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STEREOMICROSCOPIC EXAMINATION OF DENTINAL MICROCRACKS FORMATION WITH PROTAPER NEXT, PROTAPER GOLD AND E-FLEX GOLD FILE SYSTEMS

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ABSTRACT

Aim: The aim of this study was to assess the incidence of dentinal cracks following root canal instrumentation by means of ProTaper Next, ProTaper Gold and E-flex Gold rotary files.

Methodology: Samples were based on one hundred extracted lower first molars. They were allocated into a control group of ten teeth and three experimental groups of thirty specimens. Mesiobuccal canals were instrumented using ProTaper next, Protaper Gold and E-Flex Gold. Transverse sectioning was done at 3mm, 6mm, and 9mm from the apical end and stereomicroscopically viewed. Chi- Square test followed by Fischer exact tests were used for statistical analysis.

Results: The control group had no cracks. E flex Gold files yielded significantly less cracks than ProTaper Gold and ProTaper Next, (p<0.05). The middle and apical thirds showed more cracks than the coronal third.

Conclusion: Eflex Gold resulted in less dentinal crack formation than Protaper Gold and Protaper Next.

KEYWORDS: Dentinal Cracks, ProTaper Gold, E-flex Gold.

INTRODUCTION

Root canal instrumentation is a crucial phase in the endodontic therapy. Despite the improved instrumentation efficiency provided by the motorized motions and kinematics, stresses are generated in the canal walls , thereby predisposing to the generation of cracks, in horizontal or vertical directions at different root levels. A continuously evolving production of several new rotary systems provides the market with many new file designs, metallurgies and operational features. All of which are attempting to balance the flexibility and the

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cutting efficiency, while reducing the probability of crack generation whenever possible [1-3].

ProTaper Next is one of the files that showed an efficient cutting action and high flexibility. It is manufactured by the M-wire technology. The cross-sectional design is based on an off-centered rectangular geometry that provides it with a swaggering motion. This in turn reduces the friction between the file and the canal peripheries, minimizing the screwing effect and the associated stresses on canal walls [4]. Later, ProTaper Gold was introduced with the same geometry with Protaper Universal, having a convex triangular cross-section and a progressive taper, but provided with a high austenite finish temperature and a thermal treatment which imparts a more than double resistance to cyclic fatigue, besides a greater flexibility [5]. Different outcomes regarding the propensity for crack induction with these files were documented, in different testing contexts, with different assessment tools and in comparison to different file systems. Recently, E Flex Gold rotary files , new chinese files have been developed. Its design incorporates a variable pitch, a safe non-cutting tip and sharp cutting flutes. The file metallurgy is based on special NiTi heat treated CM wire besides its gold technology in order to increase flexibility. Whether this feature would reduce its propensity to develop dentinal microcracks or not has not been assessed. Therefore, the objective of this research was to compare the crack induction incidence following canal shaping by E Flex Gold, Protaper Gold and Protaper Next rotary files.

MATERIALS AND METHODS

Specimens selection and classification

One hundred extracted human lower first molars were allocated for this in vitro study from the Maxillofacial Surgery department at the faculty of dentistry , Ain Shams University. Extraction reasons included periodontal, or orthodontic problems then they were kept in purified distilled water. A random allocation into four groups was then attempted, one control group (10 canals) that were uninstrumented and three experimental groups (30 canals each) in which only the mesio-buccal canals were instrumented.

Preparation of canals

A new set of files was used every three canals as recommended by the manufacturers. For the three file systems, canals were first manually scouted using file sizes 15 and 20 (2% taper). Orifices were enlarged using the orifice openers in each kit. Protaper Next X1, X2, X3 and X4 files were operated at 300 rpm and 4-5.2 N/cm torque in a pecking motion until reaching the working length. Finishing files were operated at 300 rpm and 1.5 N/cm torque to the full canal extent. Protaper Gold S1 and S2 files were used for the cervical 2/3 at 300 rpm and 2 N/cm torque. For E Flex Gold, the electric motor was set at 500 rpm at 1.5 N/cm torque and the files were used sequentially with sizes 04/25, 06/25 , 04/35 file in a pecking motion to the full working length.

Dentinal cracks evaluation

Samples were first decoronated then were transversely sectioned at three, six and nine millimiters from the apical end with a carbide disc mounted on an electric motor and a low speed hand piece. Slices were viewed stereomicroscopically at 20X magnification by two evaluators examining the different patterns of microcracks (no fracture, partial or complete fractures). Images were then captured with a digital camera.

Statistical analysis

Data were analyzed using Chi-square test followed by Fisher's exact tests using SPSS software 15.0 with the level of significance set as $p < 0.05$.

RESULTS

All samples of the control group were devoid of cracks. Significantly lower proportion of specimens with detectable cracks was detected E-Flex Gold samples (19%), followed by ProTaper Gold (48%), while the highest percentage was found in ProTaper Next (72%), ($p < 0.05$) (figures 1 and 2).

