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Research Article

COMPARATIVE ASSESSMENT OF DENTINAL MICROCRACK FORMATION IN ENDODONTICALLY RETREATED TEETH USING CONTINUOUS AND RECIPROCATING MOTION – AN IN VITROSTUDY

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A B S T R A C T

Aim; To Evaluate And Compare Dentinal Micro Crack Formation In Endodontically Retreated Tooth Using *Protaper Universal Retreatment System (Dentsply Maillefer, Ballaigues, Switzerland)&Reciproc File System (VDW, Munich, Germany).*

Materials and Methods: Freshly extracted 40 mandibular premolars with single straight canal were selected. Decoronation was done using diamond coated disc, leaving the tooth approximately 16mm length. A silicon impression material (Aquasil LV Dentsply caulk, U.S.A) was used for coating the cemental surface of roots to simulate periodontal ligament space. Then all roots were embedded in acrylic blocks made of self-cure acrylic resin.Working length determined and biomechanical preparation followed by obturation done using F3 GP cones.Teeth were randomly divided in to 2 experimental groups (n=20)Group A and Group B. All roots were sectioned perpendicular to the long axis at 3, 6, and 9mm from the apex using a diamond coated disc under water cooling and stereomicroscopic microscopic examination is doneand statistical analysis is done.

Results: The incidence of dentinal defects (microcracks) did not differ significantly between the ProTaper&Reciproc group. ($P > .05$).

Conclusion: They evaluated the incidence of dentinal defects after root canal preparation with reciprocating instruments (Reciproc and Wave-One) and rotary instruments (ProTaper and Mtwo) and determined that instrumentation with Reciproc files was associated with significantly more complete cracks compared to Mtwo and ProTaper.

INTRODUCTION

The aims of biomechanical preparation are enabling bacterial elimination, removing debris and creating a canal form that allows a proper seal. Perforations [1], canal transportation, ledge and zip formation [2] and separation of instrumentsare some of the complications encountered during root canal preparation and retreatment cases[3]. Additionally, preparation procedures could damage the root dentine resulting in fractures or craze lines. As a result of craze lines or microcracks, there might be occurrence of root fracture that propagates due to repeated application of stress by the occlusal forces. [4 5 6]

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Currently the popularity of NiTi rotary file systems has increased because of their superiority over stainless steel files. Thus, NiTi files are widely used in root canal preparation and retreatment procedures. Despite many advantages of NiTi rotary file systems, NiTi rotary files were reported to cause dentin defects such as cracks during root canal shaping and retreatment procedures. [7 8] Besides that, it is alleged that the dentine defects, by enlarging, might cause undesired consequences such as vertical root fractures. [9]

Bier *et al* reported that the rotary nickel-titanium files caused high ratio of dentinal damage (microcrack), whereas no microcrack was observed with hand files.

In the last decades, the emergence of NiTi rotary instrumentation has transfigured the root canal treatment by reducing the operator fatigue, time required to complete the preparation and minimised the procedural errors as compared

with hand instrumentation [10]. However, rotary files with large tapers may cause significantly more complete and incomplete dentinal cracks.[7]

Recently, single file nickel titanium (NiTi) reciprocating systems has been introduced.

The purpose of this invitro study was to evaluate and compare dentinal micro crack formation in endodontically retreated tooth using protaper *universal retreatment system (dentsplymaillefer, ballaigues, switzerland)&reciproc file system (vdw, munich, germany).*

METHODOLOGY

Specimen selection

A total of 40 freshly extracted mandibular premolars with similar root sizes were selected and stored in thymol throughout the experiment. Teeth with fracture lines, open apices, or anatomic irregularities were excluded.

All samples were sectioned at or below the cemento-enamel junction using a diamond coated disc under continuous water cooling to obtain root segments with standard root canal length of 15mm. A size 15 K-file (Dentsply Maillefer, Ballaigues, Switzerland) was placed in the canal until it was visible at the major apical foramen, and the working length (WL) was determined by subtracting 1 mm from this measurement. A silicon impression material was used to coat the cemental surface of the roots to simulate periodontal ligament space.

The canals were prepared to apical size 25 with K-files (Dentsply Maillefer). Further specimens were instrumented by ProTaper Universal files in sequence recommended by the manufacturer till full sequence F3. These files were used in outward brushing manner. Each canal was irrigated with 2 mL of 2.5% sodium hypochlorite (NaOCl) between each file using a syringe and a 27-gauge needle (NaviTip; Ultradent, South Jordan, UT, USA). After completion of the preparation, the canals were irrigated with 2 mL of 17% ethylenediaminetetraacetic acid (EDTA) for 1 minute and subsequently rinsed with 2 mL of distilled water. The root canals were then dried with paper points (Dentsply Maillefer). Master gutta-percha cone size F3 (Dentsply Maillefer) were coated with Zinc oxide eugenol as sealer (Dentsply Maillefer) and placed into the root canal to the WL. A heated plugger was used to remove excess gutta-percha coronally and the access cavities of all specimens were filled with temporary filling material (Cavit; 3M ESPE, Seefeld, Germany). The specimens were stored for 2 weeks at 37° C at 100% humidity to allow complete setting of the sealer. Root canal preparation, filling, and retreatment procedures were performed by a single operator to avoid variability.

