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Research Araştırma

EFFECT OF DIFFERENT ROOT CANAL PREPARATION TECHNIQUES ON THE APICAL EXTRUSION OF DEBRIS IN CURVED AND SEVERELY CURVED ROOT CANALS

FARKLI KÖK KANAL ŞEKİLLENDİRME TEKNİKLERİNİN EĞİMLİ VE AŞIRI EĞİMLİ KÖK KANALLARINDA APİKAL DEBRİS TAŞKINLIĞINA ETKİSİ

ABSTRACT

Objectives: To compare the efficacy of various preparation techniques and root canal curvature on the apical debris extrusion.

Materials and Method: One hundred eight mesiobuccal root canals of mandibular molars were divided into three groups according to an angle of curvature 0º-10º(straight), 11º-25º (curved) and 26º-35º(severe curved) (N=36). The roots were fixed to eppendorf tubes which were previously weighted. The canals were instrumented with ProTaper Gold (PTG), One Curve (OC) and WaveOne Gold (WOG) nickel titanium (NiTi) file systems for each angle of curvature group (n=12). The amount of extruded debris in the Eppendorf tube was calculated. The statistical analysis was done using ANOVA test.

Results: The debris extrusion was recorded in all groups. No significant difference was observed between NiTi files in curved and straight root canals ($p>0.05$). PTG caused significantly higher apical debris extrusion compared to WOG in severely curved canals ($p<0.05$). The extruded debris in severely curved root canals was significantly higher than straight and curved root canals in PTG and OC groups ($p<0.05$).

Conclusion: Degree of root canal curvature affects the amount of apically extruded debris.

Key Words: Root Canal Therapy, Endodontics, Nitinol, Root Canal Preparation.

ÖZ

Amaç: Çeşitli şekillendirme tekniklerinin ve kök kanal eğiminin apikal debris taşkınlığına etkisinin karşılaştırılmasıdır.

Gereç ve Yöntemler: Yüz sekiz adet alt çene büyük azı dişinin meziobukkal kök kanalları 0º-10º, 11º-25º ve 26º-35º kurvatür açılarına göre üç gruba ayrıldı (n=36). Kökler daha önceden ağırlığı ölçülmüş olan eppendorf tüplerine yapıştırıldı. Kanallar ProTaper Gold (PTG), OneCurve (OC) ve WaveOne Gold (WOG) nikel titanyum (NiTi) eğeleri ile her bir kurvatür grubunda şekillendirildi (n=12). Eppendorf tüplerine taşan miktarı hesaplandı. İstatistiksel analiz ANOVA testi ile yapıldı.

Bulgular: Debris taşması tüm gruplarda görüldü. Düz ve eğimli kök kanallarında NiTi grupları arasında olarak anlamlı bir fark görülmedi ($p>0.05$). Aşırı eğimli kanal gruplarında PTG, WOG'a göre anlamlı derecede daha fazla debris taşkınlığına neden oldu ($p<0.05$). Şiddetli eğime sahip kök kanallarındaki apikalden taşan debris miktarı PTG ve OC gruplarında düz ve eğimli kök kanallarında anlamlı derecede daha yüksektir.

Sonuç: Kök kanal eğiminin derecesi taşan debris miktarını etkilemektedir.

Anahtar Kelimeler: Kök Kanal Tedavisi, Endodonti, Nitinol, Kök Kanal Şekillendirme.

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INTRODUCTION

The root canal should be mechanically instrumented and irrigated with chemical solutions to remove infected residues (1). In chemomechanical instrumentation processes; infected tissues, debris, bacteria, residual pulp tissues and irrigants could be extruded from the apex and some adverse conditions (pain, inflammation) may occur after the procedure (2). Although both instrumentation techniques and root canal instruments caused debris extrusion from the apex, the amount of extruded debris may be related to the instrument kinematic and design of file systems (3,4).

With various developments in heat treatment technologies of alloys, several new root canal instrumentation systems have been produced in recent years. ProTaper Gold (Dentsply, USA) has the same geometric features as the ProTaper Universal system with its precursor. However, PTG system is more flexible and presents higher cyclic fatigue resistance than PTU system as a result of the production procedure with gold alloy technology (5). WaveOne Gold is a novel NiTi instrument which works with reciprocal motion and is manufactured from Gold alloy technology like ProTaper Gold. WaveOne Gold works with reciprocal movement and has parellogram cross section geometry with two cutting edges (6). One Curve (MicroMega, Besancon, France) is a single rotary file system and it is manufactured by heat treatment technique called "C-wire". This proprietary alloy provides shape memory and pre-bending feature to the instrument.The One Curve system has triangular-shaped geometry in the tip and S-shaped cross section design close to the shaft with electropolished surface (7).

