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Araştırma/ Research Article

THE EFFECT OF QMix SOLUTION IN THE REMOVAL OF CALCIUM HYDROXIDE FROM ARTIFICIALLY CREATED GROOVES

YAPAY OLARAK OLUŞTURULMUŞ OLUKLARDAN KALSİYUM HİDROKSİTİN UZAKLAŞTIRILMASINDA QMix SOLÜSYONUNUN ETKİNLİĞİ

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ABSTRACT

Aim: The current study aimed to evaluate the effectiveness of QMix and EDTA solutions in removing $Ca(OH)_2$ from root canals.

Materials and Methods: Forty-eight mandibular premolar teeth were instrumented by ProTaper Universal instruments. All of the teeth were then fixed in modified Eppendorf vials using a silicone impression material. After the removal of the specimens from the Eppendorf vials the roots were split into two halves longitudinally and standard longitudinal grooves were then created on the dentinal walls at a level of 3 mm below the cementoenamel junction and 3 mm above from the apex of the roots. The $Ca(OH)_2$ was placed into the grooves and the specimens were then remounted into the silicone impression material. Six groups were formed: Needle-EDTA, Needle-QMix, Ultrasonic-EDTA, Ultrasonic- QMix, Sonic-EDTA and Sonic-QMix. The root halves were separated and digital images of artificially created grooves were obtained with a stereomicroscope at a 25x magnification. The $Ca(OH)_2$ left on the artificially created grooves were scored using a 4-graded scoring system and the data were statistically analyzed.

Results: Needle QMix group removed more $Ca(OH)_2$ than with the EDTA group at the apical part of the root canal ($P < 0.083$).

Conclusions: When the irrigation was performed by a conventional needle, the QMix solution had better efficiency than EDTA in removing $Ca(OH)_2$ from the apical part of the root canal. In clinical practice, the QMix solution can be used effectively for the removal of Ca $(OH)_2$.

Keywords: QMix, EDTA, calcium hydroxide

ÖZET

Amaç: Bu çalışma amacı, QMix ve EDTA solüsyonlarının kök kanalından $Ca(OH)_2$ 'i uzaklaştırma etkinliklerini değerlendirmektir.

Gereç ve Yöntem: ProTaper Universal aletleri kullanılarak 48 adet altçene küçük azı dişi şekillendirildi. Tüm dişler modifiye Ependorf tüplerine slikon ölçü materyali kullanılarak sabitlendi. Örnekler Ependorf tüplerinden çıkarıldıktan sonra kökler dik olarak ikiye ayrıldı ve dentin duvarları üzerinde, mine sement sınırının 3 mm aşağısında ve apeksin 3 mm yukarısında olacak şekilde standart oluklar oluşturuldu. Oluklara $Ca(OH)_2$ yerleştirildi ve örnekler tekrar slikon ölçü materyali içerisine yerleştirildi. 6 grup oluşturuldu: İğne-EDTA, İğne-QMix, Ultrasonik-EDTA, Ultrasonik-QMix, Sonik-EDTA, Sonik-QMix. Kök parçaları ayrıldı ve stereo mikroskop altında 25 büyütme kullanılarak olukların dijital görüntüleri alındı. 4 aşamalı skorlama sistemi kullanılarak geride kalan $Ca(OH)_2$ miktarı değerlendirildi ve veriler istatistiksel olarak analiz edildi.

Bulgular: İğne-QMix grubu apikal bölgede iğne-EDTA grubundan daha fazla $Ca(OH)_2$ uzaklaştırmıştır. ($P < 0.083$).

Sonuçlar: Kök kanalları geleneksel iğne ile yıkandığı zaman, QMix soluüsyonu, EDTA'dan daha etkin şekilde $Ca(OH)_2$ uzaklaştırmaktadır. Klinik pratikte QMix solüsyonu etkin bir şekilde kullanılabilir.

