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Original Article

Comparison of Dentinal Cracks after Root Canal Preparation with Hand Files and Protaper NEXT, HYFLEX EDM, K3 XF and Twisted Rotary Files

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ABSTRACT:

Background: Successful endodontic therapy depends upon triad of proper diagnosis, thorough biomechanical preparation and three dimensional obturation of root canal system.The purpose of this study is to compare the dentinal crack formation while using hand files, Protaper Next rotary files, Hyflex EDM rotary files, K3 XF rotary files, and Twisted rotary files. **Materials & methods:** Sixty single rooted mandibular premolar teeth were divided into 6 groups as follows:-**Group I:** Ten specimen canals were left unprepared.**Group II:** Ten specimen canals were prepared with Hand K Files (Mani).**Group III:** Ten specimen canals were prepared with The ProTaper Next files (Dentsply Maillefer) in the sequence Pro-Taper Universal SX and then ProTaper Next X1(17/.04) and X2(25/.06) at a rotational speed of 300 rpm and 200 g/cm torque. **Group IV:** Ten specimen canals were prepared with Hyflex EDM rotary files (ColteneWhaledent) size 25 with a variable taper from .08 at the tip up to .04 in the coronal part, in continuous rotation according to the manufacturer's instructions.**Group V:** Ten specimen canals were prepared with K3 XF rotary files (SybronEndo) K3XF rotary instruments were used in a crown down approach with the sequence of 25/.10 and 25/.08 for coronal shaping followed by 25/.04 upto working length and then master apical file 25/.06 was used.**Group VI:** Ten specimen canals were prepared with Twisted rotary files(Sybron Endo) in the following sequence at 500 rpm: 25/.08, 25/.04 and finally 25/.06 file as master apical file. All of the roots were sectioned perpendicular to the long axis at 3, 6, and 9 mm from the apex. Then the slices were examined for cracks under stereomicroscope.Roots were classified as "defected" if at least one of the three sections showed either a craze line, partial crack, or a fracture. All the results were analyzed by SPSS software. **Results:** The total number of cracks caused observed in Control, Hand Files, ProTaper NEXT, Hyflex EDM, K3 XF and Twisted groups was found to be 0/30 (0%), 2/30 (6.67%), 10/30 (33.33%), 9/30 (30%), 12/30 (40%) and 10/30 (33.33%) respectively. The highest total number of cracks are caused by Group V (K3 XF) whereas least number of cracks are present in Group I (Control). Group II (Hand File) showed least number of cracks among various file systems used in the study. Group IV (Hyflex EDM) showed least number of cracks among various rotary file systems used in the study. Statistical significant difference in total number of cracks was observed in six groups ($P<0.001$). **Conclusion:** All the instruments used in the study, including hand K file, induced dentinal defects,but this is less in comparison to the rotary file systems.

Key words: Dentinal Cracks, Hyflex, Protaper, Twisted, K3XF

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INTRODUCTION

Successful endodontic therapy depends upon triad of proper diagnosis, thorough biomechanical preparation and three dimensional obturation of root canal system.[1]Biomechanical preparation is one of the most important factors for successful root canal treatment and determines the efficacy of all subsequent procedure. It is done to completely remove organic tissue, micro-organisms and debris by enlarging the canal diameter and creating a shape that allows a proper seal so as to achieve a successful endodontic treatment.[2]

Stainless steel root canal instruments clean the canal superficially and can create canal aberrations such as ledges, zips, and elbows due to their straightening tendency. To eliminate these shortcomings of stainless steel instruments, Nickel-Titanium (Ni-Ti) instruments have been developed.[3]

