosan combined with ultrasonic irrigation cannot totally remove Metapex [22].

The combination of rotary instrumentation and passive ultrasonic irrigation lessen the quantity of residual calcium hydroxide in comparison to manual preparation and sonic irrigation. Although the impossibility of full removal of temporary dressings highline that when manual instrumentation and irrigation are supported by rotary instrumentation and ultrasonic irrigation the result is much cleaner root canals. It is important to be mentioned that active ultrasonic irrigation has the potential to alterate the root morphology. That is why passive ultrasonic irrigation is more highly recommended [23].

Unfortunately, it is still evident that there is a lack of unique working protocol which might be absolutely effective in its application for removal of medicaments and workable in every clinical situation.

**CONCLUSION:**

There in not a universal technique for removal of intracanal medicaments and applying more than one protocol is required.

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