Anahtar Kelimeler: QMix, EDTA, kalsiyum hidroksit

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INTRODUCTION

Calcium hydroxide [$Ca(OH_2)$] is used in endodontics for various clinical situations as an inter-appointment intracanal medicament[1,2] because of its antimicrobial efficacy against most endodontic pathogens[3]. Previous studies have reported that remnants of $Ca(OH)_2$ on root canal walls can interfere with the sealing ability of root fillings and may increase apical leakage[4,5]. To allow for optimal adaptation of the root canal to the dentinal walls, $Ca(OH)_2$ remaining inside the root canal has to be removed before the root canal filling is put in place [6].

Recently, a new irrigation solution containing ethylenediaminetetraacetic acid (EDTA), chlorhexidine, and a nonspecified detergent has been introduced called QMix 2in1 (Dentsply Tulsa Dental, Tulsa, OK)[7]. Studies have demonstrated that the QMix solution is an antibacterial agent and is able to remove the smear layer[7,8]. No studies have evaluated the effect of the QMix irrigation solution in removing $Ca(OH)_2$ from root canals. Therefore, the current study aimed to evaluate the effectiveness of QMix and EDTA solutions in removing $Ca(OH)_2$ from root canals. The null hypothesis tested was that there would be no difference in the removal efficacy between these irrigating solutions.

MATERIALS AND METHODS

Forty-eight mandibular premolar teeth with straight root canals (< 5°), mature apices, and similar dimensions were selected and stored in phosphate buffered saline until their use. To obtain a 14 mm root length for all of the teeth, the crowns of the teeth were decoronated. A size 15 K-file (Mani Inc., Tochigi, Japan) was inserted into the canal until the tip of the file extruded apically and the length of the canal was measured. The working length (WL) was determined by subtracting 1 mm from the measured length. The root canal instrumentation was performed by ProTaper Universal instruments (Dentsply, Maillefer, Baillagues, Switzerland) with an endodontic motor (X-Smart, DENTSPLY). The following root canal preparation sequence was used: Sx, S1, S2, F1, F2, F3, F4, and F5 files (size 50, 0.05 taper). The irrigation of the root canals was performed with 1 mL 2.5% NaOCl solution between each instrument change. All of the teeth were then fixed in modified Eppendorf vials using a silicone impression material. After the removal of the specimens from the Eppendorf vials, a diamond disk was used to create grooves on the buccal and lingual surfaces of the specimens. The roots were then split into two halves longitudinally using a small chisel and hammer. Standard longitudinal grooves were then created using a round bur (size 010) on the dentinal walls of the two halves of each specimen at 3 mm below the cementoenamel junction and 3 mm above from the apex of the roots. The size of the grooves was approximately 1 mm deep, 1 mm wide, and 3 mm long. Debris on the dentinal walls and grooves were removed using a toothbrush. The root canals were then flushed using 5 mL of 2.5% NaOCl and 5 mL of 17% EDTA (Werax; SDD A.Ş, İzmir, Turkey) for 1 minute each. The root canals were dried and the $Ca(OH)_2$ was mixed using powder (Kalsin; SDD A.Ş.) and distilled water and was placed into the grooves using spreader. The specimens were then remounted into the silicone impression material. The access cavities were sealed using Cavit (Espe, Seefeld, Germany), and the samples were kept at 100% humidity at 37 °C for 1 week. After 1 week, each root was coated with wax to simulate a closed system in the clinical situation. In order to prevent any penetration of modelling wax into the root canals, a gutta-percha point was inserted into the root canal during the coating. Six groups were formed according to the final irrigation protocol:

Needle irrigation with EDTA: A total of 5 mL of 17% EDTA was used for this group. All of the root canals were irrigated for 1 minute via a side port opening closed-end tip needle with a size of 30 gauge (Canal Clean; Biodent Co. Ltd, Paju, Korea). The tip of the needle was inserted at a distance of 1 mm from the WL.

Ultrasonic irrigation with EDTA: A total of 5 mL of 17% EDTA was agitated continuously for 1 minute with a size 25 smooth ultrasonic file using an ultrasonic device. The file was inserted at a distance of 1 mm from the WL.

