



STEREOMICROSCOPIC EVALUATION OF DENTINAL MICRO CRACKS CAUSED BY THREE DIFFERENT SINGLE FILE SYSTEMS

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ABSTRACT

Although Ni-Ti rotary instruments have many advantages over hand instruments, Ni-Ti rotary instruments can induce stresses on the canal wall and cause dentinal cracks in root dentin. Recently, a new generation of NiTi files has been introduced with a variable cross-sectional design and their kinematics of activation in rotary or reciprocating motion allowed the possibility to shape root canals with single-file systems. ProTaper Gold (Dentsply, Sirona), One Shape File and Reciproc files were introduced in the family of NiTi rotary instruments were introduced as single file systems. Each of these files was used to instrument 20 teeth and 10 teeth were left as control. After sectioning stereomicroscopic images were analysed at three different levels. Sections were classified as “no crack” or as “crack”. Results show that incidence of cracks is maximum in ProTaper Gold followed by Reciproc and least incidence of micro cracks has been found with One Shapefile. So the present study concludes all files cause dentinal cracks but among single files used One Shape causes less micro cracks in dentin.

Keywords: Dentsply, Sirona

Introduction:

Cleaning and shaping of root canals during endodontic treatment can induce dentinal micro cracks. Stresses are generated from inside of the root canal which is higher in the apical region and more along the walls so the distribution of stress in apical area leads to development of cracks and fracture. As a result of craze lines or micro cracks, there might be occurrence of root fracture that propagates due to repeated application of stress by the occlusal forces.^{1,2} Although crack propagation with contemporary new nickel-titanium instruments is less as compared to stainless steel rigid files.³ Multiple factors (e.g.,

flexibility) influence micro crack formation, especially in the apical third of roots. Rotary NiTi files with large tapers can produce increased friction and stresses on the canal wall and cause dentinal cracks in root dentin.⁴ Rotary instrument by its innate behaviour in the canal may result in more friction, which may increase dentinal defects and micro cracks formation in comparison to hand instruments.^{5,6} there is a definite relationship between the design of NiTi rotary instruments and the incidence of the dentinal cracks and it was suggested that the design of the file affects strain concentration and the apical stress during instrumentation of root canal.⁶ Recently, a new generation of NiTi files has

been introduced with a variable cross-sectional design and their kinematics of activation in rotary or reciprocating motion allowed the possibility to shape root canals with single-file systems.⁷ Recently, the ProTaper Gold (Dentsply, Sirona), One Shape File and Reciproc files were introduced in the family of NiTi rotary instruments with a completely new design comprising of unique designs, greater flexibility, the M-wire technology in the group of single file systems. ProTaper Gold rotary files feature the identical geometries as ProTaper Universal but offer an increase in flexibility. One Shape (MICRO-MEGA France) is a rotary NiTi single file system with variable cross-section along the entire length of instrument. Reciproc is produced with M-Wire nickel-titanium. Increased cyclic fatigue resistance is achieved through the use of this alloy produced in an innovative thermal-treatment process. Reciproc instruments have been specifically designed for use in reciprocation. Reciproc has a non-cutting tip. Review of literature reveals that there are no studies regarding the incidence of dentinal micro cracks resulting from the use of this newer file system. Thus, the purpose of the study was to compare the incidence of cracks in root dentin after root canal instrumentation with the ProTaper Gold (Dentsply, Sirona), One Shape File and Reciproc files studied under stereomicroscope.

