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RESEARCH ARTICLE

Efficacy of Ethylenediamine Tetraacetic Acid and Calcium Hydroxide in the Removal of Root Canal Filling During Retreatment

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A B S T R A C T

Objective: To compare the effect of Ethylenediamine tetraacetic acid (EDTA) and calcium hydroxide [$Ca(OH)_2$] in the removal of root canal filling material during retreatment procedure.

Methodology: Eighty extracted, single-rooted human teeth were used. Root canals were shaped with a crown-down technique using Ni-Ti rotary instruments (ProTaper, Dentsply Maillefer, Switzerland) and filled with a cold lateral condensation method. AH Plus was used as a sealer. After filling, the teeth were divided into 4 groups and root fillings were removed by ProTaper Universal rotary retreatment system. In each group different irrigation and disinfection protocols were followed; **Group I.** Sodium hypochlorite (5.25%) + EDTA (17%-1 min.) **Group II.** Sodium hypochlorite (5.25%) **Group III.** Sodium hypochlorite (5.25%) + Ca (OH)2 **Group IV.** Sodium hypochlorite (5.25%) + $Ca(OH)_2$ + EDTA (17%-1 min.). Irrigation with 17% EDTA was performed only before D_3-Retreatment instrumentation in all groups. AutoCAD system was used to detect the amount of residual root canal filling material. The results were statistically analyzed by SPSS (Statistical Package for Social Sciences) for Windows 15.0, one way ANOVA and Tukey's HSD tests. The significance was evaluated at the level of $p<0.05$.

Results: The amount of the remnant filling material in the root canals retreated in Group I was less than the amount of the material in Group II ($p<0.01$) and Group III ($p<0.05$). There was no significant difference observed between the other groups in terms of the quantity of the remnant root canal filling materials ($p>0.05$).

Conclusions: Irrigating the canals with EDTA enhanced the removal of root canal filling during retreatment. However, disinfecting the canals with $Ca(OH)_2$ had no effect in the removal of filling material.

Keywords: Retreatment, Sodium Hypochlorite, Ethylenediamine tetraacetic acid, calcium hydroxide.

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INTRODUCTION

Re-treatment is defined as the "Treatment of teeth in which case a persistent apical periodontitis occured following root canal treatment".[1] Based on the available data, the studies mostly suggest the polymicrobial infection related with root canals as the reason for failure of endodontic treatment.[2] Ability to survive in the poor environmental conditions for long term (12 months)[3] and penetration capacity into dentinal tubules, isthmuses and lateral canals[4] might be the most prominent features that enable the microorganisms to provide infection persistence. Thus, researchers attempt to improve some alternative methods which might provide the total remove of remaining filling materials or the achievement to possible access points within the root canals in spite of the filling materials. Consequently, the use of advanced methods and devices accompanied by the conventional techniques might result in better achievements in the elimination of entire root filling materials. For instance, Ni-Ti rotary instruments or ultrasonic devices for re-treatment procedures have been utilizing since 1992[5] Currently available studies suggest the efficacy of rotary instruments in re-treatment cases.[6-10]

The utilization of sodium hypochlorite (NaOCl) as an endodontic irrigant has of crucial importance for its high antibacterial and organic tissue dissolving effects for many years. As a further alternative, Ethylenediamine tetraacetic acid (EDTA) has been a material of choice in traditional root canal treatment process due to its inorganic tissue removal capability. The combined use of EDTA and NaOCl irrigation has shown to be effective in the remove of smear layer which contains both inorganic and organic portion together[11] Furthermore based on a dental microscope observation, it is claimed in the review article of Zehnder&Paque[12] that, EDTA is more able to dissolve the remaining root canal filling material than sodium hypochlorite solution during re-treatment.[12]

In terms of infection control during endodontic treatment calcium-hydroxide [$Ca(OH)_2$] has been also prefered to be used for root canal disinfection due to its high antibacterial effects for many years.[13] Moreover, the studies have reported the increase effect of $Ca(OH)_2$ medication followed by sodium hypochlorite irrigation on tissue-dissolving capability[14] likewise, the efficacy of chelating agents in the removal of smear layer has also been studied.[15] However, currently available studies indicate the unsatisfactory information about the dissolving capability of EDTA and calcium hydroxide on the root canal filling materials. Because of its high importance and irrevocable effects on infection control and organic tissue dissolution, sodium hypochlorite was preferred to be used as a part of routine endodontic treatment protocol, it was not included as an alternative irrigation solution in the present study.

Based on the hypothesis mentioned above, the present study aimed to compare the removal capability of EDTA and calcium hydroxide on the entire root canal filling material during re-treatment.

