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Original Research Article

Stereomicroscopic Evaluation of Radicular Dentinal Defects after Using EDTA Gel with Different Rotary Systems: An *In-Vitro* Study

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Abstract: The purpose of the present study was to study the occurrence of radicular dentinal defects after using EDTA gel during preparation of the root canal with ProTaper Universal (Dentsply Maillefer, Switzerland), HyFlex (Coltene-Whaledent, Allstetten, Switzerland), and ProTaper Next (Dentsply Maillefer) rotary instruments. Forty-eight single rooted premolars were selected. Twelve teeth were instrumented with hand files; another 12 teeth were instrumented with the ProTaper Universal system up to size F3 and the remaining 24 teeth were shaped with Hyflex CM 25/0.6 and ProTaper Next X3. EDTA gel was used during the root canal preparations of each tooth. After the completion of root canal instrumentation, the roots were sectioned at 3mm,6mm and 9mm followed by stereomicroscopic observation of the sections. The absence/presence of radicular dentinal defects was documented, and the data analysis was done with a chi-square test. The significance level was set at P = 0.05. The ProTaper Next and HyFlex CM instruments caused fewer cracks (33.33% and 50%) than the ProTaper Universal instrument (66.7%) (P < .05). However, there were no significant variances in radicular dentinal defects formation between the Hyflex CM and ProTaper Next groups (P > 0.05). Within the confines of this in vitro study, all of the instrumentation systems used induced radicular defects in the root dentin. The ProTaper Next and HyFlex instruments tended to cause fewer dentinal cracks compared with the ProTaper Universal instrument.

Keywords: Radicular dentinal defects, EDTA gel, Hand Files, Niti Rotary instruments

INTRODUCTION

Successful endodontic treatment depends upon the three-dimension seal of the root canal system. Perfect designing of the canal diameter and canal form that permits us to overcome this objective is of prime significance. At times, the biomechanical preparation of the canal causes damage to the root dentin, thus becoming a doorway to dentinal cracks and minute intricate fractures, thereby causing failure of treatment [1, 2].

Difficulties in canal preparation may be accredited to disparity in the design of the cutting instrument, taper and structure of the material from which it is made. Hand instrumentation which was the landmark of endodontic practice in the ancient, though has lost its popularity, still remains the essential part of canal preparation [2, 3].

Rotary instrument by its distinctive behaviour in the canal, may result in more chafing, leading to increase in dentinal defects and micro cracks in comparison to hand instruments. Kim et al (2010) stated that file design affects strain concentration and the apical stress during root canal instrumentation [4, 5].

Whether it is hand files or rotary instruments, they are anticipated to cause restricted frictional forces within the canal, thus generating radicular dentinal defects.

ProTaper Universal rotary files (Dentsply Maillefer, Ballaigues, Switzerland), have a convex triangular cross-sectional design and several percentage tapers, enabling a dynamic cutting motion and removal of comparatively more dentin coronally. ProTaper Universal rotary files are made from a traditional superelastic NiTi wire. In earlier studies and researches, the ProTaper Universal system was related with more cracks than the other rotary NiTi instruments [6, 7].

ProTaper Next (Dentsply Maillefer) instruments have been introduced recently, with an off-centered rectangular design and progressive and regressive percentage tapers on a single file, which is made from M-Wire technology. Such file design

decreases the screw effect, unsafe taper lock, and torque on any given file by lessening the contact between dentin and the file [7].

HyFlex rotary instruments (Coltene-Whaledent, Allstetten, Switzerland) are additional type of unique NiTi system. HyFlex instruments have a symmetrical cross-sectional design with 3 cutting edges [7].

A lubricant material such as Ethylenediaminetetraacetic acid (EDTA) gel can be used during the canal instrumentation to lessen the occurrence of file separation and thus facilitating the instrumentation techniques. In the interim, using EDTA gel reduces the microhardness of radicular dentin, contributing in the dentinal defect formation [8, 9].

