

Comparative Analysis of Different Rotary File System on Crack Formation in Dentin: A CBCT Analysis

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Abstract

Background: The main aim of endodontics is air tight seal of the root canal system which is achieved by proper anatomical form of the root canal system. Different file system designs, leads to different levels and severity of dentinal damage to the root canal wall.

Aims: The aim of this study was to evaluate the frequency of dentinal microcracks observed after the biomechanical preparation using protaper gold, hyflex edm and two shape.

Methods & Material: 45 intact extracted mandibular premolar were selected. The root canals were instrumented using protaper gold, hyflex edm and two shape. After instrumentation, root canals were horizontally

sectioned at 3,6 and 9mm from the apex and observed under cone beam computed tomography. The data were analysed using one-way anova and post hoc test.

Results : Hyflex edm shows less number of cracks than protaper gold and two shape file system.

Conclusion: All rotary files creates microcracks in the root dentin at all three levels, whereas hyflex edm presented with satisfactory results with less no of dentinal microcracks.

Keywords: Dentinal microcracks, Hyflex electrodischarge machining; Twoshape; protapergold

Introduction

The most common cause of pulp and periradicular pathologies is the presence of microorganisms or microbial flora inside the pulp space.¹

Root canal therapy involves treating necrotic and vital pulp tissues so that patients can retain their teeth in normal form and function. The goal of endodontic instrumentation is to eliminate microorganism, debris and tissue by enlarging the canal diameter and create a canal space for medicament delivery and optimized canal geometries for adequate obturation.²

Now a days, NiTi rotary systems are frequently used by the practitioners.³

Technological advancements in rotary nickel-titanium(NiTi) instruments has led to new designs, concepts, and easier , faster and better root canal shaping.⁴

Recent studies have shown that NiTi rotary and reciprocating files greatly improved the clinical outcomes and reduced the incidence of preparation errors.⁵ However, instrumentation with nickel-titanium (NiTi) instruments can result in some complications such as root canal transportation, perforations and vertical root fractures.⁶

Numerous studies have conducted that root canal instrumentation with nickel-titanium (NiTi) rotary instruments leads to crack formation in root dentin⁷, Thus weakening the integrity of the root and deterioration of the long term prognosis of root canal treatment.⁸

Protaper gold uses the same rotary action and works with the same motors and setting as protaper universal. However, the manufacturer claims that protaper gold provides more than twice the resistance to cyclic fatigue plus its advanced metallurgy creates an increase in flexibility.⁹

Hyflex edm(coltene) is a new rotary system developed recently. Due to its controlled properties hyflex edm files follow the anatomy of the canal, which can significantly

reduce the risk of ledging, transportation and perforation.

The built in shape memory of hyflex edm files prevents stress during canal preparation by changing their spiral shape thus preventing formation of microcracks and root dentin defects.¹⁰

Two shape, is a new generation file system produced with a proprietary heat treatment(T-wire) that according to the manufacturers, aims to improve both the flexibility and the cyclic fatigue resistance of the files¹¹.

Thus, the purpose of this study is to compare the dentinal crack formation using protaper gold, hyflex edm and two shapes.

Materials And Methods

A total of 45 extracted human mandibular premolars with mature apices and straight root canals were selected and kept in distilled water. Then, the teeth were decoronated using diamond disc with a slow speed under water coolant to obtain a standardized root length of 16mm. Root surfaces were examined under cone beam computed tomography. A size of 10 k file was introduced into the canal at the apical foramen to ensure the patency , and working length . Root canal preparation was done with size 25k file. Irrigation solutions 5% sodium hypochlorite and saline were used to flush canals intermittently between each filling.

Then, the samples were divided into 3 groups:

GROUP 1 : Root canal preparation done using protaper gold till F₂

GROUP 2: Root canal preparation done using hyflex edm 25/ 0.8%

GROUP 3: Root canal preparation done with two shape file using Ts₁ and Ts₂

The samples were then sectioned perpendicular to the long axis at 3,6 and 9mm from the root apex using diamond disc and observed under CBCT and scored using scoring criteria suggested by Barreto et al.

