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RESEARCH ARTICLE

TO COMPARE THE INCIDENCE OF DENTINAL DEFECTS AFTER CANAL PREPARATION WITH DIFFERENT NICKEL-TITANIUM ROTARY FILES- A SEM STUDY

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ABSTRACT

Background: Root canal preparations done using many rotary endodontic instruments results in formation of root dentin defects because of the stress induced by the instruments within the root canal during cleaning and shaping, thereby worsening the long term prognosis of the root canal treated teeth. Many rotary instruments are been globally studied for the purpose of generating a correct instrument for root canal preparation. **Objective:** To compare dentinal microcrack formation whilst using ProTaper Next file, HyFlex EDM file and Two Shape file system. **Materials and methods:** Thirty mandibular first molars were selected and were divided into three groups. ProTaper Next, HyFlex EDM and Two Shape files were used to prepare the mesial canals. Roots were then sectioned 3, 6 and 9 mm from the apex, and the cut surface was observed under scanning electron microscope (SEM) and checked for the presence of dentinal microcracks.

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INTRODUCTION

Adequate biomechanical preparation is one of the prime requisite of successful endodontic treatment (Shori, 2015) as it is one of the major steps in complete debridement of root canal space by removing microorganism, debris and tissues by enlarging the canal diameter and creates a canal form that allows a proper seal (Bier, 2009). During biomechanical preparation, a canal is shaped by the contact between instrument and dentinal walls. These contacts create many momentary stresses in dentin. These stress concentrations may induce dentinal defects and micro cracks or craze lines which may be associated with increased susceptibility to vertical root fracture (Kansal, 2014). Rotary instrument by its innate behavior in the canal may result in more friction, which may increase dentinal defects and micro cracks formation in comparison to hand instruments. Possible relationship between the design of NiTi rotary instruments and the incidence of the vertical root fractures was found by Kim *et al.* (2010) and it was concluded that the design of the file affects strain concentration and the apical stress during instrumentation of root canal.

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Recently, the ProTaperNext (Dentsply, Maillefer) files were introduced in the family of NiTi rotary instruments with a completely new design comprising of unique swaggering movement, greater flexibility, the M-wire technology, the5th generation of continuous improvement and its offset design. HyFlex rotary instruments (ColteneWhaledent, Switzerland) are another type of novel NiTi system. It is one file system that is produced using an innovative manufacturing process called Electrical Discharge Machining, resulting in a file that is extremely flexible, improved cutting efficiency and fracture resistance. Another newly introduced file system Two Shape (Micromega Besancon, Cedex, France) presents its new sequence of two instruments TS1 and TS2. This sequence includes the T-wire technology and triple helix cross-section resulting in improved cutting efficiency and removal of debris.

Aim: The purpose of this study was to compare the dentinal microcrack formation while using ProTaper Next files, HyFlex EDM and Two Shape files in canals.

List of Materials Used

- Extracted Teeth
- Radiovisiography (RVG)
- High Speed Alloy Grinder
- High Speed Airotor
- Endo Access Bur

- Stainless Steel No.#10, #15, #20 K-file
- Endo gauge
- 5% sodium hypochlorite
- Deionisized Distilled Water
- 0.9% w/v Normal saline (Aishwarya life Sciences, Solan, HP, India)
- Ethylene Diamine Tetra Acetic Acid (EDTA)
- Disposable Syringe 5 ml
- X- Smart^{TM} Endodontic Motor
- ProTaper Next (DentsplyMaillefer, Ballaigues, Switzerland)
- HyFlex EDM (Coltene, Whaledent AG, Altstatten, Switzerland)
- Two shape files (Micro-Mega, Besancon, Cedex, France)
- Temporary Filling Material Cavit G
- Scanning Electron Microcope (EDAX, AMETEK)

A total of thirty recently extracted intact and carious free human permanent mandibular first molars with mature apices were selected. Inclusion criteria stipulated were:

- Extracted teeth that were periodontally compromised.
- Teeth with intact and mature root apices.
- Tooth had a curved mesial root with two separate canal and apices, with curvature angles ranging within 20-40° (Schneider, 1971).

The coronal portions and distal roots of all teeth were removed using a diamond coated bur under water cooling and mesial roots were used for the study. The working length of teeth was determined by inserting size 10 K-type file (Mani, Japan) into root canal terminus and subtracting 1 mm from this measurement.

