ORIGINAL ARTICLE

In vitro evaluation of the effectiveness of different organic solvents in Gutta-percha removal

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Abstract

***Objective**: The objective of this study was to evaluate the effectiveness of eucalyptus oil, orange oil and orange liquid in removing gutta-percha in the endodontic retreatment. **Methods**: Forty human mandibular incisors with single straight root canals were prepared with ProTaper Next (up to size x3) and filled by cold lateral condensation with gutta-percha and Ad Seal Filler (Prevest Dent Pro Limited, Digiana, India). After filling the roots were incubated for 1 month at 37ºC and 100% humidity. The 40 teeth were divided into one control group and 3 retreatment groups (n = 10 each). Gutta-percha was removed using K-files and different solvents: orange oil, eucalyptus oil, orange liquid. After retreatment roots were longitudinally separated and examined by Carl Zeiss Stemi 2000cs stereomicroscope with Image Recording Camera AxioCam Mrc5. The resulting data was processed by Axio Vision 4.7 Image Analysis. Measure the area of the canals and the remaining gutta-percha areas along the entire canal. Analyzed using statistical package SPSS 20 at a statistically reliable level keeping p <0.05. **Results**: No statistically significant differences were found between orange oil, orange liquid and eucalyptus oil in softening gutta-percha (p> 0.05). However, the control group had the maximum amount remaining filling material (p<0.05). **Conclusion**: The use of solvent statistically significant reduces the amount of remaining filling material in the root canal. Orange oil is best solvent in the coronal and middle third. In the apical third the most effective solvent is eucalyptus oil.*

***Keywords**: Orange Oil, Eucalyptus Oil, Orange Liquid, Endodontic Retreatment*

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Introduction

The purpose of root canal treatment is to heal pulpitis and apical periodontitis. [1] The main causes of inflammation of the pulp are tooth decay and tooth trauma. [2] When the infection reaches the pulp - endodontic treatment is required. [3] The success rate of primary endodontic treatment is 86.5 - 98%. [4, 5] The main causes of endodontic treatment failures are the inadequate root canal disinfection, formation and poor quality filling of the canal. [6] In the poorly filled root canals, it is possible for bacteria to survive in the dentin tubules, or accessory canals, as a result, the infection recovers. Endodontic retreatment is required. [7, 8] The main purpose of endodontic retreatment is to eliminate bacterial infection. [8] During endodontic retreatment, the old root filling material is removed as much as possible and after removal disinfection is applied. This is done by re-instrumentation and chemo-mechanical processing. [10] Mechanical canal preparation can be performed using hand files, rotary instruments, ultrasonic devices and laser. [11, 12] Different chemical solvents such as orange oil, eucalyptol, and chloroform are used as a combination with these mechanical methods in order to solubilize gutta-percha. [13] Chemical solvents prevent complications, such as root perforation, canal straightening, or changing the shape of the primary canal. [14] During retreatment, solvents facilitate chemo-mechanical preparation and access to the entire root canal system, thereby reducing the amount of remaining bacteria in the canal. [15] Despite all treatment strategies, it has been shown that it is not possible to completely remove gutta-percha

from the walls of the root canals and eliminate the infection. [16] Therefore, we developed the goal of a clinical trial to find out which solvent is most effective in removing gutta-percha in the endodontic retreatment.