Materials and methodology

Seventy extracted human mandibular premolars with mature apices and straight root

canals were selected and fixed in cold cure acrylic blocks. The teeth were decoronated 2mm above proximal cement-enamel junction with a slow speed diamond saw under water coolant to obtain a standardized root length of 16 mm. The teeth were divided into three groups of 20 each and ten samples were left as negative control. One operator performed all root canal instrumentation. Patency of the canal was established using #10 K-File (Mani, Japan) in the canal. Reciproc (#25/06), OneShape (#25/06), and ProTaper Gold (#25/VT) usually require a single file to finalize root canal shaping. Instrumentation of canal was done according to manufacturer recommendations by X mart Plus endomotor (Dentsply Malleifer,) under constant irrigation by 27 gauge needle and syringe (5 mL) and 2% sodium hypochlorite (Prevest Denpro Limited) and 1% methylene blue dye to facilitate the crack detection. The samples were randomly divided into three experimental groups of twenty teeth in each according to different Single file system used and ten teeth acted as a negative control group, which were left uninstrumented. After the canal preparation, horizontal sectioning of the roots was done at 3, 6 and 9mm sections from root apex. Digital images of each sectioned root were captured using a 20X stereomicroscope by using a digital camera (Olympus, Tokyo, Japan). Two operators checked each specimen for the presence of dentinal defects. Roots were classified as “no crack”, “crack”, as described in Table 1.

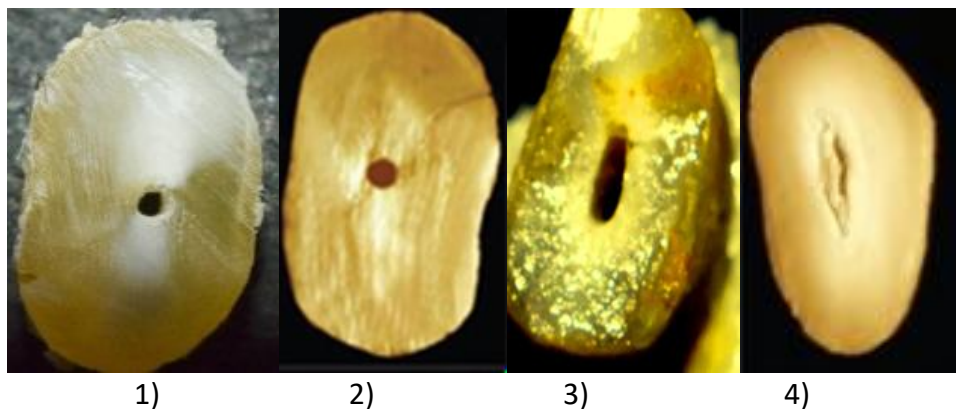


Figure 1: Representative stereomicroscopic images of different groups.

Statistical Analysis

A cracked root was determined when a crack was found at 1 or more levels. The results were expressed as the number and percentage of cracked roots in each group. Frequency of cracks among the groups was compared by chi-square (χ^2) test. A two-tailed p value less than 0.05 ($p < 0.05$) was considered statistically significant. Analyses were performed on SPSS software (20.0)

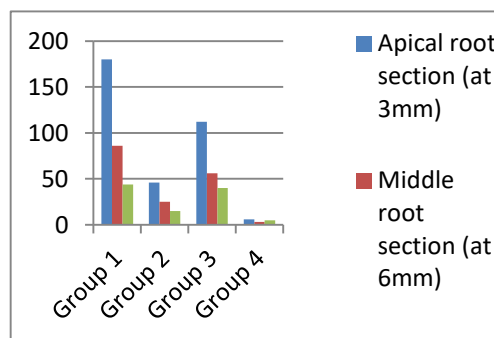
Results

The frequency distribution of micro cracks after canal preparation with three different NiTi single file systems at three different root levels is summarized in Table 1. After examining 60

experimental root section samples under stereomicroscope, total 604 cracks were found in all three groups. The maximum 310 cracks were found in Group 1 i.e, ProTaper Gold group followed by 208 in Group 3 i.e., Reciproc group and 86 in Group 2 i.e, One Shape group and thus the incidence of cracks is maximum in Group 1 i.e., ProTaper Gold group (%) followed by Group 3 i.e., Reciproc group and least incidence of microcracks have been found in Group 2 i.e, One Shape group (%). Group 4 i.e., Control group(n=10) shows 10 crack lines in all samples at all three levels. (%) (Table1 and Figure 2).

