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3 Farklı Sonik Aktivasyon Sisteminin Kök Kanallarında Standardize Yapay Oluklardan Debris ve Kalsiyum Hidroksit Uzaklaştırma Etkinliklerinin Karşılaştırılması*

Comparison of Three Different Sonic Activation Systems in Removing Debris and Calcium Hydroxide From Artificial Standardized Grooves in Root Canals

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Öz

Bu çalışmanın amacı: kök kanal irrigasyonunda sonik aktivasyon için kullanılan EndoActivator, SonicLine ve Eddy sistemlerinin, kök kanallarındaki düzensizliklerden kalsiyum hidroksit ve debris temizleme etkinliklerinin incelenmesidir.

110 sağlam üst orta keser dişin kron kısmı uzaklaştırılıp kök kanal genişletme işlemleri ProTaper Universal ile yapılmıştır. Kökler dikey olarak ikiye bölünüp kanal duvarına bir adet yapay oluk hazırlanmış ve 55 örneğe debris, 55 örneğe kalsiyum hidroksit uygulanmıştır. Birleştirilen yarımlar hermetik olarak örtülenmiş, ardından irrigasyon prosedürleri uygulanmıştır. Deney gruplarında (n=15) total sonik aktivasyon süresi 60 s olarak belirlenmiştir; bunun 30 saniyesi kanalda NaOCl varlığında, 30 saniyesi EDTA varlığında uygulanmıştır. İrrigasyondan sonra kurutulup tekrar açılan örneklerden x40 büyütmeyle stereomikroskop görüntüleri alınarak olukta kalan debris ve kalsiyum hidroksit miktarları standart bir skorlamaya tabi tutulmuştur. Skorlara Kruskal-Wallis ve Dunn-Bonferroni testi uygulanmıştır ($p<0.05$).

İstatistik inceleme sonucunda, kalsiyum hidroksit temizleme etkinliği açısından sonik aktivasyon grupları ile kontrol grubu arasında anlamlı bir fark bulunmamıştır ($p>0.05$). Sonik aktivasyon gruplarının konvansiyonel şırınga irrigasyon grubuna göre daha etkin debris uzaklaştırdığı ($p<0.05$), sonik aktivasyon sistem gruplarının birbirleri arasında anlamlı farklılık bulunmadığı ($p>0.05$) gözlenmiştir.

Yeni sistemler olan Eddy ve SonicLine'ın debris ve kalsiyum hidroksit uzaklaştırma açısından EndoActivator'e eşdeğer sonuç verdiği söylenebilir. Bu sistemlerin mekanik özellikleri ve klinik uygulamaları ile ilgili yeni çalışmalar düşünülebilir.

Anahtar sözcükler: eddy, endoactivator, debris uzaklaştırma, sonicline, sonik aktivasyon

Abstract

The aim of this study was to evaluate the efficacy of EndoActvator, SonicLine and Eddy sonic irrigation activation systems in removal of calcium hydroxide and dentinal debris from root canal irregularities.

One-hundred-ten human maxillary central incisor teeth were decoronized and instrumented with ProTaper Universal. Teeth were split in half vertically and a standardized groove was formed in canal wall. Fifty-five teeth were filled with calcium hydroxide and fifty-five with dentin debris. Two halves of the samples were brought together and sealed. Final irrigation procedures were applied. Sonic activation was applied to experimental groups. The samples were left to dry and reopened; then digital images were obtained to score remaining debris and calcium hidroxide normatively. Kruskal-Wallis and Dunn Bonferroni tests were applied to the scores ($p<0.05$).

In terms of removing calcium hydroxide from the artificial groove, sonic activation systems were not significantly different from the conventional syringe irrigation ($p>0.05$). Sonic activation systems resulted better in debris removal than conventional irrigation ($p<0.05$), however there was no significant difference amongst these three sonic systems ($p>0.05$).

It can be concluded that novel sonic activation systems Eddy and SonicLine resulted equivalent to EndoActivator. Further research can be executed on mechanical aspects and clinical properties of these systems.

