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Effect Of Different Rotary Instruments On Crack Formation After Coronal Preflaring Of Root Dentin – A Stereomicroscopic Analysis

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Abstract

Aim: The aim of the current research was to observe the crack formation in root dentin after coronal flaring with different preflaring instruments such as Gates glidden drills (Mani, Japan), Hyflex EDM (Coltene, Switzerland) and Pro Taper Universal SX (Dentsply, Switzerland)

Methodology: Freshly extracted 40 single rooted mandibular premolars were included for the research and were divided into four groups. One group used as control and in other three groups coronal preflaring done with Gates Glidden drills, Hyflex EDM and Protaper Universal SX. After preflaring the roots were sectioned perpendicular to long axis at 1mm, 2mm, 3mm, 4mm and 5mm from CEJ. The sections were observed at 40x magnification using stereomicroscope to detect the presence of dentinal cracks. The data were analyzed using Chi square test.

Results: The roots instrumented with gates glidden drills showed higher crack formation in root dentin ($p<0.05$) than Protaper Universal and Hyflex EDM while preflaring the canal orifices.

Conclusion: The gates glidden instrumentation had more crack formation when compared with ProTaper Universal and Hyflex EDM that produced less cracks on root dentin

Keywords: Coronal preflaring, Hyflex EDM, Protaper Universal, Gates Glidden, Stereomicroscope, dentinal cracks, Vertical root fracture

INTRODUCTION

Biomechanical preparation is the essential step in root canal treatment.[1] Conventionally, canal preparation was done using hand endodontic files. With recent advances in rotary nickel– titanium (NiTi) instruments, most practitioners started using rotary instruments. This led to the developments of novel rotary instruments of root canal instrumentation.[2] The specific rotary systems are selected because of their advantages, such as structured and better cutting efficiency.[3]

Adequate access opening and pre flaring of canal has numerous advantages.[4] Successful root canal treatment relies on the accurate working length determination and proper preparation of root canal.[5] various rotary instruments systems have their intrinsic coronal flaring instrument for use in cleaning and shaping of root canal. Coronal preflaring of the root canal improved endodontic width determination and also played a major role in determining the anatomical width of the canal at the working length.[6]

Various instruments are available for coronal flaring in root canal preparation. The motif of rotary instruments affects the root dentin while shaping, thereby causing stress on the dentin. Also there is a

concept that the ornamentation of the instrument affects the dentinal defects and consequently causes Vertical Root Fracture.[7] The steps involved in biomechanical preparation, obturation techniques and retreatment procedures act as factors responsible for dentinal crack formation.[8,9,10,11]
The instruments used for coronal flaring should have increased taper. The rotary instruments while contact with dentinal walls produce friction, which leads to stress concentration on the dentinal wall.[8] The coronal flaring instrument should be used after smooth glide path preparation. The Protaper Universal (SX) is alternative for gates glidden drill, will brush and cut dentin on the outstroke which is an advantage over other rotary coronal flaring instruments.[12]

Hyflex electro discharge machining (HEDM) (Coltene / Whaledent) is constructed by EDM process. EDM is a process in which top layer of the material is melted and vapourised.[13] The material is externally removed and surface becomes isotropous, has regularly dispersed craters, which provides increase in fracture resistance and cutting efficiency.[14,15]
The aim of the current research was to observe the crack formation in dentin of the root after preflaring with different instruments such as Gates glidden drills (Mani, Japan), Hyflex EDM (Coltene, Switzerland) and Pro Taper Universal SX (Dentsply, Switzerland)

MATERIAL AND METHODOLOGY

SPECIMEN SELECTION AND DISTRIBUTION

Forty freshly extracted single rooted permanent mandibular premolars were collected and cleaned from residual tissue tags. Exclusion criteria included teeth with more than one canal, teeth with moderate curvature, calcifications in the pulp chamber, internal resorption, previous endodontic treatment and teeth already subjected to any form of dental restorations. The teeth were then stored in plastic vials containing saline until use. All the samples were then sectioned
2mm above the CEJ using slow speed diamond disc under coolant with root length standardized to 16mm and also to achieve straight line access to the canal. The specimens were then observed under Stereomicroscope (Leica Macrosystems, Mannheim, Germany) to exclude any cracks or defects. The specimens were embedded in modelling wax.