Recently, ProTaper Next (DentsplyMaillefer) instruments have been introduced that have an off-centered rectangular design and progressive and regressive percentage tapers on a single file, which gives the file a snake-like "swaggering" movement as it moves through the root canal. The new Hyflex EDM files (SybronEndo) constitute 5th generation of root canal files. These files have completely new properties due to their innovative manufacturing via an electro discharge machining (EDM) process which creates their unique surface resulting in more flexible and fracture resistant files. K3XF files (SybronEndo) was developed with the R-phase heating and cooling protocol.K3XF provides clinicians with the safety, self-centering features of theoriginal K3, increased flexibility and resistance to cyclic fatigue provided by R-Phase Technology. The Twisted files has been developed by SybronEndo (Orange, CA).It has been developed with 3 design features, namely R-phase heat treatment, twisting of the metal and special surface conditioning, which are claimed to enhance strength, flexibility and resistance to fatigue, maintaining the original canal center and minimizing canal transportation even in severely curved root canals. Whether it is rotary or hand files (HFs), they are assumed to cause limited frictional forces within the canal, hence creating dentinal defects. So there is need to study the behavior of different NiTi rotary instruments and the newly developed rotary systems on root dentin.[4- 6]The purpose of this study is to compare the dentinal crack formation while using hand files, Protaper Next rotary files, Hyflex EDM rotary files, K3 XF rotary files, and Twisted rotary files.

MATERIALS & METHODS

The present study was planned in the Department of Conservative Dentistry and Endodontics, H.P.G.D.C, Shimla.Sixty single rooted mandibular premolar teeth with a root canal curvature less than 10˚ that had been extracted for reasons unrelated to this study were selected and kept in purified filtered water until use. The external root surfaces were then inspected under a stereomicroscope to exclude the possibility of any external defects or cracks.Buccolingual and mesiodistal radiographs were taken to verify the presence of single canal. To ensure standardization, the teeth were sectioned with a diamond disc 13 mm from the apex. The roots were then covered with a single layer of aluminum foil and inserted in acrylic resin set in an acrylic tube. Then the teeth were removed from the acrylic tube, and the aluminum foil suspended from the root surface. A light body silicon-based material was used to fill the space created by the foil and to simulate the periodontal ligament, and the roots were replaced to the impression material. Access cavity was prepared for each tooth and patency of canal was checked with No.10K file (Mani). The working length of the canals was determined by inserting a size 10 K-type file into the root canal terminus and subtracting 1 mm from this measurement. A glide path was performed via a size 15 K type file.

Then the specimens were divided into 6 groups as follows:-

Group I: Ten specimen canals were left unprepared.

Group II: Ten specimen canals were prepared with Hand K Files (Mani). Each canal was prepared with step back technique. Size 10 to 25 K-files were used up to the full working length, to constitute apical preparation to the desired master apical file ISO size 25. The mid-root and coronal parts of the canals were also prepared by the step-back technique, but with size 30 increased to size 50 K-files, whilst the working length (1 mm) was decreased with each instrument change to create a tapered shape. After each step recapitulation was done with a smaller number K-file.

Group III: Ten specimen canals were prepared with The ProTaper Next files (DentsplyMaillefer) in the sequence Pro-Taper Universal SX and then ProTaper Next X1(17/.04) and X2(25/.06) at a rotational speed of 300 rpm and 200 g/cm torque. Each file was used with a brushing motion away from the root concavities before light resistance was encountered.

Group IV: Ten specimen canals were prepared with Hyflex EDM rotary files (ColteneWhaledent) size 25 with a variable taper from .08 at the tip up to .04 in the coronal part, in continuous rotation according to the manufacturer's instructions.

Group V: Ten specimen canals were prepared with K3 XF rotary files (SybronEndo) K3XF rotary instruments were used in a crown down approach with the sequence of 25/.10 and 25/.08 for coronal shaping followed by 25/.04 upto working length and then master apical file 25/.06 was used.

Group VI: Ten specimen canals were prepared with Twisted rotary files (Sybron Endo) in the following sequence at 500 rpm: 25/.08, 25/.04 and finally 25/.06 file as master apical file.

One endodontist performed all of the root canal instrumentation. Each instrument was used in 5 canals and operated with X smart plus torque control motor (DentsplyMaillefer). The root canals were irrigated with 3% sodium hypochlorite solution after each instrument change. A total of 12 mL 3% sodium hypochlorite were used in each canal. After preparation, the specimens from the prepared groups were rinsed with 5 mL distilled water. All roots were kept moist throughout the experimental procedures in order to prevent dehydration.