Sonic irrigation with EDTA: A total of 5 mL of 17% EDTA was agitated continuously for 1 minute with a medium tip (25/04) using an EndoActivator (Dentsply, Tulsa, OK, USA) handpiece set at 10,000 cpm. The file was inserted at a distance of 1 mm from the WL.

Needle irrigation with QMix: A total of 5 mL of QMix solution was used for this group. All of the

root canals were irrigated for 1 minute via a side port opening closed-end tip needle with a size of 30 gauge. The tip of the needle was inserted at a distance of 1 mm from the WL.

Ultrasonic irrigation with QMix: A total of 5 mL of QMix solution was agitated continuously for 1 minute with a size 25 smooth ultrasonic file using an ultrasonic device. The file was inserted at a distance of 1 mm from the WL.

Sonic irrigation with QMix: A total of 5 mL of QMix solution was agitated continuously for 1 minute with a medium tip using an EndoActivator handpiece set at 10,000 cpm. The file was inserted at a distance of 1 mm from the WL.

Finally, all of the root canals were irrigated using 5 mL of distilled water and dried with paper points. The root halves were separated and digital images of artificially created grooves were obtained with a stereomicroscope (Novex, the Netherlands) at a 25x magnification. Four images from each tooth were obtained and all of the images were then transferred to a computer to evaluate the removal of the $Ca(OH)_2$ medicament.

Two calibrated dentists, blinded to the $Ca(OH)_2$ removal technique, scored the $Ca(OH)_2$ left on the artificially created grooves (Figures 1 and 2) using the following scoring system[9]: 0 = the cavity was empty; 1 = less than half of the cavity was covered by $Ca(OH)_2$; 2 = more than half of the cavity was covered by $Ca(OH)_2$; and 3 = the cavity was completely filled with $Ca(OH)_2$ (Figure 3).

Inter-examiner agreement was analyzed using the kappa test and the data were statistically analyzed by using the Kruskal-Wallis test. If significant differences were found, intergroup comparisons were analyzed using the Mann-Whitney U test with Bonferroni correction at a 95% confidence level (P = .0083).

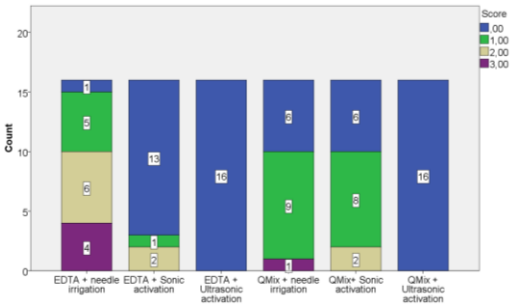

Fig 1. The distribution of scores for the removal of the Ca(OH)2 medicament at the apical part of the root canal.

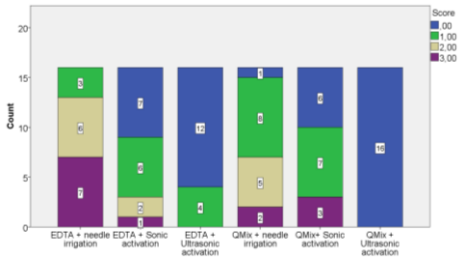

Fig 2. The distribution of scores for the removal of the Ca(OH)2 medicament at the coronal part of the root canal.

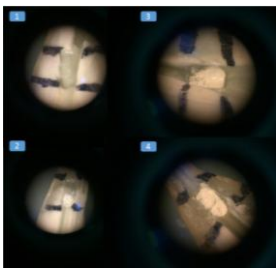

Fig 3. Examples of scoring system after removal of $Ca(OH)_2$.
Picture 1 = score 0
Picture 2 = score 1
Picture 3 = score 2
Picture 4 = score 3