Keywords: *eddy, endoactivator, debris removal, sonic activation, sonicline*

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INTRODUCTION

Endodontic treatment mainly relies on the disinfection of the root canal system. Mechanical preparation alone has been shown not to be capable of cleaning the entire canal.[1] Even if antibacterial and tissue solving chemicals are used as irrigation solutions; microorganisms, residual organic tissue and dentin debris remain in the uninstrumented areas.[2] This debris also called "smear layer" is the result of mechanical preparation and consisted of organic and inorganic materials. The smear layer can jeopardize the efficiency of obturation materials by preventing the sealer from reaching further into dentinal tubules.[3] Conventional passive irrigation with syringe is not effective in uninstrumented areas such as internal resorptions, lateral canals, fins, cul-de-sacs (dead ends), canal ramifications.[4, 5] In order to enrich the cleaning properties of irrigation to remove debris from intracanal irregularities that is beyond the reach of mechanical instrumentation, irrigation activation techniques are recommended.[6]

Calcium hydroxide is a widely known intracanal medication used for its antibacterial effects, ability to inhibit osteoclastic activity as well as induce tissue repair response.[7, 8] It is known that calcium hydroxide remnants may affect the quality of root filling negatively, thus its removal is recommended beforehand.[8] Many techniques for calcium hydroxide removal have been investigated. Irrigation with EDTA in addition to sodium hypochlorite (NaOCl) and activation with ultrasonic irrigation is shown to have better results in removal of calcium hydroxide.[7]

Irregularities within the root canal may occur naturally such as complex isthmuses or pathologically due to internal root resorption. These areas are not accessible mechanically, therefore both disinfection and medication removal from irregularities may pose a challenge. Irrigation activation systems are recommended as conventional irrigation is considered inadequate.[9]

Sonic activation, being used in endodontics since 1985, is known to promote debris removal from root canals.[10] EndoActivator (Advanced Endodontics, California, USA) is a sonic activation system that produces fluid agitation by sinusoidal oscillation of the tip. The system comes with a polymer tip in order to prevent apical transportation, ledge or perforations.[11] Two new sonic activation systems are introduced recently. Eddy (VDW, Munich, Germany) oscillates at 5000-6000 Hz frequency and has nonaggressive polyamide tips even softer than dentin itself. SonicLine (Komet Dental, Lemgo, Germany) has flexible nickel titanium tips coated with titanium nitrite claimed to be harmless to canal walls by the company. There hasn't been a study considering debris or calcium hydroxide removal efficacy of those novel sonic systems from intracanal irregularities to the best of our knowledge.

This in vitro study aims to compare debris and calcium hydroxide removal efficiency of three sonic activation systems and conventional passive irrigation from artificial standardized simulated grooves in root canals.

MATERIALS AND METHODS

This study is conducted with the ethical principles and confirmation of Izmir Katip Çelebi University Non-Interventional Clinical Studies Institutional Review Board (PRO17030061).

One-hundred-ten recently extracted sound maxillary central incisors with closed apices were used in this study. Teeth with fractures, restorations, resorptive defects, root canal obturations and caries were excluded. Soft and hard tissue remnants were cleaned from the root surfaces with a hand scaler. All the teeth were decoronized with a diamond disc by standardizing the root length to 15 mm under copious water irrigation. Working lengths were decided 1 mm shorter than the length of #10 K file that was visible through apical foramen. The

teeth in which apical patency cannot be attained or apical foramen width is equal or wider than #20 K file were excluded from the study. Glide path was checked with #15 K file.

Specimens were instrumented with ProTaper Universal Rotary System (Dentsply Maillefer, Ballaigues, Switzerland) used with Dentsply X-Smart Plus endodontic device (Dentsply Maillefer, Ballaigues, Switzerland) adjusted to 250 rpm and 3 Ncm torque. Files Sx, S1, S2, F1, F2, F3 and finally F4 (40; 0,06 taper) were used respectively according to manufacturer's instructions. Irrigation with 2 ml 2.5% NaOCl (Werax, İzmir, Turkey) was performed during instrumentation and between each instrument, glide path was controlled via #15 K files.

