Cleaning ability of XP Endo-finisher R, Passive Ultrasonic Irrigation and Conventional Filing Method to Remove Precipitated Parachloroaniline

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Abstract

The aim of this study focused on the ability of XP-endo finisher R in removing PCA compared with the Passive Ultrasonic Irrigation (PUI) and conventional filing methods. 90 premolars were decoronated and enlarged all canals to MAF no. 60. Eighty five teeth were irrigated with sodium hypochlorite and Chlorhexidine to create precipitation. The teeth were divided into 6 groups : 1) negative control, 2) positive control, 3) PUI with 15% citric acid, 4) K-file with normal saline, 5) XP-endo finisher R with normal saline, 6) XP-endo finisher R with 15% citric acid

After the cleaning process, the roots were cut into 2 parts, fixed each part of root on resin block and processed to the Electron Microscopy. Half of the samples were drilled by Peeso No.5 into powder, dissolved the powder in DMSO solution and spectrophotometrically investigated at 300 nm wavelength. The data were analyzed using the Graphpad program prism 8. Comparisons between groups were analyzed statistically using the One-way ANOVA test and Post-Hoc Tukey's HSD.

XP-endo finisher R combined with 15% citric acid is the most effective method to remove the PCA. Nonetheless, the cleaning ability between PUI combined with 15% citric acid, K file with normal saline and XP-endo finisher R with normal saline was no statistically significant differences. Hence, XP-endo finisher R can be the alternative method for removal of PCA in the root canal.

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Introduction

The objective of endodontic treatment included removal of all infected vital or necrotic tissue, microorganisms, and biofilm inside the root canal system.[1-3] The treatment involved both mechanical and chemical cleaning. The chemical agent used in root canal treatment referred to "irrigating solution" such as Sodium hypochlorite (NaOCl), Chlorhexidine (CHX), EthyleneDiamineTetreAcetic Acid (EDTA), and Citric acid. A paradigm of irrigating solution required the function of debris removal, lubrication, dissolving inorganic substances, antibacterial property, and not weaken tooth structure. However, there is no single irrigating solution that covers all the functions needed from the irrigant.[4,5] Thus, the combination of irrigants in the correct sequence will provide the successful treatment outcome.[4,5]

Sodium hypochlorite is the most commonly used in root canal treatment. It has a potent antimicrobial property that disrupts microbial membranes and also has an ability to dissolve organic substances.[4,5] CHX has a broad spectrum antibacterial property with low tissue toxicity.[6,7] These two types of irrigant can not be used together because they result in various by-products such as Parachloroaniline (PCA) a brownish-orange toxic precipitation.[1] However, Clinicians sometimes accidentally combine Sodium hypochlorite and Chlorhexidine together inside the root canal and cause the orange precipitation. This precipitation should be removed since it occludes dentinal tubule and interferes the penetration of sealer which might exert some effects to treatment outcome.[8,9] Moreover, the precipitation may have a major concern being the potential to be carcinogenic

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agent as previous demonstrated in animal studies.[10,11]

Sonic and Ultrasonic irrigation have been widely recommended to improve the efficacy of root canal irrigation. Number of studies revealed that these aiding devices yielded better cleaning, removal of smear layer especially in apical third of root canal and clearing the dentinal tubules.[12-14]

Many studies suggested two techniques to remove PCA, one is passive ultrasonic irrigation with citric acid (PUI), another is removing by F-file. However, none of them can remove PCA efficiently from the root canal.[1, 15-17]

Recently, XP-endo system has been introduced in dentistry. XP-endo finisher R (FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) is the new NiTi finishing endodontic instrument made from NiTi MaxWire alloy. The manufacturer claimed that XP-endo finisher R can increase the cleanliness of root canal and remove residual obturation materials.[18] Theoretically, if this instrument can effectively remove residual material inside the root canal, it should be able to remove PCA as well. On the other hand. There is no study that claimed the efficacy of XP endo to remove PCA inside the root canal. Thus, the aim of this study is to focus on the ability of XP-endo finisher R in removing PCA compared with the PUI and conventional filing methods.