Figure 1. Materials used for endodontic treatment

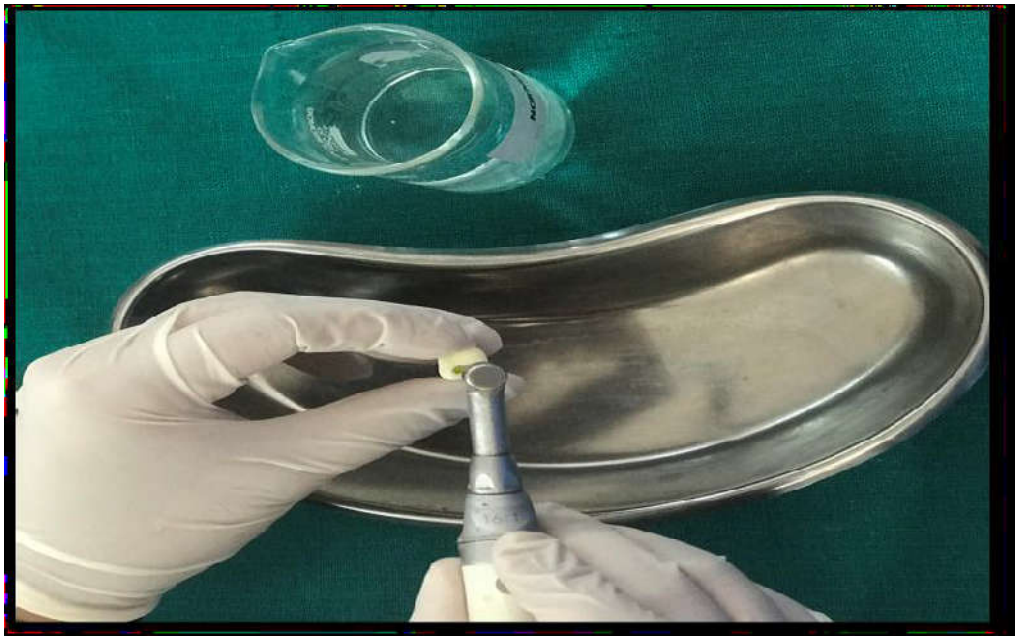


Figure 2. Biomechanical preparation of the samples using a- protaper nextb- hyflex edmc- two shape

Figure 3. Irrigants-a- edtab- sodium hypochloritec- sterile saline

Figure 4. Sectioning of the samples

FIGURE 5: SECTIONS AT 3, 6 AND 9 mm FROM THE APEX OF

A: Group i- protaper next file system

B: Group ii-hyflex edm file system

C: Group iii-two shape file system

Figure 6. Mounting of smaples in sem machine

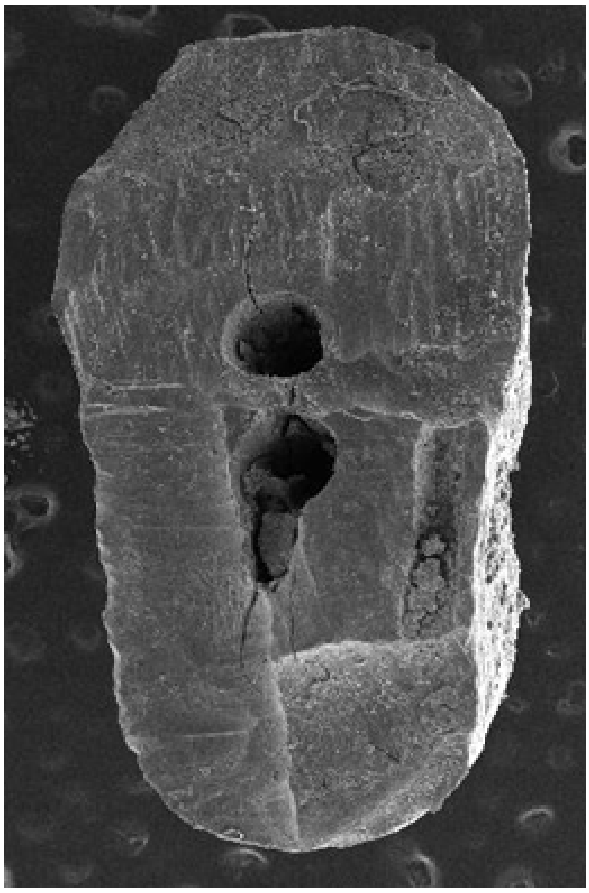


Figure 7. Scanning electron microscope images obtained for group i- protaper next at 3mm