After instrumentation, longitudinal grooves were prepared on buccal and lingual sides of the root surfaces with a diamond disc under water irrigation. The teeth in which grooves damaged the root canal space were excluded from the study. The teeth were split in half using a scalpel blade no: 15 and those without a decent fracture line were excluded.

An ultrasonic tip was modified and confirmed with a digital caliper and used in order to obtain simulation grooves represent intracanal irregularities with an ultrasonic device (Anthos u-PZ6, Imola, Italy). The grooves were prepared in a 2-6 mm distance from root apex; 4 mm in length, 0.2 mm in width and 0.5 mm in depth on one half of all specimens in the way described in previous studies.[12, 13] All grooves were checked by placing a #15 hand spreader previously curved at 4 mm. All specimens were stored in Eppendorf vials filled with distilled water while not in use in order to prevent dehydration. Specimens were divided into two main study groups randomly: debris removal (n=55) and calcium hydroxide removal groups (n=55).

Debris group:

Dentin shavings were acquired from the previously excluded teeth via round stainless steel bur. Fifty-five specimens were dried gently with paper towels. Any remains were cleaned with a soft toothbrush from the canal space. Stereomicroscope imaging (Zeiss AxioCam Erc5s camera, Zeiss Stemi 2000-c stereomicroscope and Zeiss AxioVision software, Goettingen, Germany) was performed for each specimen in order to control groove cleanliness at a magnification of 20. Dentin shavings were mixed with 2% NaOCl until the mixture gets the consistency of wet sand.[6] This process was repeated for every 5 specimens and used fresh. Debris mixture was placed into simulated artificial grooves until they are full. Any excessive debris around the groove was cleaned with a cotton applicator carefully not to force debris into the groove. Grooves full of dentinal debris were photographed again with the same magnification.

Tooth halves with grooves were reunited with their pairs and fixed using an orthodontic elastic band (1/8", 3 mm, GC-Orthodontics, Germany). Afterwards, a hermetic seal was obtained using modelling wax to cover the separation line so that a closed fluid system was acquired to reflect clinical conditions. A cotton pellet and zinc oxide eugenol cement (Cavex Holland BV, Haarlem, Holland) was placed on the access cavity as a temporary restoration while the specimen was not in use. Teeth were fixed in silicone (Speedex putty and light body, Coltene, Alstatten, Switzerland) filled Eppendorf vials with numbers written on them. Vials were stored in distilled water.

Calcium hydroxide group:

Grooves of the remaining 55 specimens were filled with calcium hydroxide paste (Kalsin, Spot Diş Deposu, İzmir, Turkey) prepared with the ratio of 1:1 after initial microscopic imaging. The medication was prepared fresh for every 10 teeth. Filled grooves were checked with a previously curved hand spreader #15 and any excessive paste was cleaned. The grooves were photographed again with 20x magnification.

Tooth halves were put together, sealed and stored in the same method as debris removal groups.

Specimens in both main groups were randomly divided into three experimental (n=15) and one control groups (n=10) using www.random.org (6 experimental and 2 control groups in total). Sample distribution is shown in Table 1.

Final irrigation procedure consisted of 6 ml 2,5% NaOCl (Werax, İzmir, Turkey) 1 ml 17% EDTA (HP, Imicryl Diş Malz. Konya, Turkey) and distilled water in all groups.[14] In experimental groups, total activation time was 1 minute.[14] Activation tips were placed 2 mm shorter than the working length.[14, 15] While irrigation and activation, cannula and activation tips were used with a 1-2 mm corono-apical motion. A luer-lok syringe (Coltene CanalPro, Langenau, Germany) and closed ended, side ventilated 30-gauge irrigation cannulas (CK Endo, South Korea) were used.

In experimental groups, 30 seconds 3 ml NaOCl irrigation was followed by activation 30 seconds. Thereafter, 1 ml EDTA irrigation was performed for 30 seconds and activation for 30 seconds followed by another 3 ml NaOCl irrigation and finally 1 ml distilled water without activation.