Retreatment technique

Teeth were randomly divided in to two experimental groups (n=20).

Experimental groups

***Group 1: The removal of filling material with ProTaper retreatment instruments* (*n* = 20)**

In this group, ProTaper Universal retreatment (PTUR) instruments (Dentsply Maillefer) were used to remove the root filling material. The PTUR instruments were used with a motor (X-Smart; Dentsply Maillefer) at the torque and speed recommended by the manufacturer. The PTUR instruments were used at a constant speed of 500 rpm for D1 and 400 rpm for D2 and D3, with a torque of 3 Ncm. The D1 ProTaper instrument (size 30, .09 taper) was used for the removal of the coronal third of the root canal filling. The D2 ProTaper instrument (size 25, .08 taper) was used in the middle third of the root canal. Finally, the D3 ProTaper instrument (size 20, .07 taper) was used at the WL. The retreatment procedure was concluded with the use of ProTaper instrument F4 (size 40, .06 taper) at a speed of 300 rpm and a torque of 2 Ncm.

***Group 2: The removal of filling material with RECIPROC instruments* (*n* = 20)**

In this group, the canal filling material was removed using the Reciproc R25 instrument (size 25, .08 taper). The instrument was introduced into the canal, activated by a VDW Silver electric motor and applied in a reciprocating motion. It was then moved towards the apex using an in-and-out pecking motion with an amplitude of approximately 3 mm. Gentle apical pressure was combined witha brushing action against the lateral walls, according to the manufacturer's instructions. This procedure was repeated until the instrument reached WL. The retreatment procedure was concluded with the use of an R40 instrument (size 40, .06 taper).

SECTIONING AND MICROSCOPIC OBSERVATION

All roots were sectioned perpendicular to their long axis at 3, 6, and 9 mm from the apex with a diamond coated disc under water cooling. Each specimen was checked for the presence of dentinal defects (microcracks).

Slices were then viewed through a stereomicroscope (BX60; Olympus) at a magnification of 25x. Pictures were taken with a digital camera (DP-70; Olympus, Tokyo, Japan). The images were then inspected for defects by two operators who were blinded to the technique used to retreat the canal.

Fig 1 Decornated samples

Fig 2 Materials

Fig 3 Stereomicroscope

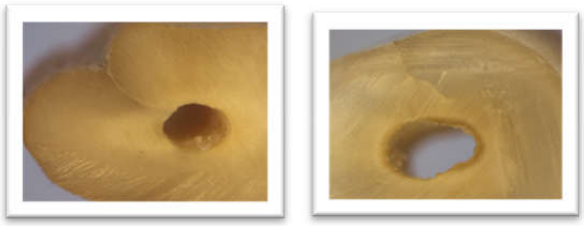


Fig 4 Group 1(Protaper)

Fig 5 Group 2 (Receproc)

Statistical Analysis

After investigator reached complete consensus on the evaluation of the specimens, the data were subjected to statistical interpretation using the Chi-square test for analysis of differences between the groups at a 95% confidence level ($P < 0.05$).

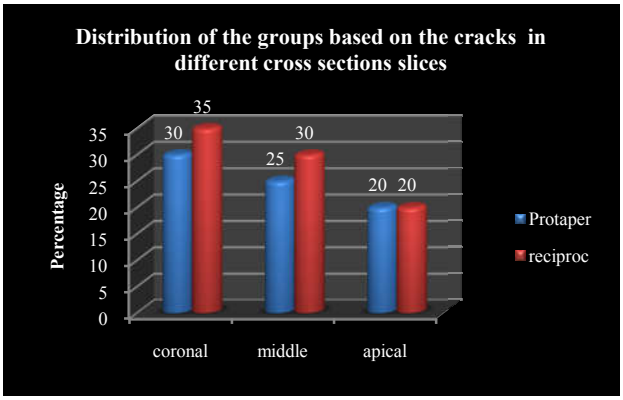
Yates correction is used because the expected cell frequency is below 10 or even 5. The level of significance set at '**P**' value ≤ 0.05.

RESULTS

The incidence of dentinal defects (microcracks) did not differ significantly between the ProTaper&Reciproc group. (P > .05).