All of the roots were sectioned perpendicular to the long axis at 3, 6, and 9 mm from the apex using a low speed saw. In each group, a total of 30 slices were examined for cracks under stereomicroscope. In order to avoid confusing definitions of root fractures, two distinguished categories were made: "no defect" and "defect".

Roots were classified as "defected" if at least one of the three sections showed either a craze line, partial crack, or a fracture. Results were expressed as the number and percentage of defected roots in each group. All the results were analyzed by SPSS software. One way ANOVA and Tukey's Post hoc test were used for assessment of level of significance. P- value of less than 0.05 were taken as significant.

RESULTS

Total number of cracks caused observed in Control, Hand Files, ProTaper NEXT, Hyflex EDM, K3 XF and Twisted groups was found to be 0/30 (0%), 2/30 (6.67%), 10/30 (33.33%), 9/30 (30%), 12/30 (40%)and 10/30 (33.33%) respectively. The highest total number of cracks is caused by Group V (K3 XF) whereas least number of cracks is present in Group I (Control).

Number of cracks caused at 3mm sections observed in Control, Hand Files, ProTaper NEXT, Hyflex EDM, K3 XF and Twisted groups was found to be 0/10 (0%), 1/10 (10%), 4/10 (40%), 3/10 (30%), 4/10 (40%)and 4/10 (40%) respectively. The highest number of cracks at 3mm is caused by Group III (ProTaper NEXT), V (K3 XF) and VI (Twisted) whereas least number of cracks were present in Group I (Control).

Number of cracks caused at 6mm sections observed in Control, Hand Files, ProTaper NEXT, Hyflex EDM, K3 XF and Twisted groups was found to be 0/10 (0%), 1/10 (10%), 4/10(40%), 5/10 (50%), 5/10 (50%)and 3/10 (30%) respectively. The highest number of cracks at 6mm sections are caused by Group IV (Hyflex EDM) and Group V (K3 XF) whereas least number of cracks are present in Group I (Control).

Number of cracks caused at 9mm sections observed in Control, Hand Files, ProTaper NEXT, Hyflex EDM, K3 XF and Twisted groups was found to be 0/10 (0%), 0/10 (0%), 2/10 (20%), 1/10 (10%), 3/10 (30%) and 3/10 (30%) respectively. The highest number of cracks at 9mm sections are caused by Group V (K3 XF) and Group VI (Twisted) whereas least number of cracks are present in Group I (Control) and Group II (Hand Files).

Highly statistical significant difference was present in total number of cracks observed in six groups (P<0.001*)*P<0.05. No statistical significant difference was present in number of cracks at 3mm sections observed in six groups (P=0.169). No statistical significant difference was present in number of cracks at 6mm sections observed in six groups (P=0.059). No statistical significant difference was present in number of cracks at 9mm sections observed in six groups (P=0.196)

Table 1: Comparison of Total Number Of Cracks Observed In Six Groups Using Anova Test

GROUP	MEAN	SD	95% CI FOR MEAN		P VALUE
			LOWER BOUND	UPPER BOUND	
I	0.00	0.00	0.00	0.00	<0.001
II	0.20	0.42	0.00	0.45	
III	1.00	0.47	0.66	1.30	
IV	0.90	0.74	0.41	1.33	
V	1.20	0.79	0.70	1.84	
VI	1.00	0.67	0.68	1.67	

SD= standard deviation, CI=Confidence Interval, *p<0.05 significant using Anova test

Table 2: Comparison Of Cracks Present At 3mm Sections Observed In Six Groups Using Anova Test

GROUP	MEAN	SD	P VALUE
I	0.00	0.00	0.169
II	0.10	0.32	
III	0.40	0.52	
IV	0.30	0.48	
V	0.40	0.52	
VI	0.40	0.52	

SD= standard deviation, *p<0.05 significant using Anova test

Table 3: Comparison Of Cracks Present At 6mm Sections Observed In Six Groups Using Anova Test