Dentinal defects were classified as follows according to Barreto et al

- No defects: root dentin without any lines or cracks on the external or the internal surfaces of the root
- Incomplete cracks: a line extending from the canal wall into the dentin without reaching the outer surfaces.
- Complete cracks: a line extending from the root canal wall to the outer surface of the root.
- Craze lines: all other lines that did not reach any surface of root or extend from the outer surface into the dentin but did not reach the canal wall.

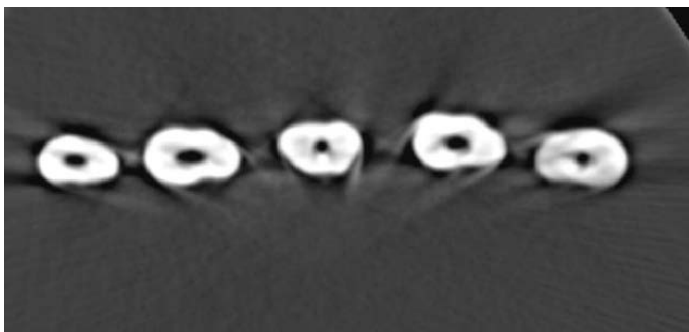


Fig. 1: CBCT images shows dentinal cracks

Statistics: Data obtained were statistically analysed using one way anova and post hoc test.

Result: The number of cracks in each group are shown in [Table 1]. [Table 3 summarizes statistically significant difference among the experimental groups ($P < 0.05$). as shown in [Table 4], hyflex EDM and protaper gold produced less number of cracks as compare to two shape.

Table 1: dentin cracks for different instruments

Expeiment	Protaper gold	Two shape	Hyflex EDM
3mm	2	8	1
6mm	2	6	1
9mm	3	5	1

Table 2: Data Analysis(SPSS20.0)

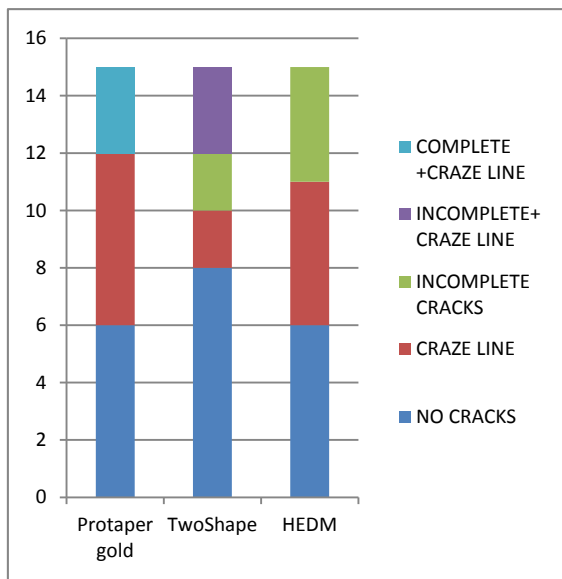
	n	mean	SD	min	max
Protaper gold	3	2.667	1.1687	2	4
Two shape	3	6.334	1.6218	5	8
HEDM	3	1.334	0.5461	1	2

Table 3: ONE WAY ANOVA for difference of mean crack

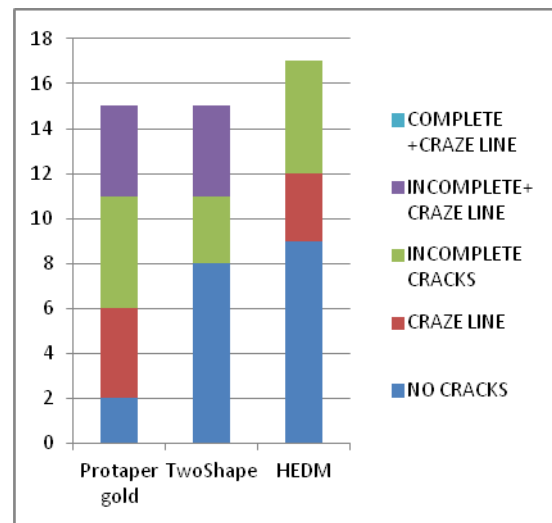
	Sum of square	Degree of freedom	Mean square	Significant
Between groups	64.882	2	32.44	0.05
Within groups	10.00	6	3.18	
Total	74.882			

