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Effect of Two Different Rotary Instruments on Dentinal Crack Formation during Canal Preparation: A Stereomicroscopic Study.

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Abstract

Introduction: Root canal preparation using many rotary endodontic instruments results in formation of dentinal microcracks that can affect the long-term prognosis of root canal treatment. This study aims to evaluate and compare the incidence of dentinal defects induced by Hyflex-EDM and Mani silk files during canal preparation.

Materials and methods: 30 extracted mandibular premolars with a single root were selected. Specimens were divided into two groups with 15 specimens each. Group 1 – Specimens were prepared with Hyflex EDM using a crown down technique as per the manufacturer's instructions. Group 2 – Specimens were prepared with Mani silk files using a crown down technique as per manufacturer's instructions. The roots were sectioned horizontally at lengths 3, 6, and 9 mm from the apex with a slow speed diamond disc under water-cooling. The sections were observed under a stereomicroscope at x40 to determine the presence or absence of cracks on the root dentin. The dentinal defects were registered as either "no cracks" or "cracks". The results were tabulated and subjected to statistical analysis.

Summary and Conclusion: Within the limitations of this invitro study, the file system which produces significantly less dentinal defects was identified to be HYFLEX EDM.

Keywords: Hyflex EDM, Mani Silk, Microcracks, Stereomicroscope

Introduction

Cleaning and shaping of the root canal system is one of the most important stages in successful root canal therapy. The primary aim of root canal preparation is the preservation of original course of the canal and cleaning of the entire root canal system[1]. The shaping of the root canal system is achieved by the use of different rotary and hand file systems. Use of stainless steel instruments has been the gold standard for shaping the root canal system, but they are less flexible and time consuming. In the last decade, the use of nickel-titanium (NiTi) rotary instruments has grown in popularity.

NiTi rotary files shows great flexibility and also reduces the operating time which have made their use widely accepted. One common complication of rotary instrumentation is the stress concentrations in dentin that may lead to dentinal defects and cracks[2,3]. Studies have shown that these cracks have the potential of developing into vertical root fractures, as the cracks propagate when subjected to occlusal stresses. Tensile stress in the root canal wall becomes greater than the tensile stress of dentin. Rotary NiTi files with large tapers have shown to produce increased friction and stresses on the canal wall[5,6].

HyFlex EDM files are manufactured using an innovative process called Electrical Discharge Machining. A pulsating electric current discharge that flows between an electrode and the workpiece immersed in a dielectric medium removes material from the surface. This is by partially melting and evaporating small portions of the material in a well-controlled and repeatable way. This procedure leaves an isotropic surface, characterized by regularly distributed craters. This manufacturing process hardens the surface of the NiTi file, resulting in superior fracture resistance and improved cutting efficiency. The built-in shape memory of HyFlex EDM files prevents stress during canal preparation by changing their spiral shape. A normal autoclaving process is enough to return the files to their original shape and fatigue resistance[7].

Silk instruments have a patented design wherein the files are heat treated from their tip end to approximately 10 mm up the cutting flutes. This provides exceptional strength and flexibility to the file. Silk has a unique “tear drop” cross sectional shape that allows debris to be channeled out of the canal efficiently, keeps the file centered in the canal and significantly decreases the “screwing in” effect all the while cutting efficiently. This system promises a predictable canal shaping with minimal stress generation in the root canal walls[8].

Hence, the aim of this in vitro study was to analyse and compare the dentinal crack formation following instrumentation with these two novel file systems – HYFLEX EDM and MANI SILK.

Materials and Methods

Thirty extracted mandibular premolars having single and straight canal were selected for the study. Teeth were cleaned and stored in distilled water until use. For standardisation all the teeth were decoronated using diamond discs under constant water cooling at 16mm from the apex.

All the roots were examined under a stereomicroscope to detect any pre-existing micro cracks. Six root samples which showed cracks were discarded and replaced after appropriate examination.

The roots were then wrapped in a single layer of aluminium foil and embedded in acrylic blocks. The roots were then removed and the foil is replaced with light body impression material and positioned back in the acrylic mould. The light body impression material simulates the periodontal ligament membrane. Apical portion of the roots were exposed and were placed in contact with distilled water to prevent drying out of the specimens.