Materials and methods

Ninety sound one-rooted canal mandibular second premolars were gathered and stored in 0.1% thymol for 3 months before the experiment. All the teeth were extracted from healthy patients for orthodontic reason. The study was exampted by the ethical Review SubCommittee Board for Human Research Involving Sciences, Thammasat University (ECScTU), Certificate of Examption no. 008/2562

At the time of experiment, all the teeth were washed with normal saline (ANB Laboratories, BKK, Thailand) and let dry in the room temperature. The teeth were decoronated with Carborundum disc, set up all the root length at 11 mm. The working length was set at 10.5 mm.

The root canals were cleaned and shaped with initial apical file (IAF) no.15, enlarged the root canal by full series of Protaper Next rotary files with a torque-controlled motor operated at 300 rpm and 400 N/cm^2 torque. Normal saline was irrigated with 27G needle at 1mm above the working length. The apical part of root canals was further prepared to MAF no.60 and step back preparation. Ten teeth were randomly selected for positive and negative control as group 1 and 2. Eighty teeth were equally divided into group 3, 4, 5, and 6 (20 teeth per group).

1) Group 1 a negative control: irrigated with 15 ml normal saline solution

The other groups were irrigated the root canals with 2% Chlorhexidine solution 10 mL followed by 2.5% sodium hypochlorite 10 ml to create the parachloroaniline orange precipitation. After finished this procedure, the teeth would be cleaned with various technique.

2) Group 2 a positive control: no further cleaning
3) Group 3: cleaned by 15% citric acid 10 ml (Krungthep chemical, BKK, Thailand) with Irrisafe tip no.25 passive ultrasonic irrigation (PUI) activated through a 5.5W 30kHz piezoelectric ultrasound unit Suprasson P5 Booster (Satelec Acteon, Merignac, France). The PUI was inserted into the canal 1.0 mm short from the working length and the irrigant was ultrasonically activated for 20 s and repeated two more times (1 minute in total). Final flush with 5 ml of normal saline with a flow rate of approximately 5 ml /min. A total irrigant volume was 15 ml.
4) Group 4: cleaned by normal saline 15 ml combine with K-file no. ISO 60. The file was inserted into the working length and operated 7–8 mm lengthwise with circumferential filing technique for 60 s. Normal saline was irrigated with a flow rate of approximately 5 ml /min.
5) Group 5: cleaned by normal saline 10 ml combined with XP Endo finisher R with a torque-controlled motor operated at 800 rpm and the torque was set to 1 N/cm2 according to the manufacturer's instructions. The XP-endo finisher R was inserted into the working length, operated for 20 s and repeated two more times using slow 7–8 mm lengthwise in-and-out motion. Final flush with 5 ml of normal saline at flow rate of approximately 5 ml /min. A total irrigant volume was 15 ml.
6) Group 6: cleaned by the combination of 15% citric acid 10 ml and XP Endo finisher R with a torque-controlled motor operated as in group5. The XP-endo finisher R was inserted into the working length, operated for 20 s and

repeated two more times using slow 7–8 mm lengthwise in-and-out motion. Final flush with 5 ml of normal saline with a flow rate of approximately 5 ml /min. A total irrigant volume was 15 ml.

To evaluate the residual PCA at the surface of the root canal, the roots were splitted longitudinally to mesial and distal parts by Carborundum disc followed by chisel and mallet. Both halves of the root would be fixed in acrylic block. The photographs were taken by Nikon D5300 DSLR camera. The samples (4 pieces from control groups, 6 pieces from experimental groups) were randomly selected from each group to explore the root canal surface by Scanning Electron Microscope (SEM) with magnitude 500x at coronal, middle and apical part.

The root canals of the remained samples (n=6 in each group with triplication) were drilled by Peeso No.5 into powder form. The powder was weighted and dissolved in DMSO solution (Sigma-Aldrish, California, USA) to the concentration of 1 µg/mL. 80 µL of solution was inserted into 96 well plate flat bottom (Corning incorporated, New York, USA). The well plate was further investigated by Flash Spectral Scanning Multimode Reader at wavelength 300 nm. The flow chart of method was shown in Figure1.

