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Efficacy of Different Irrigants and Passive Ultrasonic Irrigation on Removal of Calcium Hydroxide from Root Canals - A Comparative in Vitro Study

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Abstract **Original Research Article**

Aim: The aim of the study was to evaluate the efficacy of 1% peracetic acid, 17% EDTA, 3% NaOCl and 10% citric acid in the removal of calcium hydroxide from the root canals, coupled with passive ultrasonic activation. METHOD: 40 freshly extracted human single rooted teeth were selected. Teeth were decoronated to standardize the root length to 15mm.Working length was determined and biomechanical preparation was done using ProTaper rotary instruments. The canals were irrigated, and filled with calcium hydroxide paste using lentulospiral. The samples were divided into 4 groups depending on the final irrigation sequence. Group 1: 3ml of 17%EDTA with PUI .Group 2: 3ml of 3 % NaOCl with PUI. Group 3: 3ml of 1%peracetic acid with PUI. Group 4: 10% citric acid with PUI. The roots were split longitudinally and viewed under stereomicroscope at 30X magnification. RESULTS: Results showed that 1% peracetic acid was superior in the removal of calcium hydroxide from the root canals when compared to other groups. CONCLUSION: 1% peracetic acid was superior in the coronal, middle and apical third of the root canal followed by 17% EDTA, 10%citric acid and 3% NaOCl.

Keywords: Peracetic acid, EDTA, citric acid, NaOCl, calcium hydroxide, PUI.

INTRODUCTION

Elimination of bacteria and their byproducts from the root canal system plays a major role in endodontic therapy success. Reducing the bacterial count in infected canals is accomplished by a combination of mechanical instrumentation, various irrigation solutions, and antibacterial medicaments placed into the canal [1].

Intracanal medicaments are used in order to improve disinfection of the root canal. The most commonly used intracanal medicament is calcium hydroxide because it is effective against the majority of endodontic pathogens and is biocompatible [2].

Before root filling, the $Ca(OH)_2$ medicament that has been applied to the root canal should be removed. Any $Ca(OH)_2$ residue on the canal walls negatively affects the quality of the root filling [3, 4]. However, removing the $Ca(OH)_2$ residues from irregular canal walls is difficult [5]. The most commonly described method for removing $Ca(OH)_2$ is instrumentation along with sodium hypochlorite and EDTA irrigant solutions combined with use of a ‘master apical file’ at working length [6-8].

Peracetic acid is a strong disinfectant with known antibacterial, sporicidal, antifungal and antiviral properties. It is used in food industry, veterinary medicine, water treatment and for sterilization of hospital equipment and devices. It has also been evaluated as an endodontic irrigant. The acetic acid content is responsible for dissolution of inorganic material as it forms complexes with calcium which are water soluble [9]. It has been showed, that 2.25% peracetic acid solution is comparable with 17% EDTA in removing smear layer. However, 2.25% peracetic acid is relatively caustic when it is in contact with oral mucosa and is therefore recommended in lower concentrations [10].

The use of passive ultrasonic irrigation has been proved to improve the effectiveness of irrigants when compared with syringe delivery. This involves the placement of a small file in the canal which is allowed to oscillate freely without contacting the canal walls. The resultant acoustic streaming and cavitation produced in the irrigant enhances the effectiveness of the irrigant [11].

Therefore, the present study was undertaken to evaluate the efficacy of 1% peracetic acid, 17% EDTA, 3% NaOCl and 10% citric acid in the removal of calcium hydroxide from the root canals along with passive ultrasonic activation.

METHODOLOGY

A total of 40 human single rooted teeth were selected in this study. Soft tissues and calculus deposits were mechanically removed from the root surfaces with a periodontal scaler. The exclusion criteria were a tooth having more than a single root canal and apical foramen, root canal treatment, internal/external resorption, immature root apices, caries/cracks/fractures on the root surface. To ensure standardization, the crowns of the teeth were removed with a diamond disc (Horico, Germany) under water coolant to achieve a final 15 mm root length for each tooth. A size 10 Kfile (Mani, Japan) was then placed in the canal until it was visible at the apical foramen. Working length (WL) was determined by subtracting 1 mm from this measurement. Root canals were shaped with ProTaper Universal rotary files (Dentsply Maillefer) up to size F4 as the master apical file. During the preparation, root canals were irrigated with 1.5 mL of 2.5% NaOCl via a size 27- gauge needle (Hindustan Unolock) between each file change. The canals were dried using paper points and filled with calcium hydroxide paste (calcium hydroxide powder + distilled water) using size 20 lentulospiral (Mani, Japan). The access cavities were sealed with temporary filling material (Cavit, 3M ESPE). The teeth was stored in 100% relative humidity for one week. The specimens was randomly divided into 4 experimental groups:

