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이 논문을 치의학 석사학위신청 논문으로 제출함

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CK file의 크기에 따른 도말층 제거 효과에 대한 평가

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본 연구는 초음파 근관세척기구인 CK file의 도말층 제거 능력을 평가하고 더 나아가 CK file size 에 따라 차이가 있는지 알아보고자 하였다. 표본으로 근첨이 완성되고, 근관의 만곡이 없는 사람의 하악 소구치 48개를 준비하였다. 실험과정의 표준화를 위해 치관부를 절단하고 #40 WaveOn file로 근관 확대 후 1 mL의 2.5% NaOCl로 세척하였다. 4개의 군으로 나누어 최종 세척 단계에서 첫 번째 그룹은 syringe irrigation만을 시행하는 대조군으로 하였고, 두 번째 그룹은 #20 CK file을 사용하여 세척액이 채워진 근관내에 초음파를 적용하였고, 세 번째 그룹은 #30 CK file로 초음파를 적용하였고, 네 번째 그룹은 #20 K file에 초음파 scaler tip을 접촉시킴으로서 초음파를 적용하였다. 최종세척과정에는 5ml의 17% EDTA와 5ml의 2.5% NaOCl이 사용되었다. 근관 건조 후 치근을 절단하여 근관의 내면을 노출시킨 후 주사전자현미경으로 관찰하였다. 독립된 두명의 조사자가 현미경 하에서 얻은 이미지를 통해 도말층 제거 정도를 평가 하였다. 분석 결과, 치근단 1/3 부위에서 #20 CK file을 사용한 그룹이 다른 그룹들보다 유의적으로 높은 도말층 제거 결과를 보였으며 중간 1/3 에서는 그룹간 유의적인 차이를 보이지 않았다.

I. Introduction

It is known that cleaning of the root canal systems plays a critical step in the success of endodontic therapy.[1] This is achieved by combining instrument-base preparation with antiseptic irrigating solutions.[2] The drawback of instrument-based preparation is the creation of debris[3] and smear layer.[4] Debris on root canal surfaces prevent the complete removal of tissue and microorganisms, and make a complete disinfection of root canal system difficult.[5,6] The smear layer is potentially infected, and its removal allows more efficient penetration of intracanal medication into the dentinal tubules and a better interface between the filling material and the root canal walls.[7]

The recently introduced nickel-titianium(NiTi) files WaveOn (Dentsply Mailefer, Switzerland) and Reciproc (VDW GmbH, Germany) are claimed to be able to completely prepare and clean the root canals with only one instrument. Preparation time was decreased by up to 60% when using the single-file systems. Thus, simultaneously the time available for irrigation and chemical debridement of the root canal system is also reduced.[8] Therefore, the improvement of irrigation protocols is essential during root canal treatment in order to compensate the decreased irrigation time when using single-file systems.

Althogh various methods of irriganting methods have been used, above all, many researchers have recommended that passive irrigation technique should be used in the last stage of canal irrigation.[9-15] So, this study focused on passive ultrasonic irrigation (PUI) systems. When this system was compared with conventional technique, ultrasonic systems showed better results in the removal of the smear layer from the root canal walls.[16,17]

The recently released ultrasonic instrument, CK files were connected to the hand piece of a ultrasound generator via a 90° or 120° file holder. CK files were composed of 4 different sizes (#20, #25, #30 and #35), but which was not specified size to apply properly. The purpose of this study was to evaluate the efficacy of the CK files (B&L Biotech, Korea) as ultrasonic instrument in removing smear layer. And further, to find out if there is a difference in cleaning capacity according to the file sizes.

II. Materials and Methods

1. Sample selection

Forty eight extracted human mandibular premolars with mature apices were selected for this study. All teeth were radiographed in a bucco-lingual and a mesio-distal orientation, to ensure similar canal morphology. Teeth were stored in 0.9% physiologic saline following extraction at 4℃. Anatomical crown were removed with a diamond disk to simplifying procedures.