MATERIALS AND METHODS

In this study, Eighty extracted human teeth with single roots were used in this study. Periapical radiographs were taken in the bucco-lingual and mesio-distal directions

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to confirm the teeth have single canals. The coronal sections of the teeth were removed by diamond bur under water cooling with keeping the roots 15 mm long. The root canals were shaped with Crown-down technique using ProTaper Universal (Dentsply Maillefer, Ballaigues, Switzerland) Ni-Ti rotary instruments with 14 mm working length. Following the instrumentation, the root canals were filled by cold lateral condensation technic. AH Plus (Dentsply Maillefer, Tulsa, OK) was used as a sealer. Endodontic cavities of the root canals were temporarily sealed with Coltosol F (Coltène/Whaledent AG, Switzerland) and teeth were stored in an incubator with the temperature of 37^{o} and 100% moisturized environment for one week. Afterwards, the root canal filling materials were removed by using ProTaper Universal Retreatment kit in accordance with the irrigation protocols given below: Group I. Sodium hypochlorite (5.25%) + EDTA (17%-1 min.) Group II. Sodium hypochlorite (5.25%) Group III. Sodium hypochlorite (5.25%) + $Ca(OH)_2$ Group IV. Sodium hypochlorite (5.25%) + Ca(OH)2 + EDTA (17%-1 min.) EDTA-17% irrigation was used before D3 instrumentation. The teeth in which root canal filing materials were not removed are used as control group (n=10).

After application of removal protocol, root canals were stored in the incubator for one week, as a second time. Later on, a final instrumentation of all groups except control group was performed by using ProTaper Universal (Dentsply Maillefer, Ballaigues, Switzerland) Ni-Ti rotary instruments and sodium hypochlorite (5.25%) irrigation.

Following the removal of root canal materials, the teeth were separated into two pieces by the aid of longitudinal grooves which have been composed on teeth towards the bucco-palatal direction using diamond burs.

Analysis of the remaining filling materials on separated teeth was conducted at Laboratory of Plant Genetics and Biotechnology, Department of Genetics and Bioengineering of Yeditepe University, İstanbul, using "Leica DFC320 stereomicroscope". Firstly, the separated tooth surfaces were placed in stereomicroscope and canal surfaces were transferred to computer screen using "Leica DFC Twain Software" and analysed by zooming 15X. The images of tooth surfaces were photograghed using "Leica DFC Image Manager Software" when the images became clear. This process was applied to all teeth.

The images were transferred to technical drawing and design Programme "AutoCAD 2008 software" (Mechanical Desktop Power Pack; Microsoft, Remond, WA) and the amount of filling materials left into each canal was calculated as mm^2.

Photos of separated tooth surfaces which were taken by using AutoCAD programme were collocated and reduced down to actual tooth size. The root canal surfaces were separated into three sections: cervical 1/3, medium 1/3 and apical 1/3. The inner borders of the canals were also marked. The borders of the filling material residue left within the canals were marked and areas of them were calculated in mm^2. The ratio (%) of the remnant filling materials within the root canal was calculated by dividing the area of the filling material residue left in the canal (mm^2) to total area of the root canal surface (mm^2) followed by multiplying 100.

STATISTICAL ANALYSIS

Statistical Package for Social Sciences (SPSS) for Windows 15.0 programme was used during the evaluation of the findings in this study. The compatibility of the parameters against the standard dispersion was evaluated using Kolmogorov-Smirnov test and results indicated that all are compatible. One-way ANOVA test was applied for the comparison of the inter group parameters. Tukey HDS test was applied for the detection of the group that causes variation. Significance level was evaluated as $p<0.05$.

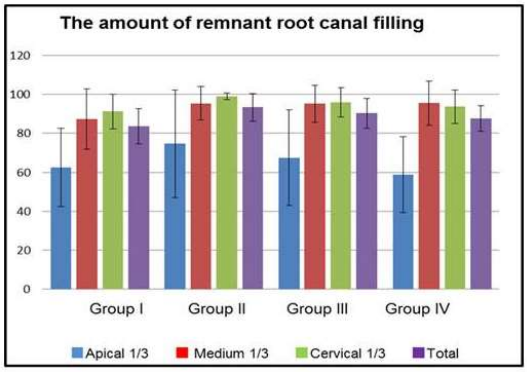
RESULTS

Considering the mean amount of remnant filling material within the intergroup comparisons of root canals, the results have shown no statistically significant difference between the medium 1/3 and apical 1/3 parts of the groups ($p>0.05$). Statistically significance has been revealed for the cervical 1/3 part of the groups I, II, III and IV ($p<0.01$). The filling material left within the cervical part of Group II was found to be significantly higher than Group I ($p<0.01$). No statistically significant difference was exhibited between the cervical 1/3 parts of the other groups ($p>0.05$).