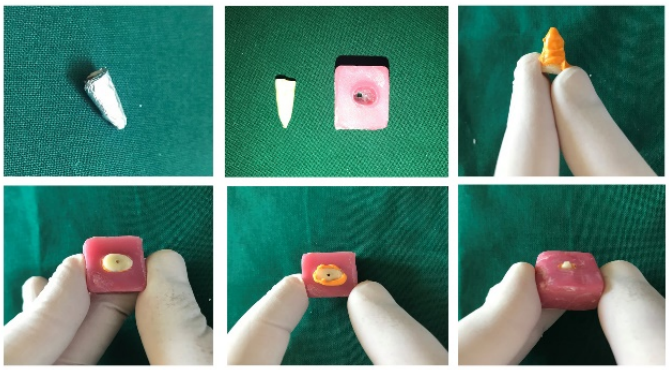

Figure 1: Mounting of root on acrylic blocks

Canals were negotiated with size 10 K files and working length was measured by substracting 1 mm from the length at which the file appeared at the apical foramen. Glide path was established using15 k-type files. Root

canal preparation was completed with size 25 instrument of each system. 3% sodium hypochlorite solution was used as an irrigant during instrumentation.

The specimens were then randomly divided into two groups (n=15) – GroupI-Mani Silk and Group II-Hyflex EDM.

Group I

Canals were prepared with Silk files (MANI, Tochigi, Japan) at 500 rpm and torque (3 Ncm) as recommended by manufacturer. The Simple pack, recommend for use in simple straight canals was used. A 0.08/25 orifice opener followed by 0.06/25 instrument upto the working length.

Group II

HEDM files were used at 500 rpm and at a torque of up to 2.5 Ncm. After using Orifice opener (0.12/25), single file 25/0.06 was used.

Sectioning and stereomicroscopic examination

Roots were removed from the acrylic moulds and sectioned perpendicular to long axis at 3, 6, and 9 mm from the root apex using a low speed diamond wheel under constant water cooling. Digital images of each section were captured at ×40 magnification using a digital camera attached to a stereomicroscope. No crack was defined as root dentin devoid of any microcracks or craze lines either at the external surface of root or at the internal surface of root canal wall. Crack was defined as any lines, microcracks, or fracture observed on the slice that either extended from root canal lumen to the dentin or from outer root surface into the dentin[12]. If a specimen showed one or more cracks, the specimen is counted as cracked but, the number of cracks in the same specimen were not counted. The number of cracked specimens at 3,6 and 9 mm were recorded.

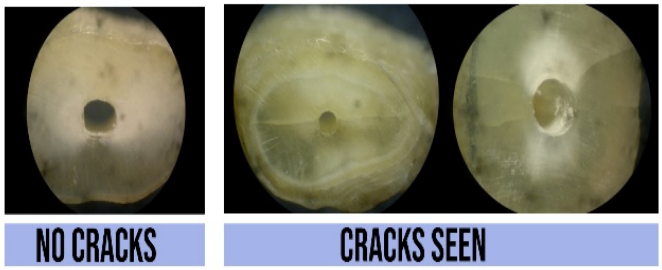

Figure 2: Stereomicroscopic images

Results

The numbers of cracks in each group (n=15) are shown in Table 1.

Table 1: Number of cracks seen in each group s(n=15)

Groups	3 mm	6 mm	9 mm
Mani Silk	2	7	6
Hyflex Edm	1	2	1

Table 2: summarizes statistically significant difference among the experimental groups ($P < 0.05$).

Table 2 - Comparison of presence of cracks between Mani Silk and n Hyflex EDM instruments at different sections using Chi Square Test

Sections	Cracks	Group I Mani Silk		Group II Hyflex EDM		c^2 Value	P-Value
		n	%	n	%		
3mm	Absent	12	80.0%	14	93.3%	1.154	0.28
	Present	3	20.0%	1	6.7%		
6mm	Absent	8	53.3%	13	86.7%	3.968	0.04*
	Present	7	46.7%	2	13.3%		
9mm	Absent	9	60.0%	14	93.3%	4.658	0.03*
	Present	6	40.0%	1	6.7%		

Chi Square Test was used to compare the presence of cracks at different sections of the tooth. At 3mm 2 specimens from Mani silk and one from HEDM showed cracks. At 6mm 7 from M and 2 from H showed cracks. At 9mm 6 specimens from Group I and 1 specimen from Group II showed cracks. That is in the 6 mm group almost 50% sp of M group showed cracks whereas in H it was only 13%. Similarly in the 9mm group almost 40% of M grp showed cracks whereas in H it was only 6.7%.

Discussion

Vertical root fracture is not a sudden phenomenon but rather a result of crack propagation. According to Bier *et al*., craze lines occurred in 4% to 16% of instrumented root canals, which may develop into fractures during

retreatment or after long-term functional stresses such as chewing[2]. The main goal of the present investigation was to study the effect of two different file systems on crack formation. Both the systems evaluated in the study produced dentinal cracks, and this finding is in agreement with previous reports (Bier et al. 2009)[2]. In addition, there was a significant difference amongst the groups. Thus, the null hypothesis was rejected.

There are no standardised criteria for sample selection in in vitro studies testing dentinal crack initiation and propagation. A finite-element analysis study had showed greater stress concentrations in oval roots with greater buccal-lingual diameter. It was suggested that higher strain accumulation occurs in the buccolingual direction due to the reduced proximal dentin thickness. The sharpened notch at the edge of the oval extension is a site more prone to crack initiation when mesiodistal forces are applied during instrumentation[14]. Mandibular premolar teeth with single canal usually shows oval configuration, hence they were used in the study.