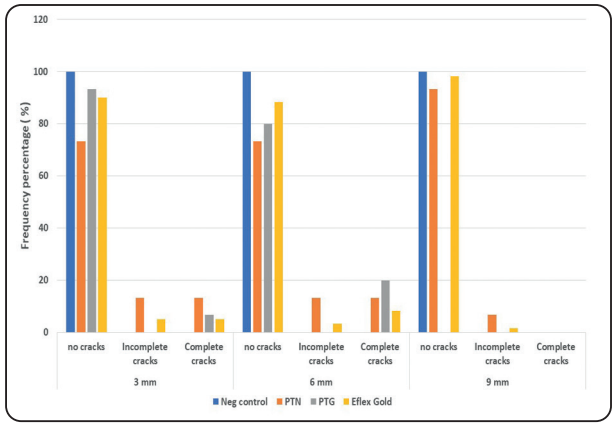

Fig. (1): Bar chart illustrating the frequency percentage of the different cracks among the three file types at the 3 indicated sectioning levels (3mm, 6mm and 9 mms) from the apical end.

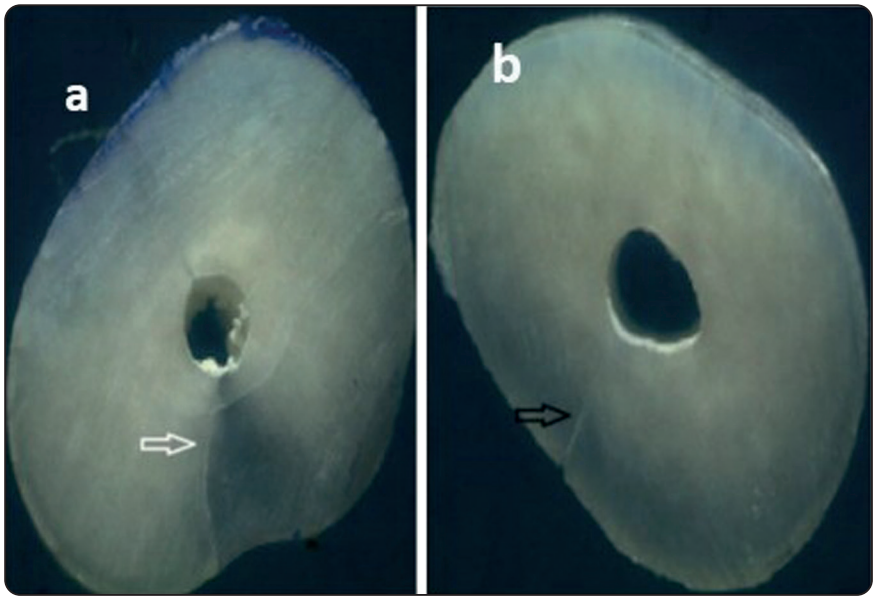

Fig. (2): Stereomicrograph showing (a) full crack in the mid-portion of the canal (pointed to by the arrow). (b) Partial crack on the outer edge of the root periphery.

DISCUSSION

Radicular instrumentation by NiTi rotary files was shown to create dentinal microcracks and defects. These cracks are potential stress concentration spots, which might predispose to canal splitting when subject to the occlusal stresses [5-7]. The instrumented canals were mandibular first molars mesiobuccals as they have a wider buccolingual diameter as compared to the mesiodistal counterpart, which besides their small measurements and thin walls increases their vulnerability to canal instrumentation stresses [8-10].

In order to preserve the mechanical properties of dentin and to reduce crack formation, molars were kept in purified filtered water[11]. This in turn would reduce the likelihood of artifacts associated with dehydration. Moreover, they were sectioned using a diamond disc under continuous cooling. Levels of sectioning were at three, six and nine millimeters from the apical end, to assess the files influence on the three regions, the constricted apical area, the beginning of the root curvature and the wide cervical area. Visualization was performed using the stereomicroscope for its simplicity and the wide

range of magnifications. The entire root slice was viewed under 20X, while whether the crack was complete or incomplete was viewed under 30X.

The control group didn't have any cracks, thereby excluding the possible contributions of the extraction method and the sectioning technique as a trigger for crack formation. This would limit any defect detected in the dentinal wall to the instrumentation itself (12-14). Conversely, cracks were found in the unprepared canals in other research studies [15,16]. These opposing findings could be attributed to variabilities in the sectioning technique, the storage conditions or the age ranges of the patients from whom the teeth were extracted. Moreover, micro CT-based studies allowed for better visualization of pre-instrumentation cracks in intact canal walls [17].

Results showed that E-Flex Gold showed the lowest incidence of crack formation, followed by Protaper Gold then Protaper Next. E Flex Gold metallurgy is based on a unique heat treated CM wire technology which enhances its flexibility and might have reduced the mechanical stresses on root dentin [18-21]. Likewise, the low incidence of cracking associated with ProTaper Gold would be attributed to their higher flexibility related to the 2-stage transformation behavior and the high Austenite finish temperatures [5,18,19]. Conversely, a higher incidence of cracks formation was observed with Protaper Next files, that could be attributed to its eccentric rotational motion, resembling an oscillatory motion. This in turn would remove a larger circumference of dentin when differentiated from other files having similar dimensions but operating with a concentric rotational axis [12]. Additionally, they operate at a greater torque of 4 - 5.2 Ncm compared to the other files assessed, which range from 1.5 to 2 Ncm, furthering the stress induction and crack formation [12,18,20]. This opinion was also asserted by Çirakoglu et al. who reported that Protaper Next produced more cracks than Protaper Gold [18].

CONCLUSION

Within the limitations of this study it could be concluded that E Flex Gold files tended to produce less cracks than Protaper Goldand Protaper Next rotary files.

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