CORONAL FLARING

The patency of the canal was established with 10k file (Mani K files 25mm, Prime Dental Products, India). All the samples were then instrumented upto 20k file (Mani K files 25mm, Prime Dental Products, India) and flared as follows:
Group 1: Specimens which were left unflared
Group 2: Flaring with Gates Glidden drills (Mani, Japan) at 800rpm, torque as suggested by the manufacturer using a Contra angle handpiece (NSK, Japan).Size 3 (3N/cm torque) with 3mm inside canal, Size 2 (1N/cm torque) with 5mm inside canal, Size 1 (0.8N/cm) with 8mm inside canal
Group 3: Flaring with SX instrument from Protaper Universal with 300rpm , torque of 3N/cm and with 8mm working length.
Group 4: Flaring with Hyflex EDM (Coltene, Switzerland) with a speed of 500rpm and torque of 2.5N/cm up to the 5mm inside canal.
The RPM, torque & depth of insertion for coronal flaring were set as per the manufacturer's guide. The files and drills were used with a gentle brushing motion using a endodontic motor with gear reductionand torque control. The canals were irrigated with 2ml of 3%NaOCl and 17% EDTA between each instrumentation followed by final rinse with normal saline.

EXAMINATION:

After preflaring the roots were sectioned using low speed water cooled saw (Diamond disc and Mandrel – Axiss Dental) perpendicular to long axis at 1mm, 2mm, 3mm, 4mm and 5mm from CEJ.. The slices were then examined under stereomicroscope (Leica Macrosystems, Mannheim, Germany) at ×40 magnification and digital images were captured. Each section was examined by two operators to detect the presence of root dentin cracks. The sections were kept in saline to prevent dehydration between the procedures.

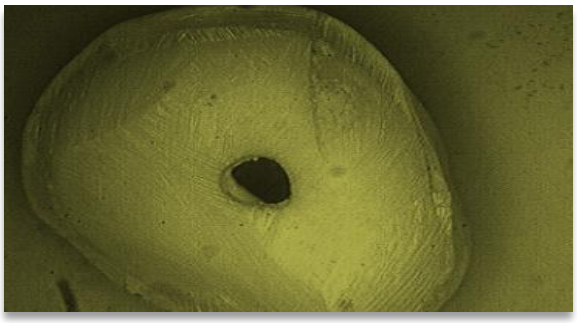


Image 1 showing the stereomicroscopic view of dentinal cracks for the control group

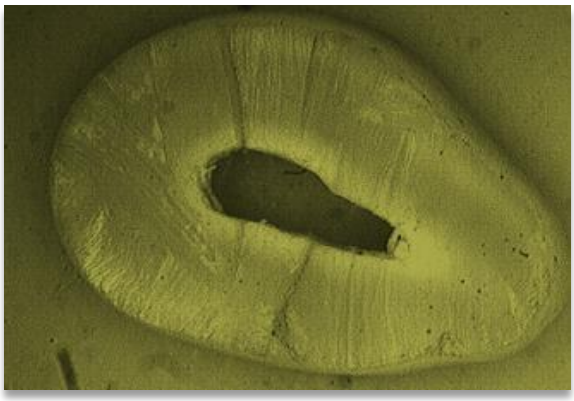


Image 2 showing the stereomicroscopic view of dentinal cracks for the Group 2: Gates Glidden Drills

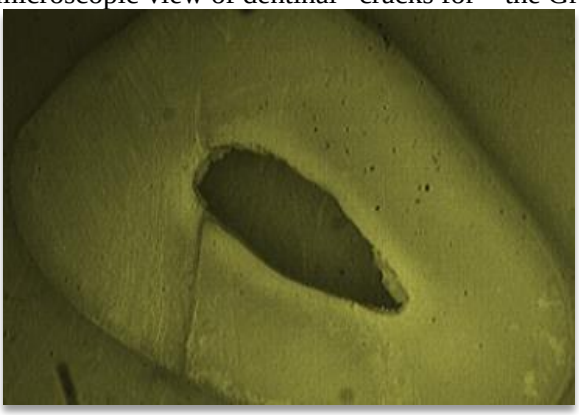


Image 3 showing the stereomicroscopic view of dentinal cracks for the Group 3: Protaper Universal

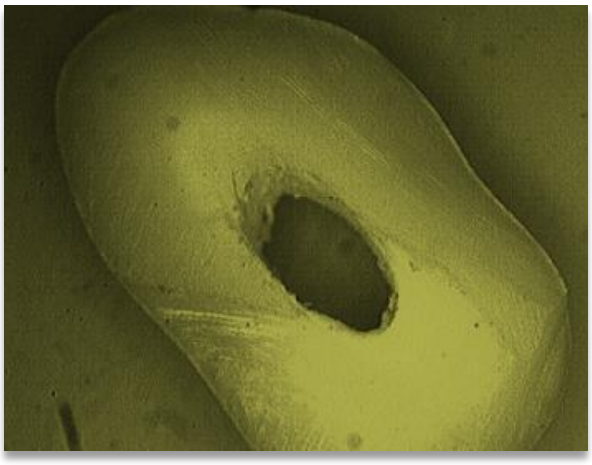


Image 4 showing the stereomicroscopic view of dentinal cracks for the Group 4: Hyflex ED

STATISTICAL ANALYSIS

Tabulated data were analyzed in SPSS version 22. The intergroup comparison was done using Chi square test.