Group 1:(n=10) 3ml of 17% EDTA with passive ultrasonic irrigation.
Group 2:(n=10) 3ml of 3%NaOCl with passive ultrasonic irrigation.
Group 3:(n=10) 3ml of 1% peracetic acid with passive ultrasonic irrigation.
Group 4:(n= 10) 3ml of 10% citric acid with passive ultrasonic irrigation.

A size 15 K file (Mani, Japan) was introduced till the working length to loosen the calcium hydroxide from root canals and to create the space for the irrigation needle. Irrigation was performed with an ultrasonic U file (Dentsply Maillefer) for 30 seconds with the help of an ultrasonic device (NSK, Japan) at a power setting of 3. Two longitudinal grooves were placed on the external surface of the roots, opposite to each other using a diamond disc (Horico, Germany). The roots were split longitudinally into two halves with a chisel (Manipal, India).Then the samples were viewed under stereomicroscope (Labovision, Olympus) at a magnification of 30X.

Removal of calcium hydroxide from the root canals was evaluated in the apical, middle, and cervical third of the roots at 30X magnification.

A scoring system that was used in the study of Kuga *et al.*, [12] was defined to assess the quantity of the residues on the canal walls.

The scores used were as follows:

- Score 0: No residue
- Score 1: Small amount of residues (20% of the root canal surface was covered)
- Score 2: Moderate amount of residues (20–60% of the root canal surface was covered)
- Score 3: A large amount of residues (more than 60% of the root canal surface was covered).

RESULTS

GROUP 1: Moderate amounts of calcium hydroxide residues that is 20-60% (score 2) was left in coronal and middle third of the root canals, and large amounts of calcium hydroxide residue (score3) in apical third of the root canal.

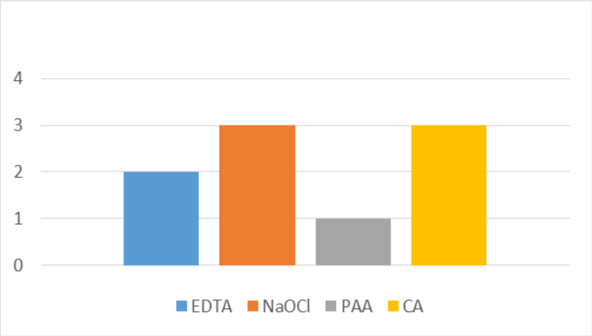
GROUP 2: Large amounts of calcium hydroxide residue, that is more than 60% (score 3) was left in the coronal, middle and apical third of the root canals.

GROUP 3: Small amounts of calcium hydroxide residue, upto 20% (score 1) was left in coronal, middle and apical third of the root canals.

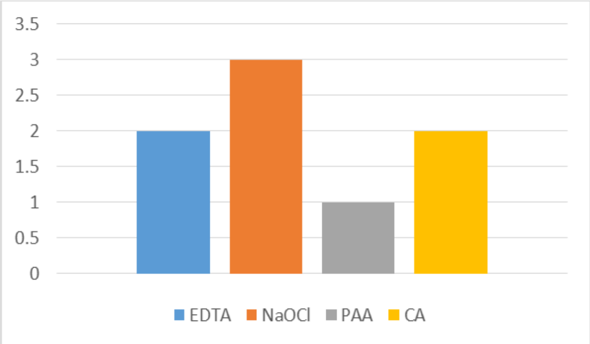
Group 4: Large amounts of calcium hydroxide residue ,that is more than 60% (score 3) was left in coronal and apical third of the root canals and moderate amounts of calcium hydroxide residue, in the middle third of the root canals.

