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Research Araştırma

Effect Of Different Single File Systems On The Dentin Thickness In The Danger Zone Of Mandibular First Molars

Farklı Tek Eğe Sistemlerinin Alt Çene Birinci Büyük Azı Dişlerinin Tehlike Alanındaki Dentin Kalınlığına Etkisi

ABSTRACT

Objective: To compare the dentin thickness in the danger zone of mandibular molars after preparation with one rotating (XP-endo Shaper) and two reciprocating (One Reci and Reciproc Blue) single file systems using a cone beam computed tomography (CBCT).

Materials and Method: Thirty-six mesial roots of mandibular first molars having two independent canals were selected. After initial CBCT scans were provided, teeth were assigned into 3 groups related to the single file used: XP-Endo Shaper (XPS), One Reci (OR) and Reciproc Blue (RB). The roots were scanned again after preparation with respective single file systems. The minimum dentin thickness in the danger zone, at 4, 5, 6 and 7 mm below the furcation level, were measured in CBCT scans. Initial and final measurements were used to calculate the removed dentin thickness in the danger zone. Data was analyzed using one-way ANOVA ($p<0.05$).

Results: No significant differences were found related with remaining and removed dentin thickness among single file systems at any level from the furcation ($p>0.05$).

Conclusion: The evaluated single file systems showed similar cutting efficiency in the danger zone of mandibular molars.

Key Words: CBCT, Danger Zone, Dentin Thickness, Single File Systems.

ÖZ

Amaç: Alt çene büyük azı dişlerin tehlike alanındaki dentin kalınlığını, bir rotasyonel (XP-Endo Shaper)ve iki resiprokal (One Reci ve Reciproc Blue) hareketle çalışan tek eğe sistemi ile şekillendirme sonrası konik ışınlı bilgisayarlı tomografi (KIBT) kullanarak karşılaştırmaktır.

Gereç ve Yöntemler: Otuz altı adet alt çene birinci büyük azının iki ayrı kök kanalına sahip mezial kökleri seçildi. Başlangıç KIBT taramaları yapıldıktan sonra, dişler kullanılacak tek eğe sistemine göre 3 gruba ayrıldı: XP-Endo Shaper (XPS), One Reci (OR) ve Reciproc Blue (RB). Kökler ilgili tek eğe sistemi ile şekillendirildikten sonra tekrar KIBT ile tarandı. Furkasyon seviyesinin 4,5,6 ve 7 mm altından tehlike alanındaki en az dentin kalınlığı KIBT taramalarında ölçüldü. Başlangıç ve final ölçümler tehlike alanındaki uzaklaştırılan dentin kalınlığını hesaplamak için kullanıldı. Veriler tekrarlayan ölçümlerde ANOVA kullanılarak analiz edildi ($p<0,05$).

Bulgular: Povidon iyotta bekletilen örneklerin kullanılan materyallere göre ΔE ölçüm ortalamaların arasında istatistiksel olarak anlamlı bir fark bulundu ($p<0,05$). Cam iyonomer numunelerinin ΔE ortalaması, kompomer ve kompozit numunelerin ΔE ortalamasından, kompomer numunelerinin ΔE ortalaması, kompozit numunelerin ΔE ortalamasından istatistiksel olarak anlamlı derecede yüksek bulundu.

Sonuç: Tek eğe sistemleri arasında furkasyondan itibaren hiçbir seviyede kalan ve uzaklaştırılan dentin miktarı açısından fark bulunmadı ($p>0,05$).

Anahtar Kelimeler: CBCT, Tehlike Alanı, Dentin Kalınlığı, Tek Eğe Sistemleri.

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INTRODUCTION

The distal region in the mesial root of mandibular molars is called danger zone (DZ) (1). Endodontic treatment can failure during shaping of root canal due to the excessive instrumentation in this region. Several novel Ni–Ti files have been brought to market for better canal preparation with respect to the root canal anatomy. One of these novel instruments is One Reci (MicroMega, Besançon, France) single file system. It is made of C wire which gives to the file flexibility and controlled memory features (2). It works in reciprocal motion. To date, no data on its shaping ability is available. The other novel instrument XP-Endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Switzerland) is fabricated with a MaxWire alloy. It has a rotating serpentine-shape. During root canal preparation its shape changes (expands or contracts) related to the shape of root canal. XP-endo Shaper has been reported to well adapt itself to the root canal system without unnecessary dentin removal (3, 4). Reciproc Blue (VDW, Munich, Germany) has a blue color which is produced as a result of some thermomechanical treatment of the alloy. According to the manufacturer this heat-treated alloy gives to the file a higher fracture resistance and makes it more flexible (5).