GROUP	MEAN	SD	P VALUE
I	0.00	0.00	0.059
II	0.10	0.32	
III	0.40	0.52	
IV	0.50	0.53	
V	0.50	0.53	
VI	0.30	0.48	

SD= standard deviation, *p<0.05 significant using Anova test

Table 4: Comparison Of Cracks Present At 9mm Sections Observed In Six Groups Using Anova Test

GROUP	MEAN	SD	P VALUE
I	0.00	0.00	0.196
II	0.00	0.00	
III	0.20	0.42	
IV	0.10	0.32	
V	0.30	0.48	
VI	0.30	0.48	

SD= standard deviation, *p<0.05 significant using Anova test

Table 5: Comparison Between Individual Six Groups Using Anova Post Hoc Test

COMPARISON GROUPS	MEAN DIFFERENCES	P VALUE
I & II	-0.20	0.971
I & III	-1.00	0.004*
I & IV	-0.90	0.012*
I & V	-1.20	<0.001**
I & VI	-1.00	0.004*
II & III	-0.80	0.035*
II & IV	-0.70	0.091
SII & V	-1.00	0.004*
II & VI	-0.80	0.035*
III & IV	-0.10	0.999
III & V	-0.2.	0.971
III & VI	-0.00	1.000
IV & V	-0.30	0.854
IV & VI	-0.10	0.999
V & VI	-0.20	0.971

*p<0.05 significant, **p<0.001 highly significant using Anova Post hoc test

Figure 1: Radiographs taken to confirm single root canals in samples

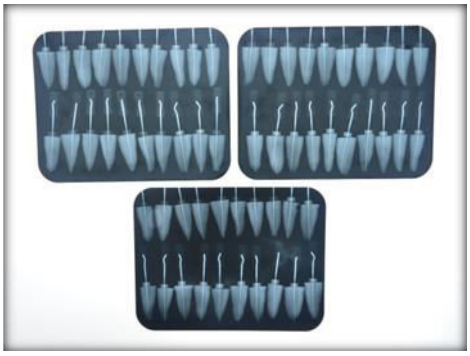

Figure 2: Sections Showing Cracks In different groups at 3 MM

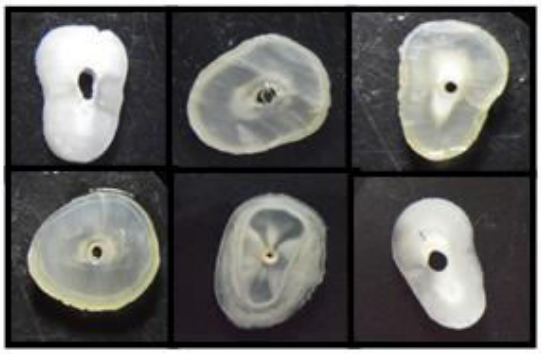

Figure 3: Sections Showing Cracks In different groups at 6 MM

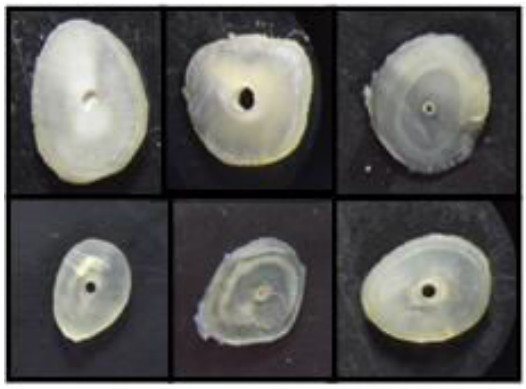

Figure 4: Sections Showing Cracks In different groups at 9 MM

DISCUSSION

To the best of our knowledge, there is no available data in the literature about the comparison of influence of the ProTaper Next, K3 XF, Twisted and HyFlexEDM rotary files with Hand files on the occurrence of dentinal cracks in single study.