To the best of our knowledge, there is no literature documentation about the effect of EDTA gel when used with these novel NiTi rotary files on the incidence of radicular dentinal defects. Thus, the aim of the present study was to evaluate the incidence of radicular dentinal defects in root dentin after using the EDTA gel during the root canal shaping procedures with the recently introduced ProTaper Next and HyFlex instruments.

MATERIALS AND METHODS

Forty-eight single-rooted premolars were selected and stored in the purified water. Teeth with curved roots, calcified canals, extra canals, and with any developmental anomaly or resorption were omitted from the study. By using a diamond disc, the teeth were decoronated at coronal portions, leaving roots approximately of 10mm in length. All the roots were examined with transmitted light for perceiving any pre-existing cracks or any craze-lines by using a stereomicroscope under ×12, for excluding teeth with such outcomes.

Canal patency was gained using a #10 K-type File (Mani, Japan). Determination of the working length of the canals was done by introducing a size 10 K-type file into the root canal terminus. A glide path was achieved with the help of a size 15 K-type file. Irrigation of the root canals was done with sodium hypochlorite solution after every instrument alteration. Shaping procedures of the root canal were completed according to the manufacturers' instructions for every instrument system.

The specimens were then distributed into four groups; each group containing 12 specimens each.
Group I: Hand Files.
Group II: Protaper Universal
Group III: Hyflex CM.
Group IV: Protaper Next

In the Hand File group, canal preparation was done file #40. In the Protaper Universal (Dentsply, Maillefer), Hyflex CM (Coltene Whaldent, Switzerland), and Protaper NEXT (Dentsply, Maillefer) groups; canal preparation was completed by means of speed and torque controlled motor (X-SMART; Dentsply, Maillefer).

EDTA gel (15% Endo-Prep Gel,Cerkamed) was used during the instrumentation of each canal.

In Hand Files group, step-back technique was used for root canal instrumentation upto file #40. In the Protaper group, the following order of the files was used for root canal preparation at 300 rpm: The shaping file X for enlarging the coronal portion, followed by S1, S2, F1, F2, and F3 files, equivalent to apical size 30, used at the working length. In the Hyflex CM group, the Hyflex NiTi files were used upto file #30 at 500 rpm and 250g/cm torque, in crown-down sequence. In Protaper NEXT group, the Protaper NEXT rotary system files were used in the following sequence at 300 rpm and 200g/cm torque: X1, X2 and X3, equivalent to apical size #30

Each instrument flutes were recurrently cleaned to check for any signs of distortion or wear. The Protaper NEXT files acclaimed to be mechanically utilized (manually in very ascetic curvatures) in a clockwise unceasing motion with a brushing motion, away from peripheral root concavities, for facilitating the unloading of flute and progression of the apical file.

Sectioning and Microscopic Evaluation of the Roots

All the roots were sectioned perpendicular to the long axis at 9, 6, and 3 mm using a diamond disc beneath water cooling. Digital images of every partitioned root was captured using a ×40 stereomicroscope by using a digital camera (Olympus, Tokyo, Japan). Two operatives evaluated each specimen for the presence/absence of radicular dentinal defects. Roots were categorized as "fracture", "no defect" and "other defects" [1, 6] as designated in Table 1.

Table 1: Classification for identification of defects

No defect	root dentin devoid of any lines or cracks where both the external surface of the root and the internal root canal wall will not present any evident defects.
Fracture	a line extending from the root canal space all the way to the outer surface of the root.
Other defects	all other lines observed that will not be seem to extend from the root canal to the outer root surface (e.g. - a craze line, a line extending from the outer surface into the dentin but will not reach the canal lumen, or a partial crack, a line extending from the canal walls into the dentin without reaching the outer surface).

Statistical Analysis

The results obtained were conveyed as the number and percentage of radicular dentinal defects in each group. The statistical analysis of the groups was done by using Chi-Square test. Level of significance was set at P = 0.05 by means of Statistical Package for Social Sciences (SPSS) version 20.0.

RESULTS

Figure 1 exhibits bar chart showing the number of root defects in each group. Hand files group showed lowest defect (1/12) followed by Protaper Universal (8/12), Hyflex CM (6/12), and Protaper NEXT (4/12). Statistical significant differences was seen between Hand files and Protaper NEXT group (P < 0 .05). There was no significant difference was seen amongst the Protaper NEXT and Hyflex CM (P > 0.05). Figure 2: shows the Stereomicroscopic pictures of Group I, II, III and IV.