Table 1: Incidence of micro cracks after canal preparation with three NiTi single file rotary systems at three different root lengths.

Group	No of samples	Apical root section (at 3mm)	Middle root section (at 6mm)	Coronal root section (at 9mm)	Total micro cracks
Group 1	n=20	180	86	44	310
Group 2	n=20	46	25	15	86
Group 3	n=20	112	56	40	208
Group 4 (Control)	n=10	06	03	01	10



Graph 1: Incidence of micro cracks after canal preparation with three NiTi single file rotary systems at three different root lengths.

Discussion

Although Ni-Ti rotary instruments have many advantages over hand instruments, Ni-Ti rotary instruments can induce various degrees of dentinal damage during root canal preparation. Reasons may be the greater taper, more

rotations and aggressive cutting which can generate increased stresses on the dentin wall and subsequent formation of dentinal defects. Yoldas et al indicated that root canal preparation with NiTi rotary systems and all additional subsequent procedures in endodontics, such as obturation and

retreatment with rotary systems, can create fractures or craze lines.⁸ Onnink et al. were the first to report dentinal defects as a consequence of canal preparation but only found small defects entirely within dentin that did not communicate with the canal wall.⁹ A concern in some recent studies about rotary instrumentation is the formation of dentinal cracks and craze lines initially that may eventually develop into complete fractures or even vertical root fractures.^{10,11} In this study, freshly extracted mandibular premolars were used because these teeth are probably more prone to be influenced by forces during instrumentation as a result of their smaller dimensions and thin dentinal walls. A solvent was used to remove gutta percha as solvents aid in faster and easier filling removal.¹² In the present study, RC solve was selected as a solvent because it is known to be efficient for dissolving gutta-percha. Sectioning method using diamond disk used in the present study could also result in dentinal defects. However, because both the control and the hand file group did not show any defect, we may conclude that the defects seen were not due to sectioning procedure used. The incidence of cracks was found to be highest with ProTaper Gold file followed by Reciproc and least incidence of micro cracks has been found with One Shape file. Results of the current study showed that there is statistically insignificant difference in causing micro cracks by ProTaper Gold and Reciproc file. Microcracks caused by One Shape file are significantly less than both Protaper Gold and Reciproc files. Crack lines are found in all samples at all three levels in teeth without preparation i.e. control group but these are statistically insignificant. The reason for more cracks in ProTaper Gold file is the more amount of material in core design and more percentage of increasing and decreasing taper design on single file, strategically less flexible than One Shape. ProTaper Gold rotary files are with progressive taper design which increases stiffness and facilitates active cutting motion and removes relatively more dentin compared with other systems.¹³ File design, however, is also likely to

affect the shaping forces on the root dentin. These results are supported by study done by Capar et al.¹⁴ The extent of dentine damage may be influenced by the tip design, cross-section geometry, constant or progressive taper type, constant or variable pitch, and flute form.⁸ The results of our study are opposite to that of Garg S et al. This is may be due to lack of taking into consideration of the role of periodontal ligament as shock absorber, which may have exaggerated our results. Other factors are role of irrigant and force used during cleaning and shaping procedures.¹⁵ The major number of micro cracks was observed in the apical section (3mm) for all tested instruments, which is in agreement with previous studies.¹⁶ most of the defects noted were on the external surface of roots under microscope. These results are consistent with the results of a study by Shemesh et al.¹⁷ They demonstrated that many of the defects did not connect with canal space and were in places away from direct contact with instruments. One possible explanation is that the stress generated by instrumentation within the canal is transmitted to the outer surface of the tooth.

Conclusion

Within the confines of the present study, it can be concluded that all files cause dentinal cracks but among single files used One Shape causes less micro cracks in dentin.

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