Root canal curvature is an anatomical challenge in root canal treatment (8). Severe curvature may cause apical transportation, zip, step formation, perforation, destruction of the apical foramen, change in root canal length or canal curvature straightening (9,10). The purpose of this study was to examine the effect of different preparation techniques and degree of root canal curvature on the amount of apically extruded debris. The present study has two null hypotheses; first, the root canal curvature does not affect the amount of apically debris extrusion and second, instrument type is not associated with the extrusion of debris.

MATERIAL AND METHODS

The study was performed in accordance with the Helsinki Declaration principles and was approved by the non-interventional ethic committee of the university.(Protocol number: 2020-17-22/01). Mesiobuccal root canals of 108 extracted human mandibular molars were used in this study. Teeth with complicated canal anatomy, immature root formation, internal or external resorption and endodontically treated teeth were discarded.

The crown and distal roots were cut and access cavity was prepared by using rond burs under air/water sprey cooling. Then, the patency was checked with a 10 K-file and the root canal working length was set 13 mm in length.

The periapical radiographs of all teeth were obtained with digital sensor (MyRay, Imola, Italy) and X-ray device (MyRay) with 0.4 s exposure time. The degree of mesiobuccal root canal curvature was calculated by using an image program (ImageJ 1.48v; National Institutes of Health, Bethesda, MD, USA) and evaluated according to Schneider's method(referans). Three equal groups were prepared according to the angle of curvature 0º-10º, 11º-25º and 26º-35º and classified as straight, curved and severely curved, respectively (n=36).

Myers & Montgomery's setup was used to collect extruded debris.[11] The eppendorf tube cover was removed, and the weight of the tube was measured with 10^{-4} g accuracy balance (Radwag, Radom, Poland). Measurements were performed three times, and the mean value was calculated.

The root was inserted to the prepared hole on the cover and a 27-gauge needle was placed to the cover to balance the air pressure. The root and needle was attached to the cover with cyanoacrylate. This setup was placed to their respective Eppendorf tubes, and each tube was put into a glass bootle which was covered with aluminum foil. All root canals were instrumented by the same researcher.

Irrigation was performed with 4 ml of distilled water for each root canal. Afterwards, 1 ml of distilled water was used to wash the root tip after shaping.. Each curvature group was divided into three subgroups according to different preparation techniques ,as follows; ProTaper Gold, OneCurve and WaveOne (n=12).

In PTG groups; root canal preparations were performed with PTG instruments (SX, S1, S2, F1 and F2) by using an endodontic motor (X-Smart Plus, Dentsply Maillefer). The endodontic motor was set at 300 rpm and 5.1 Ncm torque settings for SX and S1; 1.5 Ncm for F1 and 3.1 Ncm for F2 files according to the manufacturer recommendation..

The One Curve file (size 25/0.06) was used with same endodontic motor at 300 rpm and 2.5 N·cm torque in continuous rotation motion at the WL according to the manufacturer recommendation.

The WOG Primary file (#25.07) was used with same endodontic motor and "WaveOne GOLD" mode was selected. After three pecking motion, each One Curve file and WOG Primary file were cleaned.
Statistical analyses were done with the SPSS software (ver. 19.0; SPSS Inc., Chicago, IL, USA). The data distribution was examined using the Shapiro– Wilks test. Comparisonof the continuous variables were analyzed with one way ANOVA test and Tukey's post hoc test ($p<0,05$).

RESULTS

The debris extrusion was recorded in all groups (Table 1). No significant difference was seen between NiTi files in straight and curved root canal gorups ($p> 0,05$). In severely curved root canal groups, debris extrusion of PTG group was statistically higher than that of WOG group ($p <0,05$). In compasion of straight and curved root canals similar debris extrusion values were obtained in all NiTi file systems ($p> 0,05$). However, significantly higher debris extrusion was obtained in the severely curved groups compared to the curved and straight canals in both PTG and OC instruments ($p <0,05$). No significant difference was recorded between the straight and severely curved root canal group in WOG groups ($p> 0,05$).

file systems including heat treated reciprocating and rotary single systems and heat-treated multi instrument rotary systems were investigated in different degree of root canal curvatures. The effect of canal curvature on instrument fractrue, apical transportation, and debris extrusion have been studied in previous studies (13,15). Recently, no study is available examining and comparing the selected file types in root canals with different curvature degrees, in terms of apically extruded debris.
The experimental setup described by Myers & Montgomery was selected as the test method as it was most frequently used in similar studies. NaOCl was selected as irrigation solution in some of the past studies examining apical debris extrusion (16-18). However, many researchers have preferred to use distilled water, arguing that NaOCl may affect the results due to the formation of NaOCl crystals in the tube with debris accumulation (19,20). In the present study, distilled water used to eliminate the formation of NaOCl crystals.
In PTG and OC file systems,significantly higher amount of debris extrusion was observed in severely curved canals compared to straight and curved canals. Similarly, severely curved canals prepared with WOG files demonstrated higher debris extursion compared to curved root canals. According to these results, the first hypothesis of the study was rejected.