The mean amount of total residual root canal filling material left in Group I was found to be significantly lower than Group II and Group III [$p<0.01$; $p<0.05$]. There is no statistically significant difference between the other groups with regard to total mean amount of canal filling material ($p>0.05$).

Statistically significant difference was detected between the apical, medium and cervical 1/3 parts of the Groups I, II, III and IV ($p<0.01$). The mean of filling material remnants in apical part of all groups was significantly lower than the medium and cervical parts ($p<0.01$). No statistically significant difference was detected between the medium and cervical parts of the groups ($p>0.05$) (Table 1).

Table 1: The amount of remnant root canal filling.



DISCUSSION

In re-treatment cases, maintainance of the tooth strength has of crucial importance as well as infection control. Certainly, during a re-treatment process, the efficient promptness of rotary instruments and ultrasonic devices on the cleanliness of root canal walls can not be disregarded. As previously stated in an *in vitro* study, 90 premolar teeth were filled with resin based endodontic sealers to compare the root canal purification effects of mechanic instruments to manuel technic. Eventually, Mtwo and ProTaper Universal Rotary re-treatment instruments were found to be more quickly and effective than gates glidden, Hedstrom files and chloroform combination in the removal efficacy of sealers from root canals[16]. However, within the consideration of the currently available re-treatment studies, the results have shown the remnant filling materials to be remained through the canal walls even if solvents or rotary/hand

instruments have been applied.[16-19] Therefore, the re-treatment protocol has to be supported with some additional irrigation systems, medicaments and/or irrigants to obtain total remove of root filling material and to reach all the points in root canals regarding uninstrumented areas which depends on the complex anatomy.

In addition to common knowledge about the use of EDTA as a rinse solution, various studies have reported its dissolution effect on inorganic part of smear layer and sealers.[11, 20-22] EDTA - 15% was found to be more effective in the dissolution of calcium hydroxide, epoxy resin, polyketone, silicone and zinc oxide-eugenol based root canal sealers compared to 2.5% and 5% NaOCl solutions when sealer loaded stainless steel molds were used in *in vitro* conditions.[23] As an another example for the removal efficacy of dental materials, Wadachi et al (1998),[14] suggests the use of $Ca(OH)_2$ for 7 days as an effective removal agent of remaining pulp tissue on the canal walls of bovine anterior teeth based on a scanning electron microcope analysis. Moreover, the synergictic effect in the removal efficacy of sodium hypochlorite when combined with $Ca(OH)_2$, was pointed out in the results of that study.[14] But in addition, 1-week exposure of human teeth root dentin bars to saturated calcium hydroxide was shown to have a reducing effect to the flexural strength of dentin.[24] In the review of Mohammadi & Dummer 2011,[25] the flexural strength of dentin depends on the connection between hydroxyapatite crystals and collagen fibers which forms the organic structure of dentin.[25] According to the hypothesis of this study, the decline of this connection by using $Ca(OH)_2$ to disinfect the root canals during retreatment, creates appropriate spaces between root dentin and remnant root canal filling materials to provide better instrumentation.

In this respect, this study aimed to compare the dissolution effect of EDTA and calcium hydroxide in the removal of root canal filling material. During the study, the application of EDTA and NaOCl is performed regarding the interaction between these two materials. In a literature review, it is mentioned that EDTA reduces the tissue-dissolving effect of sodium hypochlorite which indicates the requirement of its use for a final rinse.[26, 27] In this study, in terms of to reflect the clinical simulation, EDTA was applied following sodium hypochlorite irrigation for a final rinse which has found to be more effective in the removal of remaining root canal filling material when compared with the use of sodium hypochlorite alone or sodium hypochlorite combined with calcium hydroxide. remnants were significantly decrease at the cervical part of the root canals in favor of the EDTA and sodium hypochlorite group. According to intergroup comparisons, the mean amount of remaining filling materials at the apical 1/3 of teeth of Group I, Group II, Group III and Group IV were significantly lower than the cervical 1/3 and middle 1/3 parts. However, we were not able to remove calcium hydroxide effectively from root canal walls, which might provide misleading results. As the remaining portion of $Ca(OH)_2$ on canal walls was considered to be the remnant filling material.

CONCLUSION

Within the limitations of this study, the utilization of EDTA for final irrigation during re-treatment enhanced the removal efficacy of root canal filling. However, $Ca(OH)_2$ application for root canal disinfection did not

effect the removal capacity of root canal filling during re-treatment.

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