The inter group differences in crack formation were analyzed using chi -square test at p value <0.05).

RESULTS

Table 1: Number of roots with crack and crack percentage

Group	Specimen with cracks		p value
	N	%	
Control	2	20	0.038*
Gates Glidden Drills	6	60	
Protaper Universal	3	30	
Hyflex EDM	2	20	

Table 2: Number of sections with cracks at each level

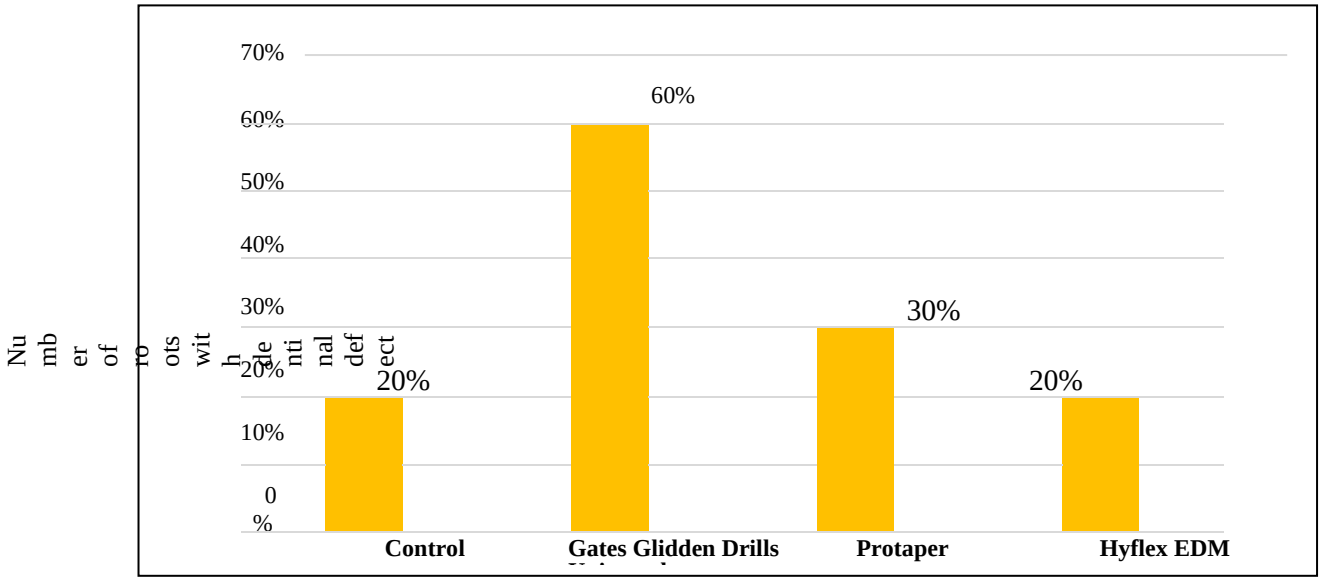
Group	1 mm		2 mm		3 mm		4 mm		5 mm		p value
	N	%	N	%	N	%	N	%	N	%	
Control	1	10	2	20	1	10	1	10	0	0	0.041*
Gates Glidden Drills	4	40	4	40	4	40	3	30	2	20	
Protaper Universal	1	10	3	30	1	10	1	10	0	0	
Hyflex EDM	2	20	1	10	1	10	1	10	0	0	

Table 3: Comparison between the groups

Group	Control	Gates Glidden Drills	Protaper Universal	Hyflex EDM
Control	-	S	NS	NS
Gates Glidden Drills	S	-	S	S
Protaper Universal	NS	S	-	NS
Hyflex EDM	NS	S	NS	-

S: Significant at p<0.05; NS: Not Significant at p<0.05, Chi-square test

Figure 1: Number of roots with cracks according to the groups



The control group had 20% crack formation , Gates Glidden Drills had 60% Crack formation , Protaper Universal had 30% and Hyflex had 20%cracks.