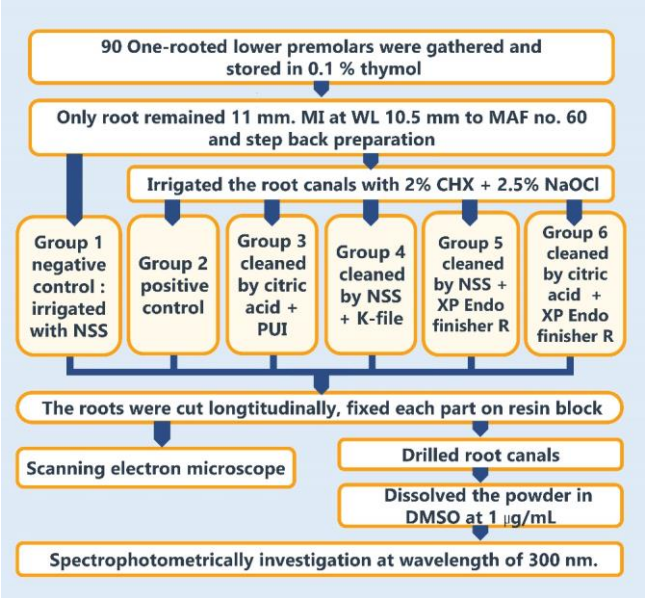

Figure 1. A flow chart showing the step for group categorization, root canal cleaning methods and quantitative analysis of PCA.

Statistical analysis

The data were analyzed using the Graphpad program prism 8 (GRAPHPAD 2365 Northside Dr., Suite 560, San Diego, California). Comparisons between groups were analyzed statistically using the One-way ANOVA test and Post-Hoc comparisons Tukey's HSD. Statistical significance level was set at $p<0.05$.

Results

The root canal sections have shown that group 6 (XP endo finisher R with 15% citric acid) had the least orange precipitation in which it was consistent with the picture from SEM. The SEM photographs of group6 revealed that there were clean and clear dentinal tubules in cervial 1/3, middle1/3, and apical 1/3 without smear layer. In contrast, group4 (K-file with normal saline) revealed that the orange precipitation was seen in the root canal from the root section and also the SEM picture in every part of the root canal (Figure2).

In group 3 (PUI with15%citric acid) and group 5 (XP endo finisher R with normal saline), there was no significant difference in cleaning ability of the orange precipitation. Moreover, the cervical part of root in group3 was less cleaning compared to any other parts of the root canal (Figure2).

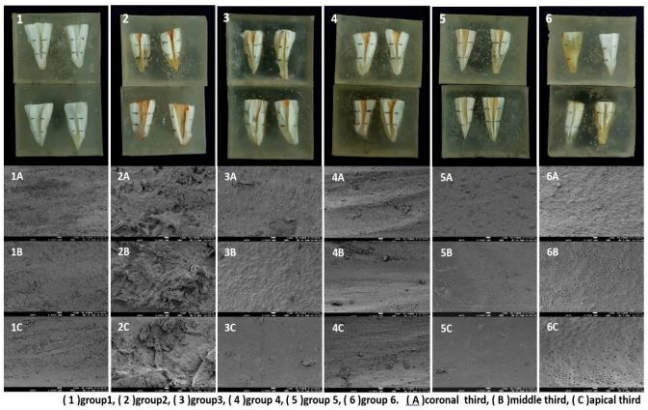

Figure 2. Illustration of root canals after various cleaning methods from group1 to group6 and SEM pictures of Cervical1/3(A), Middle 1/3(B) and Apical 1/3(C) in each group.

Furthermore, the optical density of PCA in group 3, 4 and 5 was not statistically significant difference whereas group 6 was statistically significant difference from group 3 (Figure 3). It can be assumed from our study that XP finisher

R with 15% citric acid is the most effective method to remove PCA.

