



An *in vitro* comparative evaluation of dentinal defect formation caused by three different nickel–titanium rotary file systems in permanent mandibular premolar

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Aim: The aim of this study was to assess and compare dentinal defect formation caused by three different nickel–titanium (NiTi) rotary file systems in permanent mandibular premolars.

Materials and methods: Total of 45 extracted mandibular premolars were selected for present In-vitro study. Hyflex EDM rotary files, ProTaper Next, and Waldent Walflex were used to instrument the root canals. With a slow-speed saw and water cooling, all roots were horizontally sectioned at 3, 6, and 9 mm from the apex. To assess whether a crack existed or not, the sections

were examined with a stereomicroscope at a magnification of x 25. The result showing P value ≤ 0.05 was considered statistically significant.

Results: There was a significant higher incidence of microcracks at the 6 mm and 9 mm levels of roots in the all groups ($p < 0.05$). The HyFlex EDM files produced less dentinal defect when compared with the other groups ($P < 0.05$) at 3, 6 and 9 mm.

Conclusion: Within the limitation of this *in vitro* study, it can be concluded that nickel-titanium instruments may cause cracks on the root surface. Hyflex EDM tends to produce less number of cracks as compared to Protaper Next and Waldent Walflex.

Keywords: Dentin Cracks, Hyflex EDM, Waldent Walflex, ProTaper Next.

Introduction: The fundamental goal of endodontic therapy is the eradication of germs from the root canal system, which is accomplished by removing essential tissues, remaining necrotic material, infected dentin, debris, and necrotic material. Using a stainless steel instrument for canal preparation has long been considered the "gold standard" despite the fact that the architecture of root canals in teeth makes endodontic treatment difficult.¹ The effectiveness of irrigation and obturation is decreased as a result, and fewer aberrations, such as ledge and zip formations, canal transportations, and perforations, are also caused by manually preparing narrow, curved canals with stainless steel files because it takes time and effort and only results in limited apical enlargement.²

The nickel-titanium (NiTi) files were first used in endodontics in 1998, and since then, they have experienced numerous improvements in terms of both design and idea for root canal instrumentation.³ Because of their extreme flexibility, motorised NiTi tools can be utilised to instrument root canals more quickly and with a lower incidence of canal transportation.⁴ Numerous microscopic studies have suggested that using rotary and reciprocating files can cause dentinal defects. In part, the goal of chemo-mechanics root canal preparation is to avoid the dentin's potential for dentinal defect due to the use of rotary or reciprocating files.^{5,6}

In mandibular premolar teeth, the likelihood of an oval canal is greater if there is just one canal. The currently used rotary/reciprocating NiTi endodontic files result in a circular preparation for irregularly shaped root canals. A round canal preparation in an oval canal decreases the remaining dentin thickness and increases the susceptibility to fracture.⁷

Present study was conducted to evaluate and compare dentinal defect formation caused by HyFlex EDM (HEDM; Coltene/Whaledent, Switzerland) ProTaper NEXT (PTN; Dentsply Sirona, Ballaigues, Switzerland) and Waldent Walflex files (Waldent, India).

Material and Method: Freshly extracted permanent mandibular premolars were collected for the present In-Vitro Study. To remove soft tissue, debris, or calculus deposits, teeth were cleaned using an ultrasonic scaler and then kept in distilled water. Radiovisiography was used to evaluate and assess the premolars. For this investigation, 45 single-rooted premolars with a single root canal and no abnormalities were chosen. Teeth with calcified canals, excessively broad canals, severely curved roots, presence of external or internal resorption, developmental anomalies, fractured roots, restored roots, and teeth that had previously undergone for endodontic treatment were excluded from the study.

A diamond disc was used to decoronate the teeth, leaving roots that were around 16 mm long. A no. 10 K-File (Mani, Japan) in the canal was used to determine the canal's patency. The specimens were evenly split into three groups after determining the patency.

In group I (Protaper Next), The instrumentation sequence was Path file P1, P2 followed by shaping file X1, X2 corresponding to apical size #25. The instrumentation was done to full length using an outward brushing motion. Speed used was 300 rpm and torque was 2 Ncm.

In Group II, a Hyflex EDM orifice opener to widen the opening, we followed the manufacturer's recommendations and inserted a Hyflex EDM glidepath file to the desired operating length. The canal was shaped to its full working length using a single Hyflex EDM file, rotated at 500 RPM with a torque of 2.5 Ncm, and moved gently in and out.

In Group III (Waldent Wal flex files) used W1 (17/0.08), W2 (19/0.02), W3 (20/0.04), W4 (20/0.06), and W6 (25/0.06) in order with torque of 1.8-3 Ncm and 300 rpm rotation. During the biomechanical preparation irrigation was carried out with 5.25% sodium hypochlorite (NaOCl).