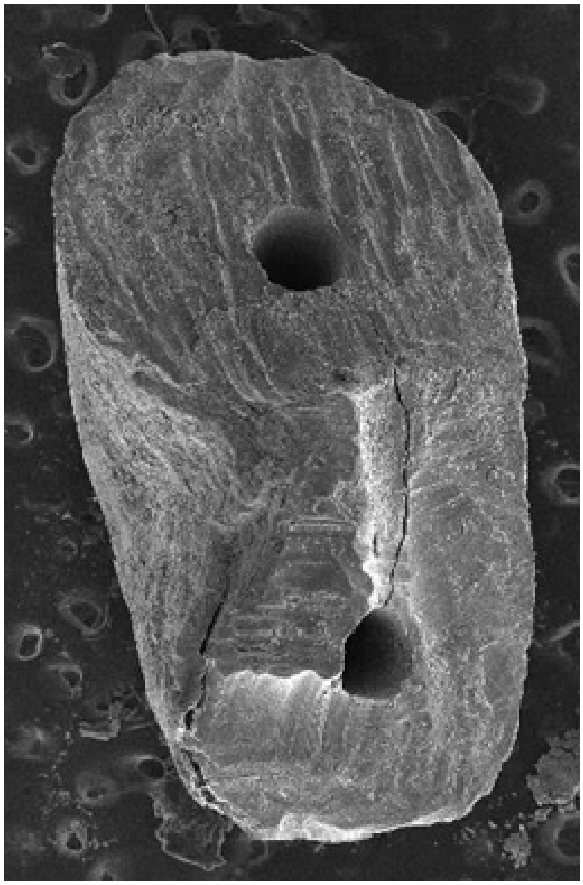


Figure 8. Scanning electron microscope images obtained for group ii- hyflex edm at 3mm

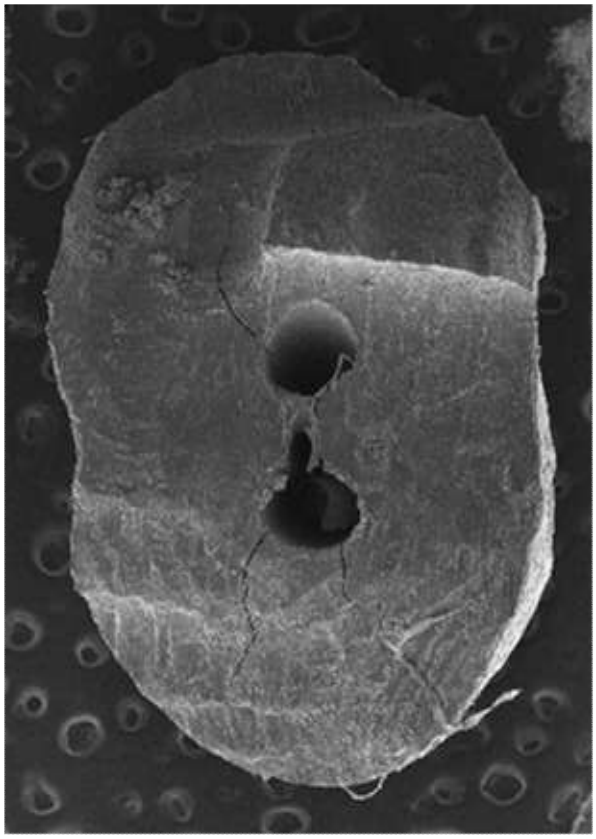
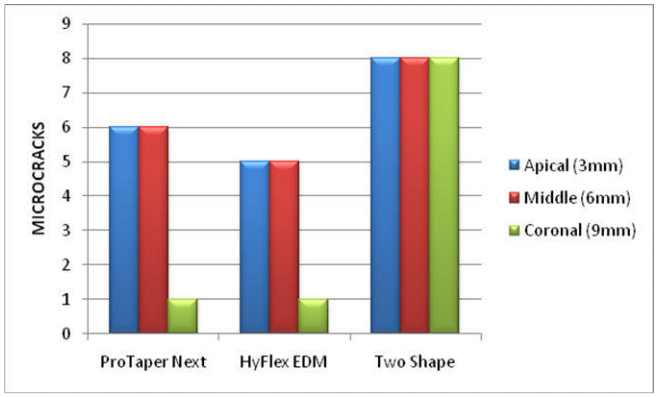


Figure 9. Scanning electron microscope images obtained for group iii- two shape at 3 mm



Graph 1. Mean Scores of Dentinal Defects of Different Groups in Different Sections of Teeth Shows that Group I and II Showed Minimum Defects and Group III Showing Maximum Defects in Coronal, Middle and Apical Sections of Teeth

A glide path was prepared with a size 15 K-type file. A number of 10 teeth each were placed in Group I- PTN, Group II- HyFlex EDM and Group III- Two Shape files Rotary System. In all the groups canal preparation was performed using a torque and speed-controlled motor (X-Smart; Dentsply Tulsa Dental, Tulsa, OK) at a torque and speed recommended by the manufacturer for each specific system used. In all groups irrigation was performed using 5% sodium hypochlorite between instrumentation during canal preparation. The prepared canals were then rinsed with 10 ml of 17% EDTA solution followed by a final flush with 10 ml of sterile saline. After irrigation root canal were dried by use of paper points. Samples were temporized with cotton followed by Cavitcoronally. Sectioning of all roots was done perpendicular to the long axis at 3, 6 and 9 mm using a low speed diamond disc under water cooling.