EndoActivator groups: Sonic activation was performed with 10.000 cpm setting, using 25/.04 tip.

Eddy groups: The polyamide tip was inserted in a sonic airscaler (Sonix, Dentamerica Inc, California, USA).

SonicLine groups: Three parts of activation system (rinsing tip, tip holder and clamping nut) were combined and inserted in a sonic airscaler. According to manufacturer's instructions, the nickel titanium tip was activated after placing in the canal space.

Control groups: 3 ml NaOCl irrigation was carried out for 60 seconds followed by 1 ml EDTA for 60 seconds, 3 ml NaOCl for 30 seconds and completed with 1 ml distilled water 14.

Irrigation procedures are shown in Table 2.

Table 1: Sample distribution to experimental and control groups

Groups	Endoactivator (Advanced Endodontics)	Eddy (VDW)	SonicLine (Komet)	Control Groups
Debris removal groups: (n=55)	Group DA (N=15)	Group DE (N=15)	Group DS (N=15)	Group DC (N=10)
Calcium hydroxide removal groups: (n=55)	Group CA (N=15)	Group CE (N=15)	Group CS (N=15)	Group CC (N=10)

Table 2: Irrigation activation procedures for experimental and control groups

Sonic activation groups		Control groups	
Process	**Time**	**Process**	**Time**
3 ml NaOCl	30 sec	3 ml NaOCl	60 sec
Activation	30 sec		
1 ml EDTA	30 sec	1 ml EDTA	60 sec
Activation	30 sec		
3 ml NaOCl	30 sec	3 ml NaOCl	30 sec
1 ml distilled water	15 sec	1 ml distilled water	15 sec

Table 3: Calcium hydroxide and debris removal score distribution

	Scores			
Groups	**0**	**1**	**2**	**3**
CA	5	9	0	1
CE	8	5	1	1
CS	9	5	1	0
CC	2	4	2	2
DA	11	4	0	0
DE	12	3	0	0
DS	11	3	1	0
DC	3	3	3	1

Specimens were pulled out of silicone and two halves were disunited. Remaining debris in the grooves was photographed under stereo-microscope with 40x magnification and scored by the same researcher 3 times with 1-week intervals; using a scoring system described in the other studies before[12, 13] (Figure 1).

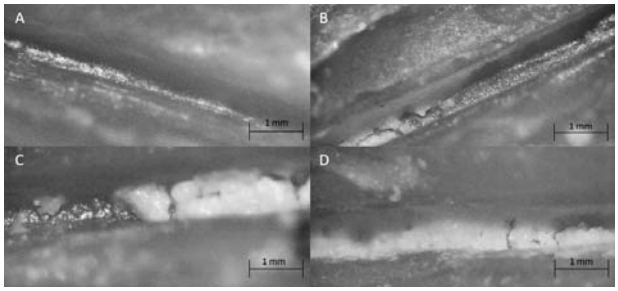

Figure 1: Groove scores (A) Score 0: the groove is empty; (B) Score 1: less than half of the groove is filled with debris; (C) Score 2: more than half of the groove is filled with debris; (D) Score 3: the complete groove is filled with debris. Original magnification, 40x.

Three sets of scores were analyzed with intraclass correlation coefficiency and mean scores were calculated from the obtained data. Kruskal-Wallis test with post hoc Dunn-Bonferroni test was performed via SPSS software (SPSS Inc, Chigaco, IL, USA) ($p>0.05$).

RESULTS

Debris and calcium hydroxide removal scores are shown in Table 3. Sonic irrigation activation groups (Groups DA, DE, DS) showed significantly better debris removal than the conventional irrigation group (Group DC) ($p<0.05$). However, there was not a significant difference among the activation groups in debris removal ($p>0.05$).

The difference between sonic irrigation activation groups (Groups CA, CE, CS) and conventional irrigation group (Group CC) was not statistically significant ($p>0.05$) in terms of calcium hydroxide paste removal from artificial grooves. There was no significant difference amongst the sonic activation groups either ($p>0.05$).