Materials and Methods

For the study, 80 extracted, endodontically untreated mandibular incisors were selected. The teeth selected for the study were drilled using the long shank round bur (Diawiss, 801l/012) in a high speed dental handpiece (Bien Air Bora, Bienne, Switzerland) to identify the entrances of the canals. Canals were instrumented with K-files (Dentsply Maillefer, Ballaigues, Switzerland) size #10 and measured teeth working length. After instrumentation teeth with multiple or calcified canals were excluded from the study. 40 single-canal teeth were selected. The root length was standardized by cutting the crown to 17mm using 0,17mm thickness diamond blades (OSE, Gaithersburg, USA). The glide path was formed with K-files up to 15 No. Canals instrumentated with Protaper Next (Densply, Maillefer, Ballaigus, Switzerland) instruments up to X3 andK-files were used to prepare to a final apical size #50 K-file. After each instrument, canals were irrigated with 1 ml of 5.25% NaOCl solution (Cerkamed, Stalowa Wola, Poland). When instrumentation was completed, canals were irrigated with 1 ml 17% EDTA (Cerkamed, Stalowa Wola, Poland) for 1min to remove smear layer, followed by rinsing with 5 ml distilled water.

The canals were dried with 50 No. paper points (Meta Biomed, Chungbuk, Korea) and obturated using the lateral compaction technique employing standardized 50 No. Gutta-percha master cones (Meta Biomed, Chungbuk, Korea). For obturation were used AdSeal Filler (PrevestDentPro Limited, Digiana, India), 25 No. finger spreaders (Densply, Maillefer, Ballaigus, Switzerland) and 25 No. accessory cones (Meta Biomed, Chungbuk, Korea). Excess gutta-percha was removed at the canal entrance with heated instruments, before vertical compaction was used to condense gutta-percha at the coronal root third. The endodontic cavities were closed with a temporary filling (Coltosol, Coltene Whaledent, Cuyahoga, USA).

Samples were kept at Heracell 150i incubator for 30 days in 100% humidity at 37 ° C by simulating the conditions in the mouth. Using a diamond long shank round bur (Diawiss, 801l / 012) a temporary filling was removed. The gutta-percha was removed using K-files. The gutta-percha removal procedure was completed by 50 No. K-file reaching working length. During the retreatment, the canals were irrigated with 1 ml of 17% EDTA after each instrumentation. Following the mechanical removal of the canal filler, different chemical solvents were used. Teeth were randomly divided into four groups. Group I (n = 10) Orange Solvent Oil (OSO) (Henry Schein, Langen, Germany); Group II (n = 10) Orange Solvent Liquid (OSL) (Hager & Werken, Duisburg, Germany); Group III (n = 10) eucalyptus oil (EO) (Cerkamed, Stalowa Wola, Poland). Control group (n = 10) - no solvent. In each group, 1 ml of solvent was kept for 5 minutes. Root canals were rinsed with 75% ethyl alcohol to remove solvents, then rinsed with distilled water and dried by 50 No. paper points. The roots were separated into two parts by longitudinal axis using diamond discs and examined by Carl Zeiss Stemi 2000cs stereomicroscope with Image Recording Camera Axio Cam Mrc 5. The resulting data was processed by Axio Vision 4.7 Image Analysis. Measure the area of the canals and the remaining gutta-percha areas along the entire canal. Analyzed using statistical package SPSS 20 at a statistically reliable level keeping $p < 0.05$.

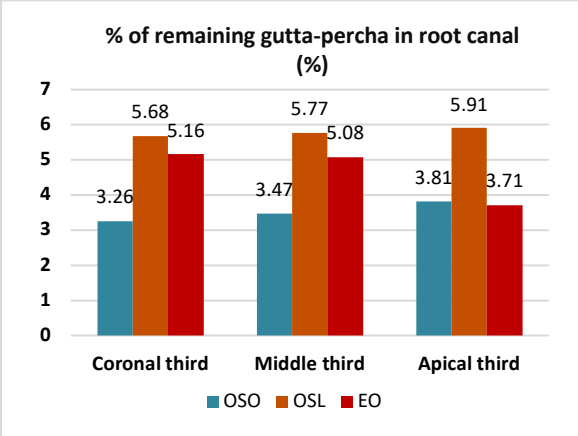
Results

The maximum remaining gutta-percha in entire canal was found in the control group - 17.15%, the smallest amount of gutta-percha –the OSO group - 3.44%. Accordingly, in the OSL group - 5.74%, in the EO group - 4.93%. Differences between groups were statistically significant ($p < 0.05$).