2. Root canal instrumentations

The working length was determined by measuring the length of a #10 K-type file at the apical foramen minus 1 mm. The apex was sealed with melted wax to close the apical foramen.[18] The aim was to prevent the irrigants from escaping through the apex in order to simulated in vivo conditions.[19] The root canals of teeth in all the groups were prepared using #40 WaveOn^{TM} file (Dentsply Mailefer, Switzerland) to the working length, and then, irrigated with 1mL of 2.5% NaOCl. The irrigant was delivered in a 10 mL syringe, with a 27-gauge side-vented needle. The needle was inserted as deep as possible in to the root canal without binding. All groups were then suctioning away the intracanal surplus NaOCl. A #45 hand file was used to confirm foramen diameter. In doing so, apical size was standardized in #45. Upon completion of instrumentation, the teeth were randomly divided into one control group and three experimental groups with 12 teeth in each.

3. Final irrigation protocols

(1) No activation group

The canals were flushed with 2.5 mL of 17% EDTA (Ethylenediaminetetraacetic acid), which was left in place for 60 seconds with no agitation. And the canal was flushed again with 2.5 mL of 17% EDTA. After apiration, the canal was rinsed with 2.5 mL of 2.5% NaOCl, which was left in place for 30 seconds and then flushed with 2.5 mL of 2.5% NaOCl. (Table 1)

(2) Passive ultrasonic activation with #20 CK-file

The canals were rinsed with 2.5 mL of 17% EDTA and ultrasonically activated for 60 seconds with a #20 CK file at the manufacturer' s recommended power setting, placed 2 mm short of the working length. To get passive activation, every attempts was made to keep the file centered in the canal so that it would not touch the canal walls. During activation, the file was moved continuously up and down 2 to 3mm within 2mm of the apex. And then flushed with 2.5 mL of 17% EDTA. After aspiration, the canal was flushed with 2.5 mL of 2.5% NaOCl, with similar activation for 30 seconds, followed by flushing with 2.5 mL of 2.5% NaOCl. (Table 1)

(3) Passive ultrasonic activation with #30 CK-file

The Irrigation was carried out with a similar protocol as Group 2 using a #30 CK-file.

(4) Passive ultrasonic activation with #20 K-file

The irrigation was carried out with a similar protocol as Group 2 using a #20 K-file. K-file was inserted to root canal, and ultrasonic energy was delivered as contacting to the file shanks.

Table 1. Irrigation protocols

Group	Apical size	Irrigants	Ultrasonic
(1) No activation	#45	EDTA/NaOCl	−
(2) #20 CK−file	#45	EDTA/NaOCl	+
(3) #30 CK−file	#45	EDTA/NaOCl	+
(4) #20 K−file	#45	EDTA/NaOCl	+

4. Sectioning of the roots and preparation for SEM

After preparation, all roots were dried with paper point. Colored Gutta−percha cones were fitted and used as markers to best gauge groove depth. The object was to avoid any intrusion of cutting disk into the canals, which would pollute the samples by splattering cutting debris in to the root canal system. Longitudinal groove was made with a diamond disk on buccal and lingual surface of the root, and then, horizontal groove were made on 3mm, 6mm from apex of the roots. A continuous supply of air was delivered to improve cutting precision, which eliminated the potential of introducing debris into this region of the canal. The roots were then split with a chisel resulting in a mesial and distal half for each roots. All intact halves were used for evaluation. To avoid any contamination, coronal third were discarded.[2] Each sample was dehydrated in graded series of ethanol solutions (Junsei chemical, Japan). Then coated with gold, and viewed with a scanning electron microscope (S4700, Hitachi, Japan) at 15 kv. (Figure 1)

5. SEM evaluation

Each fragments was firstly viewed at low magnification (x100) in order to gain an overview of the sample. Image acguisition on the most typical zones of the sample was performed at a magnification of x1000 to assess the presence of smear layer. Smear layer of the root canal was evaluated in two areas (Apical and middle third of the

root). A total 96 images were independently analyzed by 2 trained evaluators. They had no inside knowledge of the operative procedures and were trained with qualitative analysis on root canal images produced by scanning electron microscopy. Each image was scored for the amount of smear layer by two independent evaluators using a 4-step scale as follows (Figure 1); Score 0: all tubules visible, score 1: more than 50% of tubules visible, score 2: less than 50% of tubules visible, score 3: no tubules visible.[20]