Table 4: post hoc test for pairwise comparision

Method (I)	Method (j)	Mean difference	Standard error	Significant
Protaper gold	Two shape	-3.67	0.943	0.008
	HEDM	+1.34	0.943	0.206
Two shape	Protaper gold	+3.67	0.943	0.008
	HEDM	+5.00	0.943	0.002
HEDM	Protaper gold	-5.00	0.943	0.002
	Two shape	-1.34	0.943	0.206



Graph 1 : dentinal cracks are shown at 3mm.



Graph 3 : Graph shows dentinal cracks at 9mm

Discussion

Biomechanical preparation is one of the principal steps in achieving endodontic success which includes the preservation of original course of the canal and cleaning of the entire root canal system.

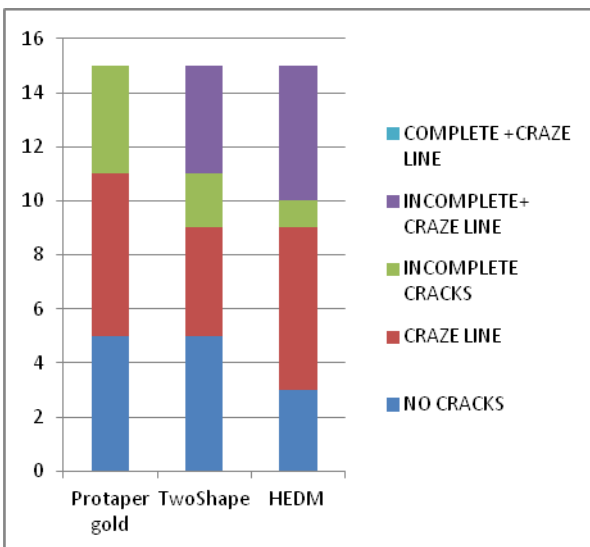
Various NiTi instruments with different design have been introduced, which causes less fatigue to the clinician and saves time, but all of them causes incomplete cracks or even vertical root fracture. Hence, such defects should be prevented.

During preparation, the contact between the instrument and canal walls creates momentary stress concentration in dentin which may lead to dentinal defects wherein vertical root fracture can initiate. Microcracks formation may be related to instrument features such as tip design, cross-sectional geometry, taper, pitch design, and flute form.

In the present study, we have used 3 rotary system as follows:

- Protaper gold
- Hyflex EDM
- Two shape

Protaper gold (PTG) files have featured manufactured metallurgical characteristics with 2-stage specific transformation behaviour and high austenite temperatures.



Graph 2: Graph shows dentinal cracks at 6mm

PTG systems consist of 3 shaping files(sx,s1 and s2) and 5 finishing files(F1,F2,F3,F4 and F5), have triangular cross sections and progressive tapers like PTU, and uses the same rotary action and setting as PTU. However, PTG files have been found to be more resistant to cyclic fatigue compared with PTU files; this is because of its advanced metallurgy, which results in increased flexibility.

HEDM files are produced by control memory treatment just like HyflexCM. EDM process created a rough and hard surface that could improve cutting efficiency of these files. This new file has three different cross-sections over 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. Different speed and torque were used for the three-file system. According to Peter et al., increased rotational speed is associated with increased cutting efficiency. HEDM files are more resistant to cyclic fatigue, so recommended speed is 500rpm. Thus, HEDM file resulted in less cracks than other two files.

Two shape is made of T-Wire heat-treated alloy with an asymmetric triangular cross-section. The 2s system is composed of TS(25/.04),TS(25/.06), F₃₅(36/.06), and F₄₀(40/.04) files.

Conclusion

Within the limitation of this in vitro study, it can be concluded that NiTi instruments may cause cracks on the root surfaces. Hyflex EDM and protaper gold tends to produce less no of cracks than two shape.

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