Each specimen was then analyzed by use of scanning electron microscope for dentinal defects at magnification 20x. To define crack formation two different categories of crack and no crack were made. No crack was defined as root dentin devoid of any craze lines or micro cracks originating from the canal lumen. Crack was defined if any craze lines, micro cracks or fractures were present originating from the root canal lumen.

Statistical analysis: The data thus obtained were entered on a Microsoft Excel spreadsheet and imported into Statistical Package for Social Sciences (SPSS) version 22 for statistical analysis. Chi-square test was performed to find significant relation in micro cracks in between the groups. A *P*-value less than 0.05 were considered statistically significant.

RESULTS

A total of 90 samples were examined. Defects were found in all NiTi rotary file systems. All the rotary files (ProTaper Next, HyFlex EDM and Two Shape) used in the study caused cracks in the root dentin. Not significant difference was observed between ProTaper Next and HyFlex EDM groups with Two Shape producing maximum number of micro cracks.

Table 1. Shows the Presence and Absence of Dentinal Defects in Different Groups at 3, 6 And 9mm from Apex

Table 1A. Protaper next file system

Sections	Microcrack present	Microcrack absent	Total
3mm	6(60%)	4(40%)	10(100%)
6mm	6(60%)	4(40%)	10(100%)
9mm	1(10%)	9(90%)	10(100%)

Table 1B. Hyflex edm file system

SECTIONS	MICROCRACK PRESENT	MICROCRACK ABSENT	TOTAL
3mm	5(50%)	5(50%)	10(100%)
6mm	5(50%)	5(50%)	10(100%)
9mm	1(10%)	9(90%)	10(100%)

Table 1c. Two Shape File System

SECTIONS	MICROCRACK PRESENT	MICROCRACK ABSENT	TOTAL
3mm	8(80%)	2(20%)	10(100%)
6mm	8(80%)	2(20%)	10(100%)
9mm	8(80%)	2(20%)	10(100%)

DISCUSSION

When NiTi rotary instruments are used, a rotational force is applied to root canal walls. Thus, they can create microcracks or craze lines in root dentin. The extent of such a defect formation may be related to the tip design, cross-section geometry, constant or progressive taper type, constant or variable pitch, and flute form (Yoldas et al., 2012). HyFlexEDM files are produced by control memory treatment just like Hyflex CM file. EDM process created a rough and hard surface that could improve cutting efficiency of these files. HyFlexEDM files have tip size of 25 (0.08) taper contrast to Two Shape and ProTaper Next 25 (0.06). The taper is constant in apical 4 mm of instrument but reduces progressively up to 0.04 in coronal portion. This new file has three different cross-sections over the entire length of working part (rectangular) in apical part, trapezoidal cross-section in middle part, triangular in coronal part to increase fracture resistance and cutting efficiency (Pedullà, 2016). ProTaper Next has a rectangular cross-section design, increased and decreased tapering over entire length. Off-centered rectangular design of ProTaper Next may have contributed to less number of cracks than Two Shape. This design generates a swaggering motion, which decreases screw effect, dangerous taper lock, and torque on the file.[4] Two Shape has asymmetrical cross-section over entire length and variable pitch, noncutting safety tip. Different speed and torque were used for the three-file system which may be a limitation of the study. According to Peter et al.,[7] increased rotational speed is associated with increased cutting efficiency. HyFlexEDM files are more resistant to cyclic fatigue, so recommended speed is 500 rpm which is higher than other two files tested in this study. Thus, HyFlexEDM file could result in fewer cracks than other two files. All the three tested instruments have variable pitch and noncutting tip. ProTaper Next and HyFlexEDM have rectangular cross-sectional design.TwoShape has almost triangular cross-sectional design. Thus, this difference in design could be attributed to more cracks in Two Shape. Previous studies suggested that instruments manufactured from M-wire alloy and controlled memory NiTi wire have more flexibility than conventional NiTi wire (Pereira, 2012; Shen, 2011). Hence, ProTaper Next and HyFlex EDM (manufactured with M-wire alloy and controlled memory NiTi wire)would have contributed to less number of cracks. However more ex vivo studies need to be conducted to correlate the results of this study.

Conclusion

Within the limitation of this ex vivo study, rotary endodontic preparation methods induce the dentinal defects. In conclusions all the experimental rotary systems created dentinal defects.HyFlex EDM (Group II) showed minimum defects among all the NiTi rotary instruments groups followed by ProTaper Next (Group I) and Two Shape (Group III). There was no significant difference between HyFlex EDM and ProTaper Next file groups.

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