Table 1 Compare the percentage of dentin defects found in 2 groups taken in the study

	Coronal n(%)	Middle n(%)	Apical n(%)
Group 1 (protaper)	6 (30%)	5 (25%)	4 (20%)
Group 2 (reciproc)	7 (35%)	6 (30%)	4 (20%)
Chi-square with Yates correction- 0.125 p-value- 0.93			



Graph 1 Distribution of the groups based on the cracks in different cross sections slices

DISCUSSION

There are a number of limitations present in previous studies evaluating dentinal defect formation: 1) it is possible that the defects occurred during the extraction of the teeth (Shemesh*et al.* 2009), 2) it is possible that the defects occurred during the sectioning procedure (Bier *et al*. 2009), 3) it was not possible to evaluate at which point during the instrumentation procedures the cracks were produced, and 4) it is possible that the same defects extended to different levels of the root and were counted as separate defects (Onnink*et al*. 1994), 5) it is not possible with the current methodology (root sectioning and direct observation by optical microscopy) to detect pre-existing defects. Micro- CT imaging has a much higher definition than stereomicroscopy and a large number of sections can be analyzed per tooth without creating defects.

It has been proposed that the remaining filling material could be minimised by means of further canal enlargement beyond the initial root canal size (Friedman *et al.* 1992, Marques da Silva *etal.* 2012). In the present study, this additional instrumentation was performed with ProTaper F4 and Reciproc R40 files to minimise the amount of residual filling material on the root canal walls.

In the present study, the effect of two different NiTi systems, working with different motions, on the incidence of dentinal defects during the retreatment procedure was evaluated. According to the results, the Reciproc system created more dentinal defects than did the ProTaper Retreatment system in the coronal and middle thirds. However, there was no statistically significant difference among the groups.

The ProTaper retreatment system works in a continuous rotation motion and consists of 3 retreatment files: D1, D2 and D3. The D1 instrument is designed to remove the filling material from the coronal third and to facilitate the working of the next instrument (D2). The D2 instrument removes the gutta-percha from the middle-root third and creates a space for entry to the apical third by the D3 instrument. However, the Reciproc system is a single file system, working witha reciprocating movement. Specifically, the Reciproc system does not incorporate an instrument that shapes the coronal and middle thirds of the root canal system initially which will facilitate working in the apical third of the root canal system. This could mean that the instrument encounters more stress during the retreatment procedure in the coronal and middle thirds of the root canal system.

In the present study, the retreatment procedure was performed with the Reciproc R25 instrument at WL, followed by the R40 instrument. It has been stated that the reciprocal motion seems to enhance debris transportation toward the apex during root canal preparation (Bürklein& Schäfer 2012) and may increase torsional forces (Bürklein*et al.* 2013). However, in the present study, the effect of the Reciproc system on dentinal defect formation during the retreatment procedure was evaluated.

According to the results, a greater number of dentinal defect formations were observed in the Reciproc group in the coronal and middle root thirds than in the ProTaper retreatment group. The amount of debris formation that occurred during the retreatment procedure may be greater than the amount of debris accumulated during the initial root canal preparation. Hence, the additional torsional forces that occur with the instrument could be the reason for dentinal defect formations on the root canal walls. Shemesh*et al*. (2011) evaluated the effect of retreatment procedures on the appearance of defects on the root canal wall and found that both hand files and the

ProTaper retreatment system caused dentinal defects. Similar to this study, the ProTaper retreatment group was associated with more dentinal defects during the retreatment procedure.

Bürklein*et al*. (2013) stated that when using only one instrument to complete preparation, more stress is generated during mechanical instrumentation compared to canal instrumentation using full-sequence systems. They evaluated the incidence of dentinal defects after root canal preparation with reciprocating instruments (Reciproc and Wave-One) and rotary instruments (ProTaper andMtwo) and determined that instrumentation with Reciproc files was associated with significantly more complete cracks compared to Mtwo and ProTaper. Although the current study evaluated the effect of retreatment procedures on the incidence of dentinal defects, the findings were similar to those in the study by Bürklein*et al*. (2013). This may be due to increased stress on canal walls duringthe use of a single file for the retreatment procedure in the Reciproc group.

The current study evaluated the effect of NiTi systems (ProTaper retreatment and Reciproc files) on the incidence of dentinal defects. The findings showed that there was a difference between the retreatment groups in the coronal and middle thirds, but not in the apical third. Bürklein*et al.* (2013) stated that when using only 1 instrument for complete preparation, more stress will be generated during mechanical instrumentation compared with canal instrumentation using full-sequence systems. Therefore, it could be concluded that the incidence of dentinal defects might be increased compared with preparations using full-sequence rotary systems. The results indicate that there might be an association between the designs and motions of the NiTi systems used in the present study and the incidence of dentinal defects.

CONCLUSION

They evaluated the incidence of dentinal defects after root canal preparation with reciprocating instruments (Reciproc and Wave-One) and rotary instruments (ProTaper and Mtwo) and determined that instrumentation with Reciproc files was associated with significantly more complete cracks compared to Mtwo and ProTaper.

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