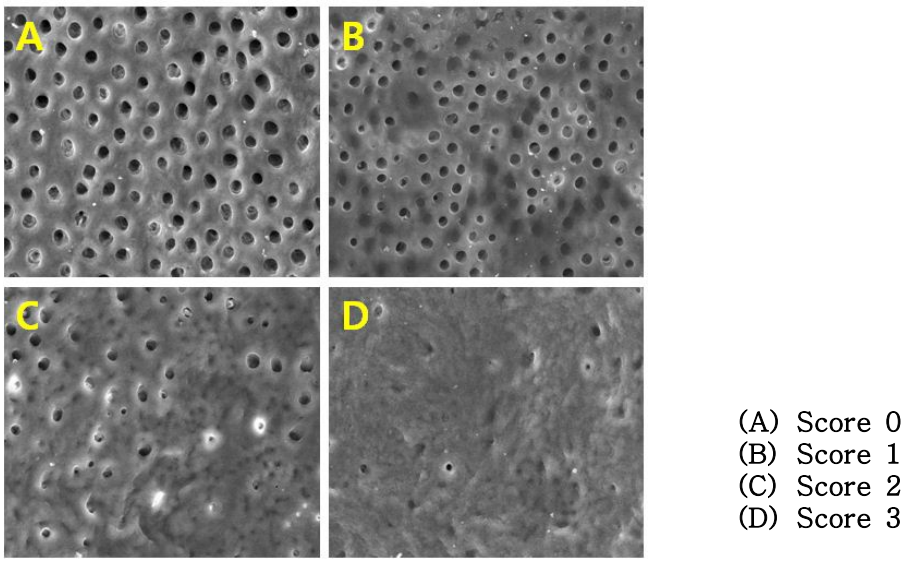

Figure 1. SEM images and a scale used to evaluate sample cleanliness. Magnification: x1,000.

6. Statistical analysis

The data were analyzed by using the kruskal-Wallis test and Mann-Whitney rank sum test for pairwise comparisons. The significant level was set at $p \leq 0.05$.

Ⅲ. Results

The results for smear layers removal in the apical third and middle third are presented in Table 2 and Figure 2.

Table 2. Smear layer scores (Mean ± SD)

Group	N	Apical third(3mm)	Middle third(6mm)
(1) No activation	12	2.00±0.603	1.50±0.674
(2) #20 CK-file	12	1.75±0.621	1.67±0.577
(3) #30 CK-file	12	1.83±0.577	1.58±0.668
(4) #20 K-file	12	1.83±0.577	1.33±0.651