Cone-beam computed tomography (CBCT) is used as a nondestructive technique for evaluation of the root canal system pre- and post-shaping procedures (6). The remaining dentin thickness in DZ have been assessed in several studies using CBCT (7-10). In a previous study, in which micro–computed tomographic (μCT) imaging was used as the reference standard, it was showed that dentin thickness can be accurately measured using CBCT imaging after simulated instrument removal (11).

be no difference between these single file systems.

MATERIAL AND METHODS

The present study protocol approved by the Ethic committee of the University (approval no:2022/04). The inclusion criteria for the mandibular molars were: mesial root with a degree of curvature moderate (10-20°, according to Schneider's method (12); 12 ± 1 mm in length and separate mesial root canals [mesiobuccal (MB)/ mesiolingual (ML)]; intact root structure, closed apex and no history of endodontic treatment. The exclusion criteria were: incomplete root formation; open apex; obliterated root canals; root resorptions; root fractures. The cusps were flattened to standardize the teeth to 16 mm in length. After access cavity preparation apical patency was checked with a size 10 K-file. The working length (WL) was determined by subtracting 1.0 mm from the measured length after the tip of the instrument was visible through the apical foramen.

Initial CBCT Analysis

Before shaping of root canals, teeth were embedded in custom-made silicone molds (Zetaplus; Labordental, São Paulo, Brazil) to scan the mesial roots in the same position. Initial CBCT images were obtained using a CBCT device (Veraviewapocs 3D R100; J. Morita Corp., Kyoto, Japan) with the following parameters: voxel size of 0.125 mm, FOV 81 mm high x 51 mm diameter, 9.3-s exposure, X-ray output of 90 kV and 5mA.

Preparation Procedures

36 mesial roots were assigned into 3 groups using a randomizer program (available at http: //www. randomizer.org) by one of the investigators (n = 12). The MB root canals were prepared with respective single file systems according to the advisable speed and torque according to the manufacturers' instruction.

- **One Reci (OR) Group:** One Reci (25.06) was used in a reciprocating motion at 400 rpm and 4 Ncm at the WL.
- **XP-Endo Shaper (XPS) Group:** XP-endo Shaper (30/.01) was used in-and-out motions with an amplitude of 3–4 mm up to the WL in a continuous rotation at 800 rpm and 1 Ncm.
- **Reciproc Blue (RB) Group:** Reciproc Blue R25 (25/.08) was used in a reciprocating motion in a slow in-and-out pecking motion and 3-mm amplitude limit combined with brushing motion.

A single operator was performed all the preparation procedures. 5 ml of 2.5% NaOCI was used during shaping. 5 ml 2.5% NaOCI, 5 ml 17% EDTA and 5 ml distilled were used for final irrigation.

Post-Instrumentation CBCT Analysis

Roots were scanned with the same exposure parameters as at the time of initial imaging. Axial sections were obtained with i-Dixel software (i-Dixel3DX, 3D, Version 1.691; J Morita Mfg Corp.)

from 4-7 mm below the furcal area. The minimum dentin thickness of the danger zone was calculated by measuring of the minimum distance from the edge of the root canal to the external surface of the distal root concavity (Figure 1). This measurement was repeated three times, and the mean thickness was recorded. The amount of removed dentin was measured by subtracting the post-instrumentation measurements from the initial measurements.

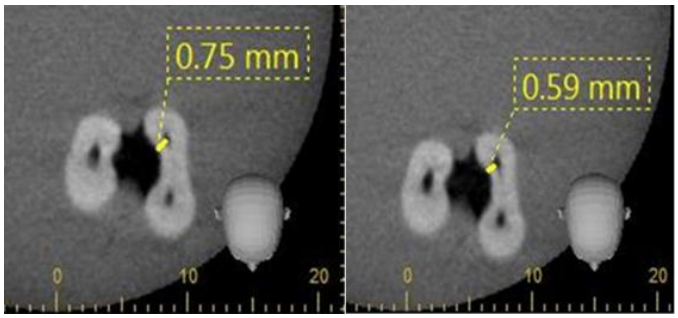

Figure 1. Measuring the minimum dentin thickness of the danger zone

Statistical Analysis

After analysis of normality with the Kolmogorov-Smirnov test. Data were analyzed using repeated measures ANOVA (IBM SPSS Statistics for Windows, p=0.05).

RESULTS

Table 1 and 2 show the descriptive values of the remaining and removed dentin thicknesses, respectively. Remaining dentin thicknesses were similar for all single file groups, at 4 mm (p=0.798), 5 mm (p=0.496), 6 mm (p=0.959) and 7 mm (p=0.523) from the furcation. There was no significant difference related to the removed dentin thickness at any level from the furcation (p>0.05).