Kruskal Wallis test was applied to find out significant difference between the study groups. In all the above test “p” value of less than 0.05 was accepted as indicating statistical significance.

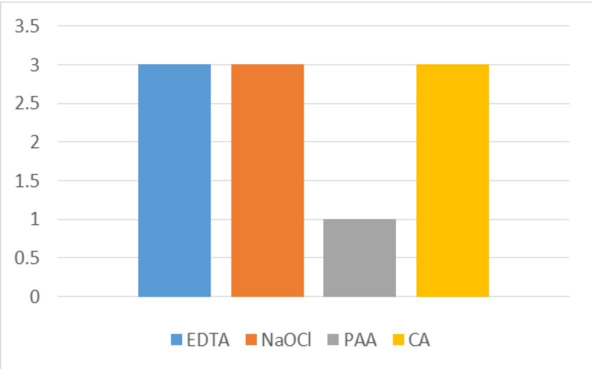
When 1% peracetic acid was compared with 17% EDTA, 3% NaOCl and 10% citric acid, 1% peracetic acid showed better results in coronal, middle and apical third of the root canals which was statistically significant.



Graph-1: Mean scores in coronal third



Graph-2: Mean scores in middle third



Graph-3: Mean scores in apical third

DISCUSSION

Optimizing root canal disinfection and preventing reinfection are essential for the success of endodontic treatment. Complete disinfection is impossible because of the complex root canal anatomy, which includes the lateral and accessory canals, isthmuses, and deltas. Regardless of the instrumentation technique used, large areas of the root canal walls can remain untouched [13]. Therefore, it is also necessary to disinfect root canals via chemical means using different intracanal medicaments and irrigating solutions. Many additives are included in $Ca(OH)_2$ intracanal medicaments, and many different formulations are used for root canal sealers. The combination of $Ca(OH)_2$ and sealer thus presumably affects their physical properties and apical sealing ability [14]. It has been reported that residual $Ca(OH)_2$ on the root canal walls interacts with zinc oxide-eugenol based sealers and produced calcium eugenolate [15]. The remnants could also influence the penetration of sealers into dentinal tubules [16], markedly compromising the quality of the seal provided by the root filling [17, 18]. Intracanal $Ca(OH)_2$ material should therefore be removed as much as possible prior to root filling [14].

Different types of irrigation protocols have been used in the removal of $Ca(OH)_2$ medicament from the root canals. Kuga *et al*., [12] used NaOCl or EDTA solutions in combination with two types of rotary instruments and reported that final irrigation solutions were not very effective in the removal of $Ca(OH)_2$ residues.

Wiseman *et al*., [19] evaluated the effect of sonic and ultrasonic agitation techniques in the removal of $Ca(OH)_2$ paste and reported the ultrasonic technique as more effective. Kenee *et al*., [20] reported that ultrasonic and rotary instrumentation in $Ca(OH)_2$ removal were more effective than the irrigant-only technique.

NaOCl solutions remains the most widely used irrigant in endodontics. It is a good solvent of organic tissue but has limited ability to dissolve inorganic materials. It was used in the study to compare its ability to remove calcium hydroxide from the root canals with other irrigating solutions [21].

Peracetic acid (PAA) solutions have been evaluated in endodontics as an irrigant by several authors [22-25]. It showed that PAA solutions could dissolve the smear layer as well as 17% EDTA solution [23, 24].

Peracetic acid is a strong disinfectant with known antibacterial, sporicidal, antifungal and antiviral properties. The acetic acid content is responsible for dissolution of inorganic material as it forms complexes with calcium which are water soluble and can be easily removed [9]. Therefore it was used as an irrigating solution in this study for the removal of calcium hydroxide from the root canal.

Ultrasonic activation was used because it increases the penentration of irrigating solutions into apical thirds of the root canals. Passive ultrasonic irrigation involves placing a thin file into the root canal which oscillates freely without contacting the root canal walls at ultrasonic frequencies in the presence of an irrigant, this helps in removal of organic or inorganic debris from the root canal walls [26].