Horizontal sectioning of all the roots was carried out at 9 mm (coronal), 6 mm (Middle), and 3 mm (Apical) using a diamond disk under water cooling. These sections were individually observed under stereomicroscope at $\times 25$ magnification, and photographs were taken using a digital camera. A crack is a flaw that starts in the inner root canal space and spreads to the outside of the tooth. All other flaws were not caused by the canal wall, like craze lines, which

were not considered cracks. i) No defect-root dentin free from crazelines or defects on the root surface (inner and outer). ii) Defects- all lines and cracks observed, which were extended to the external root surfaces. Chi Square were used to analyze the data. The result showing P value ≤ 0.05 was considered statistically significant.

Result: There was a significant higher incidence of microcracks at the 6 mm and 9 mm levels of roots in the all groups ($p < 0.05$). The HyFlex EDM files produced less dentinal defect when compared with the other groups ($P < 0.05$) at 3, 6 and 9 mm.

Section	Score	Groups			P Value
		Protaper Next	Hyflex EDM	Waldent Wal Flex	
9mm	No Defect	14 (93.3)	14 (93.3)	13 (86.7)	<0.05
	Defect	1 (6.7)	1 (6.7)	2 (13.3)	
6mm	No Defect	13 (86.7)	14 (93.3)	12 (80)	<0.05
	Defect	2 (13.3)	1 (6.7)	3 (20)	
3mm	No Defect	11 (73.3)	12 (80)	10 (66.6)	<0.05
	Defect	4 (26.6)	3 (20)	5 (33.3)	

Discussion: The purpose of root canal instrumentation is to keep the original anatomy and canal course while removing diseased tissues and shaping the root canal into a smooth conical lumen.⁸ The instrumentation procedure is a crucial stage that can impact the outcome of endodontic treatment. Inadequate instrumentation can result in issues including dentinal cracks and root fractures as well as mistakes such canal stripping and preformation.⁹ In addition to iatrogenic causes, it has been shown that parameters like file design and the alloy used to make these files have a direct bearing on the frequency and severity of such errors and problems.¹⁰

When the tensile stress limit of dentine is exceeded by stresses applied to a dentinal wall, dentinal defects result. Manufacturers have created files with asymmetrical cross sections, files with varying tapers, and files with alternate contact edges in an effort to lessen these stresses. These designs might lessen the file's tendency to screw into the canal, which would lessen the tensile pressures acting on the dentinal wall. Protaper Taper Next, files with asymmetrical

rectangular cross sections are created, together with progressive and regressive tapers and two-point contacts with the canal wall.^{11,12}

Waldent Walflex files are rotary files that are very flexible, less likely to wear out from repeated use, better at cutting, have a triangular cross-section, and have sharp cutting edges.¹³ HyFlex EDM files are manufactured via electro-discharge machining technology using controlled memory alloy and have continuous rotation motion and remarkably enhanced mechanical properties.^{14,15} Hence the present study was conducted to evaluate and compare dentinal defect formation caused by HyFlex EDM, ProTaper NEXT and Waldent Walflex files.

Mandibular premolars that had recently been extracted were chosen for this investigation because of their vulnerability to instrumentation stresses due to their tiny size and delicate dentinal walls. The teeth were also simple to obtain because they had closed apicals and had been extracted for orthodontic treatment.

In present study it was found that Hyflex EDM tends to produce less number of cracks as compared to Protaper Next and Waldent Walflex.

The Hyflex EDM is a continuous rotation single file system produced by EDM. The EDM process results in extremely flexible and fracture-resistant files. The built-in shape memory prevents stress during canal preparation by changing their spiral shape and following the anatomy of the root canal, thus preventing the formation of microcracks and root dentin defects. The higher incidence of cracks in ProTaper Waldent Walflex next can thus be attributed to its relative stiffness which led to more stress generation and concentration of stress, especially in the apical root area with subsequent crack initiation as compared to other rotary NiTi systems used in this study. Highly flexible endodontic instruments were associated with fewer dentinal defects since the high flexibility of the alloy generates not only less stresses on the root canal walls but also less pressure during instrumentation.¹⁵

This finding is in accordance with the findings of Devi TP et al.¹⁶ Pedullà et al.,¹⁷ Pereira et al.,¹⁸ and Peters et al.¹⁹ concluded in their respective studies that endodontic instruments manufactured with M-wire alloy and CM NiTi exhibit more flexibility than conventional NiTi rotary instruments. Since Hyflex EDM instruments are manufactured from M-wire alloy, they exhibit high flexibility and would have thus contributed to a lesser number of cracks.

Conclusion: Within the limitations of the present study, it can be concluded that

1. The defects were present more in the apical third (3 mm) and 6 mm (middle third) compared to 9 mm (coronal third) sections.
2. Hyflex EDM tends to produce less number of cracks as compared to Protaper Next and Waldent Walflex.

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