200 slices were totally examined.

Table 1: summarizes cracks observed for all groups. Gates Glidden drills had higher number of cracks, when compared with the control group ($P < 0.05$). Corona flaring with the protaper universal and Hyflex instruments had reduced rate of crack formation same as that of control ($P > 0.05$).

Table 2: summarizes the number of slices with cracks at each millimeter section for all the groups. Number of cracks at 1mm in control was 1, whereas in gates glidden - 4, Protaper Universal -1 and in Hyflex EDM - 2. At 2 mm, number of cracks in control - 2, gates glidden - 4, Protaper Universal- 3 and in Hyflex EDM-1. Likewise, at 3mm, number of cracks in control - 1, gates glidden - 4, Protaper Universal- 1 and in Hyflex EDM - 1. At 4mm, number of cracks in control was 1, gates glidden - 3, Protaper Universal- 1 and in Hyflex EDM - 1.

At 5mm, no cracks were found in control, Protaper Universal and Hyflex EDM whereas in gates glidden - 2 cracks were found.

Table 3: summarizes the comparison between the groups.

DISCUSSION

A promising endodontic treatment depends how root canals cleaned and shaped afore obturation. The biomechanical preparation at the apical area of the root canal has always been discerning[16]. The instrument binding method does not provide a precise method for evaluating anatomical diameter at the working length. Coronal preflaring of the canal at the cervical and middle third has helped in the determination of the anatomical diameter and the type of instrument also play a significant role[17,18]. As suggested by Leeb, be whatever the method used, coronal preflaring, removes the premature contacts of the instrument with the canal irregularities. This helps a file progress towards the apex more easily[19].

Coronal preflaring can be attained manually or by mechanical means. Mechanical preflaring though less time consuming, is accompanied by a number of complications. Inappropriate use of sizes can result in lateral perforations, ledges and instrument separations[20].

Vertical root fracture is the most common complications associated with the mechanical shaping of the root canal systems which leads to the tooth loss[21]. Wu et al.,[22] stated GG drills might affect the thickness of dentin and increase the risk of perforation while instrumentation. During instrumentation with nickel–titanium

rotary instruments, a varied rotational force is applied on the root dentin that leads to crack formation of in the root dentin[8]. The instruments used for coronal flaring have more thickness, have more contact with the root canal dentin which creates momentary stress concentration[7]. The microcracks and craze lines formed by the coronal preflaring weakens the peri-cervical dentin[23].

In this study, Rotary instruments of various sizes and taper have been used- the GG drills, Protaper Universal and Hyflex EDM. Each system is associated with unique design feature and a distinct preparation technique. All instruments have been used as per manufacturer's instructions for each system.
Several studies have been conducted on dentinal cracks incidence and assessment of relation between crack formation and file type and instrumentation technique[7,24,11]. In this study we have assessed the dentinal cracks caused by Gates Glidden Drill, Protaper universal and Hyflex EDM under stereomicroscope at 40X magnification. Freshly extracted single rooted premolars have been used, as they are probably more prone to forces of instrumentation because of their smaller dimension and thin dentinal walls.
Research works of Toure et al[7] and Yoldas et al[23] stated that dentinal cracks were not present in the teeth instrumented with hand files. The rotary and reciprocating instrumentation are known to cause more dentinal cracks because of their properties and motion[18.19].
Various attributes that leads to crack formation are tip design, cross-sectional geometry, constant or variable pitch, and taper, flute form [8]. Arbab et al. reported that canals instrumented with Protaper files exhibited more microcracks than other NiTi instruments because of their large cross-sections, stiffness, and high level of torque and bending force[22].
A canal instrumented with Gates Glidden drills had a high rate of crack formation, preflaring of the root canals using the Protaper universal and Hyflex instruments had less crack formation .The density of cracks assessed at the various level of cut sections at 1mm and 2mm are in the order of Gates Glidden drills > Protaper universal > Hyflex EDM. As per study of Peter et al.
increased rotational speed has increased cutting efficiency[25]. Hyflex EDM have a taper of 0.08 files which are cyclic fatigue resistant with a recommended high speed of 500 rpm. Thus, Hyflex EDM file could have resulted in less cracks than other two files and this may be also due to the manufacturing process.

CONCLUSION

Within the limitation of this study, it was concluded that all the coronal preflaring instruments used in this in vitro test showed dentinal defects, irrespective of design and material. In comparison the Gates Glidden drills produced the highest number of cracks and Hyflex EDM files produced the least number of cracks

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