In this study 1% peracetic acid was the most effective irrigant for the removal of calcium hydroxide from the root canal, which showed a score of 1 in the coronal, middle and apical third of the root canal. This could be because the high acidic pH of peracetic acid releases free oxygen and hydroxyl ions. In turn the hydroxyl ions releases acetic acid which bonds to the calcium ions and forms complexes which are easily soluble in water and can be removed. This complexes once formed do not reprecipitate, and help in easy removal of calcium hydroxide from the canals. This is in accordance with study by Burak et al who reported that 1% peracetic acid was superior in coronal, middle and apical third in the removal of calcium hydroxide from the root canal when compared to EDTA and NaOCl [9].

17% EDTA and 10% citric acid was used as they are the most common chelating solutions used in endodontics. They react with the calcium ions forming soluble chelates, removing calcium. So both were evaluated as an irrigating solution for the removal of calcium hydroxide from the root canals.

EDTA and citric acid were not effective in the removal of calcium hydroxide mainly in coronal and apical third of the root canal because in coronal third there is presence of more amount of calcium hydroxide paste. The chelator molecules which form complexes and are unable to bind to calcium ions. Due to this there is less decalcifying effect seen. In apical third of the root canal because of the reduced quantity of solution contained in a smaller canal volume there is less removal of calcium hydroxide. This is in accordance with the Hulsmann and Torabinejad who reported that EDTA and citric acid showed poor removal of calcium hydroxide mainly in the coronal and apical third [27].

In this study1% peracetic acid was superior in coronal, middle and apical third of the root canal, this difference was found to be statistically significant. The results of this study also suggests that passive ultrasonic activation is an effective adjunctive method to remove calcium hydroxide from the coronal, middle and apical thirds of the root canals.

CONCLUSION

Within the limitations of this in vitro study it can be concluded that:

- 1% peracetic acid was most effective in removing calcium hydroxide in the coronal and apical third of the root canal than 17% EDTA and 10% citric acid were not effective in removing calcium hydroxide in the coronal and apical third of the root canal. 3% NaOCl was least effective in the removal of calcium hydroxide from the root canal.
- Passive ultrasonic activation seems to be a promising adjunctive method for the removal of calcium hydroxide from the root canal.

REFERENCES

1. Ahmetoğlu F, Şimşek N, Keleş A, Ocak MS, Er K. Efficacy of self-adjusting file and passive ultrasonic irrigation on removing calcium hydroxide from root canals. Dental materials journal. 2013 Nov 28:32:1005-1010.
2. Athanassiadis B, Abbott PV, Walsh LJ. The use of calcium hydroxide, antibiotics and biocides as antimicrobial medicaments in endodontics. Australian dental journal. 2007 Mar;52:S64-82.
3. Caliskan MK, Turkun M, Turkun LS. Effect of calcium hydroxide as an intracanal dressing on apical leakage. International endodontic journal. 1998 May 1;31(3):173-7.
4. Barbizam JV, Trope M, Teixeira ÉC, Tanomaru-Filho M, Teixeira FB. Effect of calcium hydroxide intracanal dressing on the bond strength of a resin-based endodontic sealer. Brazilian dental journal. 2008;19(3):224-7.
5. Rlcucci D, Langeland K. Incomplete calcium hydroxide removal from the root canal: a case report. International endodontic journal. 1997 Nov;30(6):418-21.
6. Lambrianidis T, Margelos J, Beltes P. Removal efficiency of calcium hydroxide dressing from the root canal. Journal of Endodontics. 1999 Feb 1;25(2):85-88.
7. Lambrianidis T, Kosti E, Boutsioukis C, Mazinis M. Removal efficacy of various calcium hydroxide/chlorhexidine medicaments from the root canal. International Endodontic Journal. 2006 Jan;39(1):55-61.
8. Salgado RJ, Moura-Netto C, Yamazaki AK, Cardoso LN, de Moura AA, Prokopowitsch I. Comparison of different irrigants on calcium hydroxide medication removal: microscopic cleanliness evaluation. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2009 Apr 1;107(4):580-4.
9. Siqueira Jr JF, de Uzeda M. Influence of different vehicles on the antibacterial effects of calcium hydroxide. Journal of endodontics. 1998 Oct 1;24(10):663-5.
10. Yücel AÇ, Gürel M, Güler E, Karabucak B. Comparison of final irrigation techniques in removal of calcium hydroxide. Australian Endodontic Journal. 2013 Dec;39(3):116-21.
11. Nandini S, Velmurugan N, Kandaswamy D. Removal efficiency of calcium hydroxide intracanal medicament with two calcium chelators: volumetric analysis using spiral CT, an in vitro study. Journal of Endodontics. 2006 Nov 1;32(11):1097-101.
12. Kuga MC, Tanomaru-Filho M, Faria G, Só MV, Galletti T, Bavello JR. Calcium hydroxide intracanal dressing removal with different rotary instruments and irrigating solutions: a scanning electron microscopy study. Brazilian dental journal. 2010;21(4):310-4.
13. Versiani MA, Leoni GB, Steier L, De-Deus G, Tassani S, Pécora JD, de Sousa-Neto MD. Micro–computed tomography study of oval-shaped canals prepared with the Self-adjusting File, Reciproc, WaveOne, and Protaper Universal systems. Journal of Endodontics. 2013 Aug 1;39(8):1060-6.