In the coronal third, the smallest amount of gutta-percha found in OSO group - 3.26%, the maximum in the OSL group - 5.68%. In the EO group was found 5.16% of gutta-percha. There was no statistically significant difference between groups ($p > 0.05$). In the middle third, the smallest amount of gutta-percha was found in the OSO group - 3.47%, the maximum

remaining gutta-percha in the OSL group - 5.77%. In the EO group was found 5.08% of gutta-percha. There was no statistically significant difference between groups (p> 0.05). In the apical third, the smallest amount of gutta-percha was found using the EO-3.71%. The maximum amount of gutta-percha was in the OSL group - 5.91%. In the OSO group was 3.81% gutta-percha. There was no statistically significant difference between groups (p> 0.05) (Fig. 2).

Figure 1: **Percentage of remaining gutta-percha in root canal (%)**



Discussion

The retreatment of a filled root canal is necessary when there are persistent bacteria. Persistent bacteria remain because of incomplete canal cleaning, shaping and filling. Nonsurgical retreatment is the most common procedure of failed endodontic cases. Gutta-percha and a variety of root canal sealers is the most commonly used root canal filling material. Some methods are used to remove the gutta-percha that includes the use of rotary systems, hand files, ultrasonic devices, solvents and laser. In this study the most difficult to control parameter was the volume of the anatomical variations that are present in human teeth. In order to minimize these variables the root canals length was standardized and only teeth with straight canals were selected.

Remaining gutta-percha is measured by various methods including longitudinal tooth splitting, radiography, cone-beam computed tomography (CBCT) and others. [17, 18] In present study, teeth were longutudinaly seperated, the residual gutta – percha and sealer were measured by using Carl Zeiss Stemi 2000cs stereomicroscope. However, splitting is an invasive method and can spread the remaining filling materials. As alternative Cone-beam computed tomography (CBCT) is used. CBCT does not require the destruction of the teeth and it allows three – dimensional evaluation of the root canal system. [19]

This study compared three different types of solvents: orange solvent oil, orange solvent liquid and eucalyptus oil.

Our results showed no statistically significant differences between orange oil, orange liquid and eucalyptus oil in softening gutta-percha, in agreement with the other studies. [20, 21, 22] However, orange oil is the most effective compare to the other solvents. Previous studies showed that xylol and chloroform are the most effective solvents and orange oil is the second. [23, 24] While the others studies observed that there is no significant difference between the effectiveness of orange oil and chloroform. [25] Furthermore, we separated canal to coronal, middle and apical thirds and measured effectiveness of each solvent. In coronal and middle thirds the most effective solvent was orange oil. Meanwhile, dissolving capacity of eucalyptus oil in the apical third of the canal is superior to orange oil and orange liquid. We excluded from our study xylol and chloroform because of cytotoxicity. Orange oil is an efficient alternative to potentially toxic solvents. Orange oil consists of approximately 90% D-limonene. There is no evidence for its carcinogenicity or genotoxicity. [26] Further, orange oil is less cytotoxic and more biocompatible than eucalyptol and chloroform. [24]

In comparison orange oil and liquid, more effective was orange oil. The composition of orange liquid and oil contains d-Limonene. [27] The orange oil has a higher amount of d-Limonene than orange oil. The substance that contains a higher percentage of d-Limonene has a higher potential to dissolve gutta-percha.

As in many *in vitro* studies, it is hard to transfer all the results of our study directly to clinical situations because simulating all the conditions of the oral environment is not possible. The limitations of this study should be considered.

Conclusion

The following conclusions can be drawn from this study:

1. The use of solvent statistically significant reduces the amount of remaining filling material in the root canal.
2. Orange oil is best solvent in the coronal and middle third.
3. In the apical third the most effective solvent is eucalyptus oil.

Conflict of Interest: *None declared*
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