Yoldas et al. stated that certain design features of rotary instruments like the tip design, cross-sectional geometry, constant or variable pitch and taper, and flute form could be related to crack formation [9]. Kim et al. (2010) evaluated the potential relationship between the design of NiTi instruments and the incidence of vertical root fractures. They found that higher stress concentration, which raises the risk of dentinal defects, varies with instrument design[5].

HEDM files are manufactured by control memory treatment. EDM process creates a rough and hard surface with surface craters that could improve cutting efficiency of these files. This working part of this file has three different cross sections, (rectangular) in apical part, trapezoidal in middle part, triangular in coronal part, which helps to increase fracture resistance, and cutting efficiency[7,12]. The built-in shape memory of HyFlex EDM files prevents stress during canal preparation by changing their spiral shape within the canals. This could be reason for the relatively lesser crack formation when HyFlex EDM file system was used.

On the other hand, microcracks formation seen with silk files could be attributed to some of its design characteristics. Even though the design characteristics lihe tear drop cross section and selective heat treatment promise lesser screwing in effect, the more number of cracks formed could be due to the difference in metallurgy[8].

The limitation of the study was application of elastomeric material to simulate the periodontal ligament. Adorno *et al* suggested that elastomeric material may collapse and permit direct tooth to acrylic contact[13].

Conclusion

NiTi instruments may cause varying degrees cracks on the root surface. HEDM tend to produce less cracks as compared to MANI SILK files. The heat treatment, flexibility and kinematics of the file and its basic architecture are the most significant factors affecting crack formation.

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References

1. Estrela C, Holland R, Estrela CR, Alencar AH, Sousa-Neto MD, Pécora JD. Characterization of successful root canal treatment. Brazilian dental journal. 2014 Feb;25(1):3-11.
2. Bier CA, Shemesh H, Tanomaru-Filho M, Wesselink PR, Wu MK. The ability of different nickel-titanium rotary instruments to induce dentinal damage during canal preparation. Journal of Endodontics. 2009 Feb 1;35(2):236-8.

3. Aydınbelge HA, Yılmaz MÖ. Dentinal crack formation after root canal preparation: Rotary versus reciprocal instrumentation. Selcuk Dental Journal.;5(2):111-6.
4. Rzhanov EA, Belyaeva TS. Design features of rotary root canal instruments. ENDO (Lond Engl). 2012;6(1):29-39.
5. Kim HC, Lee MH, Yum J, Versluis A, Lee CJ, Kim BM. Potential relationship between design of nickel-titanium rotary instruments and vertical root fracture. Journal of endodontics. 2010 Jul 1;36(7):1195-9.
6. Versluis A, Messer HH, Pintado MR. Changes in compaction stress distributions in roots resulting from canal preparation. International Endodontic Journal. 2006 Dec;39(12):931-9.
7. Pirani C, Iacono F, Generali L, Sassatelli P, Nucci C, Lusvarghi L, et al. HyFlex EDM: Superficial features, metallurgical analysis and fatigue resistance of innovative electro discharge machined NiTi rotary instruments. Int Endod J 2016;49:483 -93.
8. Mounce R. Mani Silk: A new and novel means of predictable canal shaping. Endod Prac. 2015.
9. Yoldas O, Yilmaz S, Atakan G, Kuden C, Kasan Z. Dentinal microcrack formation during root canal preparations by different NiTi rotary instruments and the self-adjusting file. Journal of endodontics. 2012 Feb 1;38(2):232-5.
10. Ruddle CJ, Machtou P, West JD. The shaping movement 5th generation technology. Dent Today. 2013 Apr;32(4):94.
11. Langaliya AK, Kothari AK, Surti NR, Patel AR, Doshi PR, Pandya DJ. In vitro comparative evaluation of dentinal microcracks formation during root canal preparation by different nickel-titanium file systems. Saudi Endodontic Journal. 2018 Sep 1;8(3):183.
12. Das S, Pradhan PK, Lata S, Sinha SP. Comparative evaluation of dentinal crack formation after root canal preparation using ProTaper Next, OneShape, and Hyflex EDM. Journal of conservative dentistry: JCD. 2018 Mar;21(2):153.
13. Adorno CG, Yoshioka T, Suda H. Crack initiation on the apical root surface caused by three different nickel-titanium rotary files at different working lengths. Journal of endodontics. 2011 Apr 1;37(4):522-5.
14. Lertchirakarn V, Palmara JE, Messer HH. Patterns of vertical root fracture: factors affecting stress distribution in the root canal. J Endod. 2003 Aug;29(8):523-528.