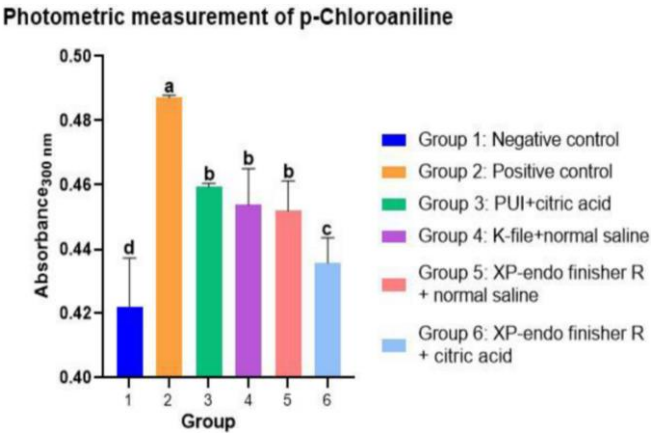

Figure 3. Photometric measurement of parachloroaniline after cleaning in group 1 to group 6.

Discussion

Parachloroaniline (PCA) is a toxic orange precipitation formed when NaOCl and Chlorhexidine are mixed together. The precipitation decreased dentin permeability, impeded diffusion of intra-canal medication, opposed sealing of obturation materials, tooth discoloration, and cytotoxic to cell. Moreover, this precipitation might exert some effects to endodontic treatment outcome.[8,9]

Passive ultra sonic irrigation (PUI) has been used for a while in endodontics. It has been showed that PUI can effectively remove the intracanal medication more than sonic irrigation.[19] Some studies[2,15] suggested that PUI combined with citric acid is a standard protocol to clean the canal that contaminated with PCA. Metri M et al showed that PUI can remove PCA effectively more than F-file in all parts of the root canal.[15] However, our research found that PUI with 15% citric acid, K-file with normal saline, and XP-endo finisher R with normal saline were no statistically significant difference in cleaning ability of PCA inside the root canal. It is possible that the difference of irrigating solution, give no different result.

Furthermore, it has been shown that XP-endo finisher R with 15% citric can effectively remove PCA more than PUI with 15% citric acid significantly. Due to XP-endo finisher R has an expansion capacity which can enlarge itself along the canal shape. In additions, XP-endo finisher R also has shape-memory effect in which the file changes its structure when the temperature changes. In room temperature, the structure is in Martensitic phase but in body temperature the structure is in Austenitic phase. In Austenitic phase, the shape of file is in rotational mode allowing the file to access and clean the area that are normally impossible to reach with other instruments. On the other hand, Passive ultrasonic irrigation (PUI) removes PCA by acoustic streaming which creates small, intense, circular fluid movement.[20,21] In the apical area, tip of ultrasonic file needs to be inserted deeply down because the flow will occur at the tip of the instrument.[22,23] From this reason, it could explain why the cervical part of root in group3 was less cleaning area compared to any other parts of root. Unfortunately, many studies have shown that PUI can cause canal deviation, apical zipping, root perforation.[24,25]

Previous study[26] revealed that XP-endo Finisher R can remove filling material inside the root canal more effectively than PUI. However, none of the supplementary approaches can completely remove filling material in oval-shape canals.[26] Conversely, the efficacy of conventional filling method, XP-endo finisher and PUI were no significant differences in removal of calcium hydroxide paste from artificial standardized groove.[27] On the contrary, there is no study suggested that XP-endo finisher R is inferior to PUI in terms of cleaning potential.

Further study should be conducted because there are many factors that cause different conditions from in vitro to in vivo or in clinical situation such as temperature, acid-base condition or the complicated internal anatomy. In additions, the irrigation pathway was not mimic the clinical situation due to vital periapical tissue may have some resistance to irrigants towards apical direction.[24] The safety way of use should be determined by assessment of apically extruded irrigation compared with the previously used system for instance EndoVac, PUI, and Manual needle irrigation.[28]

Conclusions

From this study, XP-endo finisher R combined with 15% citric acid had the highest potential to remove parachloroaniline whereas other conventional methods can still remove the PCA with different capacities. XP-endo finisher R

can be the alternative method for removal of PCA in the root canal.

Declaration of Interest

The authors report no conflict of interest.

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