RESULTS

The kappa test showed that the inter examiner agreement was good (kappa value = 0.871). The Kruskal-Wallis test showed that there was a significant difference among the groups in terms of $Ca(OH)_2$ removal (P<0.083) (Fig 1, Fig 2). The ultrasonic irrigation removed more $Ca(OH)_2$ than the needle irrigation for both the EDTA and QMix irrigation groups (P< 0.083). Needle irrigation with the QMix group removed more $Ca(OH)_2$ than with the EDTA group at the apical part of the root canal (P< 0.083). However, there was no significant difference between the needle irrigation with QMix and with EDTA at the coronal part of the root canal (P>0.083). Additionally, there was no significant difference between the ultrasonic irrigation with EDTA and with QMix in terms of $Ca(OH)_2$ removal at both the apical and coronal parts of the root canal (P> 0.083). Similarly, there was no significant difference between the sonic irrigation with EDTA and with QMix (P>0.083). However, the sonic irrigation with EDTA was superior to the needle irrigation with EDTA in removing $Ca(OH)_2$ from both of the apical and coronal parts of the root canal (P<0.001). However, there was no significant difference between the needle irrigation with QMix and sonic irrigation with QMix (P> 0.083).

When comparing the different parts of the root canals, there was less $Ca(OH)_2$ removed in the apical artificial grooves than from the coronal artificial grooves irrespective of the irrigation protocols ($P < 0.05$).

DISCUSSION

The results of the present study showed that when the irrigation is performed with sonic or ultrasonic agitation, QMix and EDTA solutions have similar $Ca(OH)_2$ removal effectiveness. However, the QMix solution was superior to EDTA in the apical section, when the irrigation was performed by a conventional needle. The QMix solution contains EDTA, chlorhexidine, and a nonspecified detergent that decreases the surface tension and increases the surface wettability[7,10]. It has been stated that low surface tension enables better penetration of the mixture into the dentinal tubules[11,12]. Moreover, several studies have indicated that the surfactant improves the performance of the solutions when compared to the same compounds without the surfactant[13-15]. Therefore, the detergent included in the QMix might have decreased the surface tension of the solution and led to the removal of more $Ca(OH)_2$ than the EDTA in the apical sections. As no studies have evaluated the efficacy of the QMix solution in removing $Ca(OH)_2$ from root canals, a direct comparison could not be performed between the results of previous studies and the current study.

In the present study, ultrasonic irrigation removed more $Ca(OH)_2$ than the needle irrigation for both the EDTA and QMix groups. This finding was in accordance with previous studies that compared needle irrigation with passive ultrasonic irrigation [16-18]. It has been reported that the removal of organic and inorganic debris from the root canal walls is improved by irrigation with passive ultrasonic agitation [19, 20]. The higher velocity of irrigant flow created by passive ultrasonic irrigation [21] may explain its efficiency on the removal of $Ca(OH)_2$ from root canals [9].

The needle irrigation with QMix and sonic irrigation with QMix groups showed similar results in terms of $Ca(OH)_2$ removal from artificially created grooves both at the apical and coronal sections. In contrast, in the EDTA groups, the needle irrigation removed significantly less $Ca(OH)_2$ than the sonic irrigation at both sections. As mentioned above, this result may be due to the detergent and chlorhexidine included in the QMix. It can be speculated that when root canal irrigation is performed with QMix, needle irrigation is as effective as sonic irrigation on the removal of $Ca(OH)_2$ from root canals due to the solution's compounds.

In the present study, at the apical part of the root canal, significantly more $Ca(OH)_2$ was removed than in the coronal part, irrespective of the irrigation solutions and techniques. This may be explained by the reduced amount of irrigation solution contained in a smaller canal volume [22-24]. Additionally, in the coronal part of the root canal, more chelator molecules are able to bind calcium ions [25-27] because of the larger canal volume at this part.

CONCLUSION

It can be concluded that when the irrigation was performed by a conventional needle, the QMix solution had better efficiency than EDTA in removing $Ca(OH)_2$ from the apical part of the root canal. Ultrasonic irrigation was superior to needle irrigation in removing $Ca(OH)_2$ for both the EDTA and QMix groups. Moreover, the ultrasonic irrigation completely removed the $Ca(OH)_2$ in both the EDTA and QMix irrigation groups at the apical part of the root canal.

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