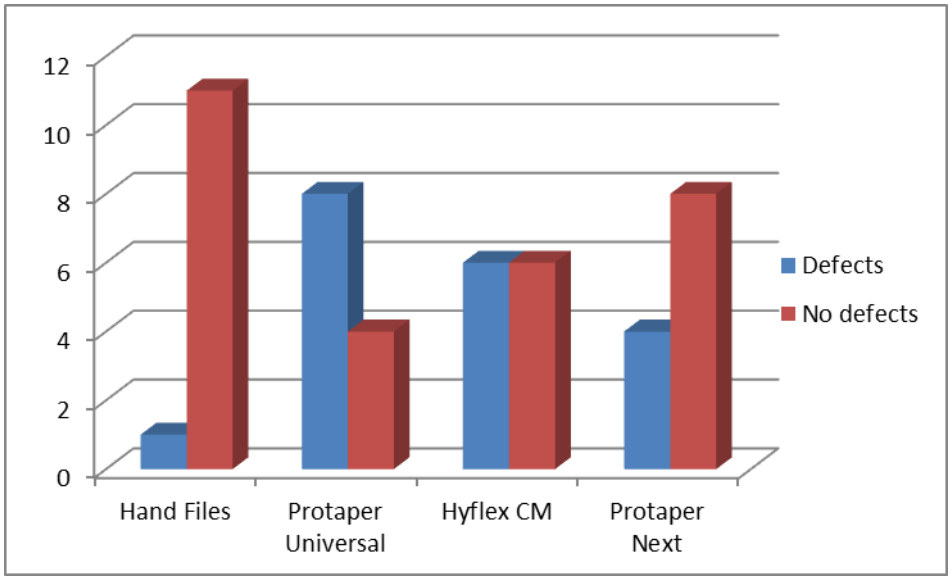

Fig-1: Bar chart showing the number of root defects in each group

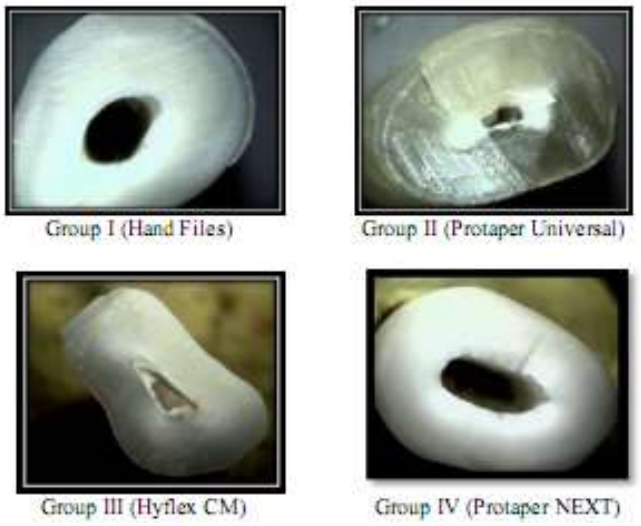

Fig-2: Stereomicroscopic Images of all groups

DISCUSSION

In the present study, the number and incidence of radicular dentinal defects observed in Hand Files (Group I) , Protaper Universal (Group II) , Hyflex CM (Group III), and Protaper NEXT (Group IV) was found to be, 1/12 (8.33%), 8/12 (66.7%), 6/12 (50.00%), and 4/12 (33.33%). The maximum radicular dentinal defects were shown by Protaper Universal (Group II) and least by Protaper NEXT (Group IV).

Till now, maximum of the researches concentrated on the effect of stress on the instrument, less effort has been put into the result of the same stress on the root dentine. Few authors have concluded that rotary files can produce several degrees of radicular dentinal defects. The degree and percentage of such defect development may be associated to the movement of file, design of the tip, cross-sectional geometry; constant or progressive taper type, constant or variable pitch, and form of the flute [1, 6, 10, 11].