Hence, the present study was aimed to compare dentinal crack formation caused by hand files with the following rotary instruments: Protaper NEXT, with an off-centered rectangular cross-section design and manufactured with M-wire technology; Hyflex EDM, with three different cross sections: quadratic in the apical third, trapezoidal in the middle third, and almost triangular in the coronal third and manufactured with CM-wire technology; K3 XF, with a modified triple U shaped cross section design and manufactured with R-phase technology; and Twisted, with a triangular cross section design and manufactured with R-phase technology.

In the present study, after root canal shaping with Hand files and ProTaper Next, HyFlex EDM, K3 XF, and Twisted rotary files the incidence of dentinal microcracks observed in root dentin was 6.66%, 33.33%, 30%, 40% and 33.33% of the specimens respectively. 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.

Hand files produced least defects because the amount of force application is less, the number of rotation is less, and screwing effect is not present.

The rotary file systems tend to generate greater stress on the root canal walls. Higher stress induction on the walls is due to greater number of rpm, resulting in faster and more aggressive cutting. At the same time, due to positive rake angle and lower contact area as compared to hand files, the stress concentration is higher.

Hyflex EDM produced fewer, but not significantly different, cracks compared with other rotary file systems used in the study. Among rotary file systems, Hyflex EDM which is a single file system induced least number of defects when compared to multiple file system. This result is probably caused by the high flexibility of HEDM caused by the synergistic effect of the Controlled Memory wire and the electrical discharge machining manufacturing process which is in agreement with previous reports.[8- 12]

In coherence to our study, Eugenio Pedulla et al compared the formation of microcracks after canal preparation performed with different single-file systems and concluded that HyFlex EDM showed fewer microcracks than other experimental groups; however, no significant difference was found between them in crack formation.[13]

Contrary to the findings of our study in which ProTaper Next and K3XF causedmicrocracks in 33.33% and 40% respectively, BertanKesim et al compared the incidence of root cracks after root canal instrumentation using hand K-files with thermomechanically processed nickel-titanium files (K3XF, ProTaper Next, Reciproc, Twisted File Adaptive) with different instrumentation kinematics and concluded that ProTaper Next(14%) and TF Adaptive(17%) produced significantly more cracks than the hand files(1%), Reciproc(3%) and K3 XF(3%).[14] The less number of cracks caused could be due to the use of less quantity and lower concentration of sodium hypochlorite i.e 2mL of 1% sodium hypochlorite after each instrument.

In our study, all the samples were prepared till the apical size 25 and showed that microcracks caused by Twisted files is 30%, whereas a study done byOguzYoldas et al compared dentinal microcrack formation while using hand files (HFs), 4 brands of nickel-titanium (NiTi) rotary files [HERO Shaper, Revo-S, Twisted File, ProTaper] and the self-adjusting file [SAF]. They concluded that dentinal microcracks were observed in 44% of roots prepared with Twisted files whereas the SAF file and hand instrumentation presented satisfactory results with no dentinal microcracks.[15] The increased number of cracks in their study could be due to the preparation of root canal to a larger apical size i.e. 30/.06. and also because both mesiobuccal and mesiolingual canals of mesial roots of mandibular first molars were instrumented in this study. Therefore, repeated instrumentation of these roots might also increase the defect rates in their study.

The major number of microcracks was observed in the apical and middle section(3mm, 6mm) for all tested instruments, which is in agreement with previous studies.[16,17] This is the result of an accumulation of mechanical stress over the successive instrumentation sessions or of lower capability of thinner and therefore more fragile apical dentin to withstand the mechanical stress produced by direct contact with the instrument tip. These results are probably influenced from the different cross sections of the rotary file systems used such as variable taper which can explain the reduced number of microcracks in coronal teeth sections.

The number of dentinal microcracks caused at 6mm sections is slightly more than the dentinal microcracks caused at 3mm, although the difference is not significant. Using an initial instrument with greater taper and size may explain why more cracks occurred at 6mm level. Likewise, preparing root canals without performing an open and wide pathway with the smaller size of the instruments may result as more cracks at 6mm level.