	One Reci (Mean±SD)	Reciproc Blue (Mean±SD)	XP-EndoShaper (Mean±SD)
4mm	0.13 ± 0.13	0.15 ± 0.06	0.15 ± 0.06
5 mm	0.09 ± 0.09	0.13 ± 0.12	0.15 ± 0.09
6 mm	0.12 ± 0.11	0.13 ± 0.13	0.14 ± 0.14
7 mm	0.09 ± 0.09	0.13 ± 0.11	0.09 ± 0.07

*$p>0.05$ *mm: millimeter * SD: standard deviation

Table 2. The removed dentin thickness data in danger zone.

DISCUSSION

The thin dentin layer on the distal wall of mesial roots of mandibular molars, which is considered DZ, is more vulnerable to strip perforations. Therefore, the selection of an endodontic instrument may become very important to avoid excessive root canal preparation at this area. In recent years, several single-file systems made from novel alloys and powered with rotational or reciprocal motion have been introduced (3-5). In this study the effect of 3 different single file systems, two reciprocating (OR and RB) and one rotating (XPS), were compared on the remaining and removal dentin thickness in the DZ of MB root canals. In previous studies, researchers stated that root length affect the minimal dentin thickness of mesial roots of mandibular molars (13, 14). Therefore, in the present study the roots with 12 ± 1 mm in lengths were selected. The location of DZ of mandibular molar teeth is determined 4 -7 mm below the furcation area in previous research by De-Deus *et al*. (15). Therefore, the present study choses the levels of 4, 5, 6 and 7 mm from the furcation for analysis in MB root canals using CBCT. Although µCT is the most exact imaging technique to evaluate the root canal anatomy (16).

After Preparation Levels	One Reci (Mean±SD	Reciproc Blue (Mean±SD	XP-Endo Shaper (Mean±SD	*p value*
4 mm	0.67 ± 0.23	0.73 ± 0,25	0.82 ± 0,23	0.798
5 mm	0.68 ± 0.23	0.69 ± 0.27	0.76 ± 0.23	0.496
6 mm	0.64 ± 0.23	0.64 ± 0.28	0.69 ± 0.28	0.959
7 mm	0.63 ± 0.15	0.53 ± 0.27	0.71 ± 0.25	0.523

Table 1. Dentin thickness data in danger zone (mm: millimeter, * SD: standard deviation).

CBCT is currently the common imaging technique which has been applied to clinical practice (17). The advances in voxel size and field of view make the CBCT an admissible technique to assess the root canal anatomy (17, 18) and to compare the dentin thickness pre- and post- procedures (19).

Results revealed that the amount of removed dentin thickness for RB, OR and XPS were not significantly different. All the single file systems removed the dentin in similar amount, regardless of the instrument taper, and the movement kinematics. In the present study, the taper of tested instruments was 0.01 for XPS, 0.06 for ORand 0.08 for RB. Although the RB, which is used with reciprocal motion, has the largest taper among the tested files, showed similar results with OR (reciprocating) and XPS (rotating) files. Reciproc Blue is made of a thermal treatment alloy. By the manufacturer it was reported that heat treatment processing makes the file more flexible and ensures to follow the original canal anatomy (20). In a previous study, Reciproc Blue showed less resin removal than Reciproc while these two systems have same diameter, taper, and cross-section design (21). Based on that result, authors stated that the heat-treatment processing improved the flexibility and mechanical properties of Reciproc Blue and influenced the outcome (21). De-Deus *et al*. (22) stated that Blue thermal treatment of Reciproc files provides increasing the file flexibility and canal-centering capability.

The other tested novel instrument XPS, is made of MaxWire alloy. This alloy type gives to the file some features such as flexibility and resistance to cyclic fatigue. In a previous study XPS and RB files have similar shaping and cleaning capacity while they worked with different motion kinematics, having different cross sectional design and taper (23]) On the other hand, Pérez *et al*. [24] showed superior shaping ability for Reciproc Blue compared with XP-Endo Shaper. Kabil *et al*. (25) stated that Reciproc Blue produced more canal transportation and less centered preparations compared with XPS. However, due to the lack of standardization of the studies it is difficult to compare results directly.

OR file which is produced with C-wire and has variable off-centered cross section. C-Wire alloy gives to instrument a remarkable cutting efficiency and provides flexibility and centering ability. To date no data is available about its cutting efficiency. Therefore, it is not possible to compare with the results directly.

It was reported that the minimal dentin thickness in the danger zone should be no less than 0.3 mm after preparation to provide fractural strength to the forces during the filling process of the root canal [26].In the present study the remaining dentin thickness in the danger zone was greater than ≥0.53 mm and this can be considered a safe thickness as reported by Sausa *et al*. (27). According to the results of the present study, no significant difference was found among single file systems related with the amount of remaining dentin thickness.

CONCLUSION

The evaluated single file systems showed safety dentin preparation in the danger zone of mandibular first molar teeth regardless of the type of movement (rotary or reciprocating). It can be concluded that different heat treatment might have an important improvement in flexibility and mechanical properties of the instruments. However, further studies are necessary to clarify this topic.

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