DISCUSSION

This study compared three different sonic activation systems in debris and calcium hydroxide medication removal from artificial grooves. In calcium hydroxide removal groups, only 24 in 55 samples (43.6%) scored 0. This result indicated the challenge in medication removal during routine clinical practice. The results of the present study showed that there was no significant difference between the sonic irrigation activation systems and conventional irrigation in terms of calcium hydroxide removal. This result is compatible with the study carried out by Topçuoğlu et al.[16] which compared EndoActivator and conventional irrigation systems. However, Khaleel et al. and Alturaiki et al. stated that EndoActivator removed calcium hydroxide better than conventional irrigation.[17, 18] Khaleel et al.[17] have finished canal enlargement at 30/.06 while final apical file was 40/.06 in the present study. In

other words further enlargement of root canals in the present study may have resulted in more effective conventional irrigation.[17, 19] Alturaiki et al.[18] used 3 ml EDTA, while in this study 1 ml was preferred based on the model described in a previous study [14], and the difference between the results may have been resulted from this discrepancy.

The success of root canal therapy relies on not only disinfection of root canals but also removal of smear layer that formed during mechanical preparation process. Intracanal irregularities such as isthmuses, lateral canals and internal resorptions pose a challenge as extra debris may be packed into these areas during mechanical preparation. While smear and debris removal from root canal walls can be evaluated using scanning electron microscope (SEM)[20], removal efficacy from irregularities may be assessed using standardized artificial grooves. We also preferred an artificial groove study model that had been previously used for both debris and calcium hydroxide removal studies with the same groove dimensions and location on the canal Wall.[12, 13]

In the present study, sonic activation systems showed better results than conventional irrigation in debris removal. Although this result is consistent with previous studies that found EndoActivator is more effective[21, 22]; it is in contradiction with the studies which could not find an statistically significant difference in the same subject[23-25]. This difference may have been resulted from the lack of irrigation activation with EDTA in two studies.[23, 24] Rödig et al. evaluated debris removal from curved canals and concluded that sonic activation efficacy is weaker beyond the curvature.[25] In the present study, apart from the conventional irrigation system, there was no significant difference among sonic irrigation activation systems EndoActivator, SonicLine and Eddy in terms of debris removal from artificial grooves.

Sonic and ultrasonic devices have been compared for their debris or medication removal efficacies in many studies. It has been stated that ultrasonic devices are better at debris removal[26], irrigant penetration to lateral canals[27] and calcium hydroxide removal.[15] Although the ultrasonic systems are used according to manufacturer's suggestions, they may uncontrollably remove the root canal dentin especially in apical third even if the root canals are straight.[28] Thus, different sonic activation systems with less aggressive tips have been preferred in the present study. EndoActivator system has polymer tips whereas Eddy system consists of polyamide tips which are said to be softer than dentin itself. SonicLine however has flexible nickel titanium tips coated with titanium nitrite and it has a blunt end. There is no study regarding the uncontrolled dentin removal of these new sonic systems from root canal walls to the best of our knowledge.

A few studies could be found concerning newly introduced Eddy activation tips. It has been stated that activation with Eddy equally increased the organic tissue dissolving activity of irrigants from artificial grooves in root canals as observed in passive ultrasonic and EndoActivator.[14] An antibacterial efficacy study[29] stated that Eddy is at least as effective as passive ultrasonic irrigation in both straight and curved root canals. Urban et al.[30] evaluated the debris removal from straight canal walls by means of SEM and observed that EndoActivator, Eddy and Passive ultrasonic irrigation were all more effective than manual irrigation. Although canal walls had no grooves and only sodium hypochlorite was used as an irrigation component in this study, the results showing the efficacy of Eddy and EndoActivator were similar to those of our study.

CONCLUSIONS

Within the limitations of this study sonic activation systems showed significantly better performance at debris removal than the conventional irrigation, whereas there was no significant difference in means of calcium

hydroxide removal efficacy. New sonic activation systems such as Eddy and SonicLine had similar effectiveness with EndoActivator.

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