Overall, the discrepancy in results can be explained by the differences in methodological design such as the use of Gates-Glidden instruments, different sectioning levels, periodontal ligament simulation, and different types and sizes of instruments, which precludes a direct comparison of the results of the present study with those reported in the related literature.

CONCLUSION

All the instruments used in the study, including hand K file, induced dentinal defects,but this is less in comparison to the rotary file systems. Among rotary file systems, highest total number of cracks is caused by K3 XFwhereas Hyflex EDM have a least tendency to cause dentinal cracks. The total cracks caused were least in the coronal sections as compared to the apical and middle sections.

However, for more conclusive result, further studies and evidences are required to extend thefuture scope of various rotary file systems used in the study regarding the occurrence of dentinal defects.

REFERENCES

1. Peters OA. Current challenges and concepts in the preparation of root canal systems: A review. J Endod. 2004;30:559-67.
2. Bier CA, Shemesh H, Tanomaru-Filho M, Wesselink PR. The Ability of Different Nickel-Titanium Rotary Instruments To Induce Dentinal Damage During Canal Preparation. J Endod. 2009;35(2):236–38.
3. Krishna V, Kumar CS, Madhusudhana K, Mathew VB, Reddy A, Babu L. Evaluation of dentinal damage after root Canal preparation with Protaper Universal, Twisted files and Mtwo rotary systems. International journal of medical and applied sciences. 2014; volume3,issue4,2320-3137.
4. Blum JY, Machtou P, Ruddle C, Micallef JP. Analysis of mechanical preparations in extracted teeth using ProTaper rotary instruments: Value of the safety quotient. J Endod 2003;29:567-75.
5. 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. IntEndod J. 2016;49(5):483-93.

6. Perez-Higueras JJ, Arias A, de la Macorra JC. Cyclic fatigue resistance of K3, K3XF, and twisted file nickel-titanium files under continuous rotation or reciprocating motion. J Endod. 2013;39(12):1585-8.
7. Larsen CM, Watanabe I, Glickman GN, et al. Cyclic fatigue analysis of a new generation of nickel titanium rotary instruments. J Endod 2009;35:401–3.
8. Adorno CG, Yoshioka T, Suda H. The effect of working length and root canal preparation technique on crack development in the apical root canal wall. IntEndod J. 2010 Apr;43(4):321-7.
9. 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. J Endod. 2011;37(4):522-5.
10. Capar ID, Arslan H, Akcay M, Uysal B. Effects of ProTaper Universal, ProTaper Next, and HyFlex instruments on crack formation in dentin. J Endod. 2014;40(9):1482-4.
11. Topçuoğlu HS, Demirbuga S, Tuncay Ö, Pala K, Arslan H, Karataş E. The effects of Mtwo, R-Endo, and D-RaCe retreatment instruments on the incidence of dentinal defects during the removal of root canal filling material. J Endod. 2014;40(2):266-70.
12. Pedulla E, Lo Savio F, Boninelli S, et al. Influence of cyclic torsional preloading on cyclic fatigue resistance of nickel - titanium instruments. IntEndod J 2015;48:1043–50.
13. Pedullà E, Genovesi F, Rapisarda S, La Rosa GR, Grande NM, Plotino G, Adorno CG. Effects of 6 Single-File Systems on Dentinal Crack Formation. J Endod. 2017;43(3):456-61.
14. Kesim B, Sagsen B, Aslan T. Evaluation of dentinal defects during root canal preparation using thermomechanically processed nickel-titanium files. Eur J Dent. 2017 Apr-Jun;11(2):157–161.
15. 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. J Endod. 2012;38(2):232-5.
16. Karatas E, Gunduz HA, Kırıcı DO, Arslan H, Topcu MK et al. Dentinal Crack Formation during Root Canal Preparations by the Twisted File Adaptive, ProTaper Next, ProTaper Universal, and WaveOne Instruments. J Endod. 2015;41:261–64.
17. Cicek E, Kocak MM, Saglam BC, Kocak S. Evaluation of microcrack formation in root canals after instrumentation with different NiTi rotary file systems: a scanning electron microscopy study. Scanning 2015;37:49–53.

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