Lubricating material such as EDTA gel when used during the instrumentation of the root canal is known to decrease the occurrence of file parting and facilitating the root canal instrumentation techniques. Furthermore, this lubricant material can lessen the rotational and frictional force on the radicular dentinal wall and may hypothetically decrease or minimize the frequency or prevalence of dentinal defects. However, the use of EDTA gel decreases the radicular dentin, which may be responsible for defect formation in dentin [8, 9].

Hence, the objective of the present study was to study and compare the effect of using EDTA gel during instrumentation of root canal using hand files, ProTaper Universal, Hyflex CM and Protaper NEXT rotary systems on the occurrence of radicular dentinal damage in the form of root dentin microcracks.

Sectioning technique utilized in the present study permitted assessment of the consequence of root canal instrumentation procedures on the root dentin by direct examination of three root sections and is in settlement with the procedure designated by Shemesh *et al* [11].

Results of the present study indicated that instrumentation techniques and rotary systems used for all the canals created dentinal defects without a significant difference between them. These results are in agreement with previous studies that validated augmented crack formation and due to instrumentation, fracture vulnerability of teeth. Though, this appears not in accordance with the study of Bier *et al* which exhibited no impact of hand file procedure on formation of crack [1, 10]. Balanced force technique was used in the study by Bier *et al* [10] whereas a step back technique was used in the present study.

Number of root sections exhibiting the connecting cracks (fracture lines) was few than the other defects (craze lines or partial cracks) nevertheless of the instrumentation method, which is in settlement with previous studies by Bier *et al* and Shemesh *et al* [11, 12]

In our study, rare internal craze lines were detected and maximum of the defects were external cracks. These results are accordance with the results by Shemesh *et al* and Milani *et al*. The reason may be the generation of stress because of the instrumentation inside the root canal, which is conveyed to the external surface of the tooth where it incapacitates the bonds holding the dentin organized [10-12].

Rotational forces accompanying with the ProTaper rotary files and the large apical tapers produced by this system may contribute in crack formation. The ProTaper and HyFlex rotary instruments have a triangular cross-sectional geometry. ProTaper

Universal rotary instruments have a variable taper design, however the taper design of HyFlex constant. Thus, in the present study, it is challenging to state that these design features added to the formation of radicular dentinal defects. Furthermore, the file design might affect the shaping forces on root dentin. During instrumentation, the forces created have been related to an augmented menace of root fracture. This may be the reason for formation of more percentage of dentinal defects by Protaper Universal group in the present study.

Protaper NEXT files having M-wire technology with off-centered rectangular cross-section, gives a snake-like swaggering movement to the file as it travels along the root canal, thus minimizing the screw effect, the unsolicited taper lock, and torque on any of the given file; thus declining the file interaction with the root dentin [6, 7].

M-wire alloy NiTi material with well-ordered memory NiTi wire are elastic than those prepared from conventional NiTi wire. Therefore, such elasticity of Protaper rotary files may have added in fewer number of radicular dentinal defects development as compared to Protaper Universal and Hyflex CM. It was concluded by Capar *et al* that the swaggering motion and minimal taper of the Protaper NEXT files might alter the volume of the root canal to a degree as that of the higher tapered instruments [6, 7].

Use of EDTA gel inconsequentially augmented the percentage of dentinal defects in all experimental groups of the present study. This may be elucidated by the gel form of EDTA, which may gather more debris in the cutting flutes of the files, thus lessening the cutting efficacy of the file and circuitously aggregating the stress on the dentinal wall and thus augmenting the dentinal crack formation [13, 14]. On the basis of the existing interpretations, it can be concluded that the use of hand files and rotary NiTi instruments could induce diverse types of dentinal defects. Suggestively, the use of EDTA gel did not affect the occurrence of radicular dentinal defects.

LIMITATIONS

i. For Each rotary system, use of different speed and torque settings might be the limitation of our study. Rise in the rotational speed is connected with augmented cutting efficiency.

ii. In the present study, the periodontal ligament simulation was not done. Capar ID *et al* specified that the periodontal ligament simulation is essential for studying the impact of forces on crack or fracture formation [15, 7].

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