	Straight Root Canal (Mean±std. dev.)	Curved Root Canal (mean±std. dev.)	Severely Curved Root Canal (mean±std. dev.)
ProTaper Gold	,00057311 ± , 000233226^{Aa}	,00059444 ± , 000238189^{Aa}	,00095269 ± , 000420405^{Ab}
WaveOne Gold	,00051294 ± , 000143783^{Aa}	,00045642 ± , 000178405^{Aa}	,00064344 ± , 000162122^{Ba}
One Curve	,00044722 ± , 000118457^{Aa}	,00044167 ± , 000174150^{Aa}	,00074011 ± , 000204420^{Bb}

***std. dvd.:** Standard Deviation
Table 1. Mean and standard deviation values for the amount of debris extrusion from the apical.(Upper case superscript letters in the same column indicate statistical differences. Lower case superscript letters in the same row indicate statistical differences).

DISCUSSION

Various factors including canal anatomy, file diameter, shaping technique, apical diameter, irrigation solution and irrigation techniques may affect the extrusion of debris and irrigation solution through the apex (12). In the present study, debris extrusion from the apex after instrumentation with different NiTi

Our finding may have related to the easier transport of debris towards the coronal in straight or slightly curved canals. Additionally, severely curved root canals require more pecking motion,back and forth movement during preparation. This situation may have result in more debris extrusion in the severely curved canals.
Borges et al., demonstrated no significant differences between slight (<10°) and modarate curved (11°-25°)

canals (21). This study supports the present results, because no significant differences were found between straight and curved root canals. In accordance with our results, Karaşlıoğlu et al., showed that no significant differences were seen between slight and modarate curved root canals and highest extrusion values were obtained in severely curved canals (22). In all instrumentation techniques, severely curved groups presented highest debris extrusion values in the present study. Karataşlıoğlu et al. used the Reciproc file working with reciprocal motion. In our study, the WOG file, which works with reciprocal movement was used. In the WOG groups, unlike the previous study, significantly higher apical debris extrusion values were obtained in the severely curved group compared to the medium curve, while any significant difference was found compared to the straight root canal group. This result may have arisen due to the fact that the WOG file has a parallelogram cross-section and provides preparation with a single contact point and manufactured with different alloy.

Studies showed that ProTaper Universal (PTU) nickel titanium files caused more apical debris extrusion compared to reciprocal files (23,24). De-Deus et al., stated that PTU instruments caused more extrusion than Reciproc and WaveOne instruments in curved canals (25). The PTG system, a new generation NiTi file system with a similar design to PTU, was used. Consistent with previous studies, the WOG file working with reciprocating motion caused less debris extrusion than PTG in all curvature groups, while significantly less apical extrusion of debris was observed in severely curved canals. Since, no difference was recorded between straight and curved canals, the second hypothesis was rejected because the results between WOG and PTG in severely curved canals were not significantly different.

With the gold technology, the alloy's unique gold-colored files were obtained as a result of repetitive heat treatment and cooling. PTG and WOG files produced with this current alloy show superior cyclic fatigue resistance and flexibility. Karataş et al., compared PTG, WOG, PTU and WaveOne file systems and showed that gold technology instruments presented less debris extrusion compared to previous generations (26). Moreover, in accordance with the results of our study, insignificant difference was found between WOG and PTG file systems.

Limited studies examined the debris extrusion of the OC file system (27,28). Sarıçam and Kayaoğlu reported that the OC file was similar to the other single file system, One Shape, and was better than the multiple file system 2Shape in terms of debris extrusion (27). In another study, Tüfenkçi et al., stated that OC and Reciproc files showed similar apical debris extrusion in the presence of conventional access cavities (28). Similarly, no difference was reported between the OC file and the WOG file working with reciprocal motion in all curvature groups in the present study.

CONCLUSION

1. All file systems caused apical debris extrusion.

2. Rotational motion instruments caused more apical debrisextrusion during preparation in severely curved canals.

3. Similar amount of debris extrusion occurred during instremantation with PTG and OC systems in all curvature groups.

4. While similar debris extrusion was observed in severely curved canals in single file systems, WaveOne Gold file system extruded significantly less debris compared ProTaper Gold file system.

5. Clinical studies comparing these file systems in different root canal curvatures are needed in order to see the results in endodontic practice.

DECLARATION OF CONFLICTING INTERESTS

The Authors declare that there is no conflict of interest.

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