14. Hosoya N, Kurayama H, Iino F, Arai T. Effects of calcium hydroxide on physical and sealing properties of canal sealers. International endodontic journal. 2004 Mar;37(3):178-84.
15. Margelos J, Eliades G, Verdelis C, Palaghias G. Interaction of calcium hydroxide with zinc oxide-eugenol type sealers: a potential clinical problem. Journal of Endodontics. 1997 Jan 1;23(1):43-8.
16. Çalt S, Serper A. Dentinal tubule penetration of root canal sealers after root canal dressing with calcium hydroxide. Journal of Endodontics. 1999 Jun 1;25(6):431-3.
17. Caliskan MK, Turkun M, Turkun LS. Effect of calcium hydroxide as an intracanal dressing on apical leakage. International endodontic journal. 1998 May 1;31(3):173-7.
18. Kim SK, Kim YO. Influence of calcium hydroxide intracanal medication on apical seal. International endodontic journal. 2002 Jul;35(7):623-8.
19. Wiseman A, Cox TC, Paranjpe A, Flake NM, Cohenca N, Johnson JD. Efficacy of sonic and ultrasonic activation for removal of calcium hydroxide from mesial canals of mandibular molars: a microtomographic study. Journal of endodontics. 2011 Feb 1;37(2):235-8.
20. Kenee DM, Allemang JD, Johnson JD, Hellstein J, Nichol BK. A quantitative assessment of efficacy of various calcium hydroxide removal techniques. Journal of endodontics. 2006 Jun 1;32(6):563-5.
21. GHoBadI M, Dadresanfar B, Raoof HR, Abbas FM. Removal of intracanal calcium hydroxide paste with two rotary systems: RaCe and Mtwo. Dental Press Endod. 2012;2:23-7.
22. Sağsen B, Üstün Y, Aslan T, Çanakçi BC. The effect of peracetic acid on removing calcium hydroxide from the root canals. Journal of endodontics. 2012 Sep 1;38(9):1197-201.
23. De-Deus G, Souza EM, Marins JR, Reis C, Paciornik S, Zehnder M. Smear layer dissolution by peracetic acid of low concentration. International Endodontic Journal. 2011 Jun;44(6):485-90.
24. Lottanti S, Gautschi H, Sener B, Zehnder M. Effects of ethylenediaminetetraacetic, etidronic and peracetic acid irrigation on human root dentine and the smear layer. International Endodontic Journal. 2009 Apr;42(4):335-43.
25. Zehnder M, Schmidlin P, Sener B, Waltimo T. Chelation in root canal therapy reconsidered. Journal of Endodontics. 2005 Nov 1;31(11):817-20.
26. Van der Sluis LW, Wu MK, Wesselink PR. The evaluation of removal of calcium hydroxide paste from an artificial standardized groove in the apical root canal using different irrigation methodologies. International Endodontic Journal. 2007 Jan;40(1):52-7.
27. Rödig T, Vogel S, Zapf A, Hülsmann M. Efficacy of different irrigants in the removal of calcium hydroxide from root canals. International endodontic journal. 2010 Jun;43(6):519-27.