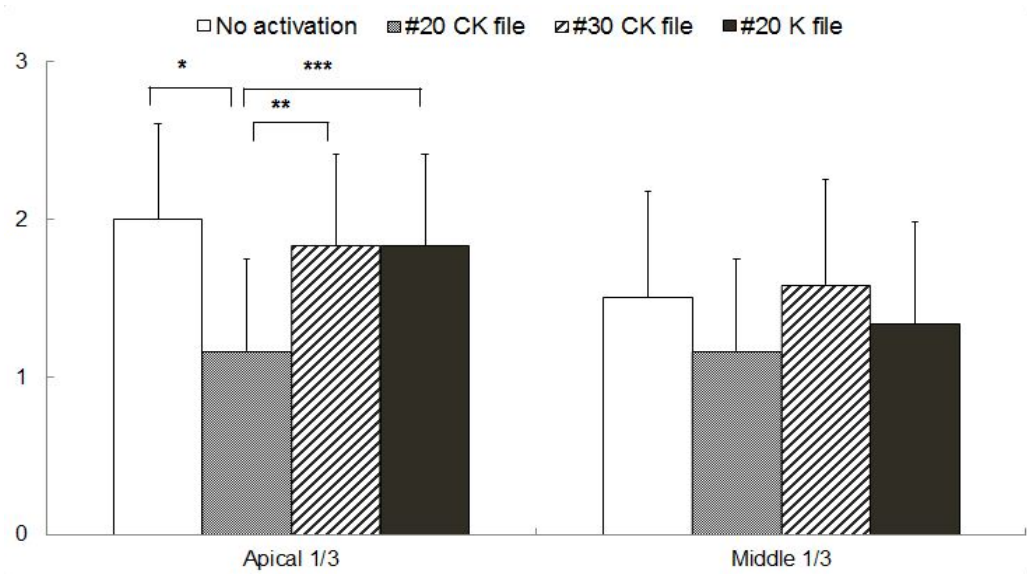

Figure 2. Bar diagrammes showing mean smear layer score.
Significant differences are indicated as * $p < 0.05$ or as ** $p < 0.01$

There was a trend to have more smear layers increasing from middle to apical, with the exception of the #20 CK file group. When comparing the each groups in the apical third, #20 CK file group

significantly better than the other groups ($p < 0.05$), while no significant difference were obtained among the other groups. In the middle third, among the groups did not showed significant differences.

Ⅳ. Discussion

Ultrasonics is known to produce acoustic streaming fields in the irrigant around the file, and they may help moving irrigant around the canal. Passive ultrasonic irrigation (PUI) technique used this principles.[21]

The PUI involves placing a thin file into the root canal, which is driven to oscillate freely without contacting the root canal walls at ultrasonic frequencies in the present of an irrigant.[22] The use of an ultrasonic activation increases the effectiveness of the final rinse procedure in apical third of the canal walls.[23] As above, in this study, the results showed that ultrasonic activation removed more smear layer in the apical part when compared to conventional syringe irrigation. In contrast, current results reported that the apical part of the canals was least influenced by the activated irrigation. It is because that the oscillation of ultrasonic instrument is decreased by constraining it in the root canal because of smallest canal diameter.[25]

A #20 CK file was more effective than #30 CK file in smear layer removal. Smaller file generated greater acoustic streaming because of the increased amplitude of the file.[25] Therefore, to maximize the effects of acoustic streaming, smaller files should be used within the canal space.[11]

In the middle part, significantly differences were not detected among the groups. This could be explained as follows; large canal size enable the irrigation needle to penetrate deeply.[26,27] so, it is thought that smear layer were fully removed with only syringe irrigation.

A difficult variable to control in this study is the wide variation in canal morphology. The size of a canal may influence the incidence of binding of the ultrasonic file and irrigation volume, thereby effect the

debridement efficacy of the instrument.

Passive activation implies that no attempt is made to instrument, plane, or contact the canal walls with the file.[28] When a file is introduces into the root canal, through necessity, it will touch the dentin wall. This will influence its amplitude of oscillation and hence its clinical performance.[29] No matter how we try, file contact with the canal walls may be unavoidable.[28] Thus, experimental appliances are designed for evaluating truly passive ultrasonic effects.

A various scoring method has been described to evaluate the amount of smear layer left on canal walls. This study used only one score at each level examined.[20] However, This method may be inaccurate to evaluate smear layer because they are often non-uniformly distributed. Furthermore only a small part of the root canal can be evaluated with x1000 magnification. To improve this problem, following method is recommended. Grid is superimposed over the photomicrographs under lower magnification and the amounts of smear layer are evaluated in each assessment units.[30]

Although passive activation of ultrasonics with #20 CK file during final irrigation produced cleaner canals than syringe irrigation alone, it was not able to debride the canal system completely. Though technological advances have brought several devices that rely on various mechanisms, any appliances were not able to remove the intra canal debris.[31] Clinicians make an effort to compensate this, sufficient volume of irrigants and time are needed.

V. Conclusion

Within the limitations of this study, the result indicated that the ultrasonic irrigation with a #20 CK file is most beneficial during final irrigation steps. It implies that smaller size CK file is more effective in removing the smear layer at the apical part.

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