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Research Article

EVALUATION OF DENTINAL DAMAGE CAUSED BY DIFFERENT ROTARY NITI SYSTEMS DURING ROOT CANAL PREPARATION: AN INVITRO STUDY

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ABSTRACT

Objective - To compare the incidence of dentinal cracks caused by rotary NiTi instruments using ProTaper Next, 2 Shape (2S) and Neolix systems after root canal preparation.

Materials and Method – Forty five freshly extracted mandibular premolars were obtained and randomly divided into three experimental groups (n=15). Group I- BMP done with ProTaper Next (PTN) files; Group II – BMP done with 2Shape (2S); Group III – BMP done with Neolix files. The roots were then sectioned horizontally at 3mm (coronal), 6mm (middle) and 9mm (apical) from the apex. The slices were viewed under stereomicroscope. The presence of dentinal defects was noted. Data were analysed using non parametric Chi square test and Kruskal-Wallis test.

Result – There was statistically significant difference amongst the three groups ($p \leq 0.05$) when compared in apical third, with maximum number of cracks in Group III. In middle third, maximum cracks were seen in Group III followed by Group II and Group I. The difference was statistically non-significant ($p > 0.05$). In coronal third non-significant ($p > 0.05$) difference was observed between Group II and Group III with more cracks in the latter. No cracks were observed in Group I group for coronal third.

Conclusion- 2 Shape files show lesser cracks than Neolix & more than PTN system. Pro Taper Next system showed least cracks and was found to be better than other file systems.

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INTRODUCTION

Emergence of NiTi rotary instrumentation has created a revolution in the field of endodontics. Preparation of canal system is one of the most important facts of the triad of root canal therapy. The primary aim of chemomechanical preparation involves the pulp extirpation, complete elimination of microorganisms, and preservation of original canal anatomy for adequate obturation.¹

Improvements in design concepts and kinematics of different rotary NiTi files have led to easier and better root canal shaping and lesser chances of ledge formation & canal transportation.² However, instrumentation with these rotary NiTi files having larger taper & active cutting edges tends to produce significant forces leading to dentinal defects that may lead to potential root fracture.³

ProTaper Next (PTN; Denstply, Maillefer), the successor of ProTaper Universal files systems that were reported to create

more dentinal damage owing to its large taper and removal of substantial amount of dentin. (Pratik 2015) The PTN system with its asymmetric square cross-section consists of X1(17/.04), X2 (25/.06), X3(30/.07), X4 (40/.06) and X5(50/.06). The PTN was reported to cause less dentinal damage than ProTaper Universal system.³

Single file rotary systems have been recently launched to complete the canal preparation with a single file. This was introduced with an intention to reduce the number of files & relieve the stress that could be created with it.¹ The 2Shape system (TS; Micro Mega) with its asymmetric triangular cross-section is composed of TS1 (25/0.4), TS2 (25/.06), F35 (36/.06) and F40 (40/.04) files.⁴

Neolix (Orikam) having a rectangular non-similar cross section all along its length gives suitable flexibility to the instrument resulting in more efficient preparation of curved canals while preserving the initial anatomy of the root canal. This system consists of A1 & C1 where in the C1 is used for flaring of

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coronal aspect of the root canal { 25 / 0.12, length -15mm. A1 available as 20/0.08 , 25/0.08 and 40/ 0.08 is used for the preparation of the apical aspect of the canal.²

Hence the purpose of this study was to evaluate and compare the dentinal microcracks observed after root canal preparation with ProTaper Next, 2Shape and Neolix rotary file systems.

MATERIALS AND METHODS

Forty-five freshly extracted human mandibular premolars having straight roots extracted for orthodontic purposes were selected and stored in distilled water to prevent dehydration. Radiographs were taken to confirm the presence of single canals. Teeth with open apices, fractures, internal resorption or complex canal anatomy were excluded from the study. The root surfaces were examined under stereomicroscope to exclude the external defects and cracks.

The coronal portions of all teeth were removed with diamond disk, establishing a standardized root length of 16 mm. Working length was determined by inserting a size 10K-file (Dentsply, Maillefer) into the canal until the tip was visible in the apical foramen and subtracting 1mm from it. A glide path preparation was done by 15 K file. Apical preparation was completed with size 25 instrument of each system. The specimens were randomly divided into three experimental groups (n=15) The groups are, Group 1 (n = 15) Protaper Next Rotary System (PTN) (Dentsply); Group 2 (n =15)2-Shape (TS) (Micromega) and Group 3 (n =15) Neolix (Neolix,Orikam).

ProTaper Next(PTN): The root canals were instrumented using Protaper Next files at a speed of 300rpm and 2Ncm torque. The sequences were Sx, X1(17/0.04) and X2(25/0.06) in a brushing motion

Shape (TS): The canals were prepared using TS1 (25/0.04) and TS2 (25/0.06) at 300rpm and a torque of 1.2Ncm in a brushing motion

Neoniti: Initially C1 (25/0.12) was used for opening and widening of coronal portion of canal. A1 file was used for the preparation of apical portion.A1 comes in three different sizes, in our study we have used 20/0.06 and 25/0.06 at 300 rpm and torque of 1.5Ncm in brushing motion.

Each canal was irrigated with 2ml of 3% sodium hypochlorite solution between each instrument using EndoActivator (Dentsply). 2ml of distilled water was used for final rinse of each canal.

Sectioning and Microscopic Evaluation

All specimens were sectioned perpendicular to the long axis at 3, 6 and 9 mm from apex using a low speed saw under water cooling. Slices were observed under stereomicroscope (Wuzhou New Found Instrument Co. Ltd, China) at magnification (10X) and pictures were taken. The images were analyzed using Image analysis software (Chroma Systems Pvt. Ltd, India)

Assessment of Dentinal Damage

To define crack formation, 2 different scoring criteria were made. ‘No defect’ was defined as root dentin devoid of any microcracks or craze lines either at the internal surface of the

root canal wall of the external surface of the root. ‘Crack’ was defined as all lines, microcracks or fractures observed on the slice that extended from the root canal lumen to the outer surface or from outer root surface into the dentin.

Statistical Analysis

The results were expressed as the number and percentage of cracked roots in each group. The data were analysed using Chi square test and Kruskal-Wallis test .The statistical analysis were performed using SPSS 20 software (SPSS Inc. Chicago) and p> 0.05 was considered as the level of significance.

RESULTS

Dentinal microcracks were obtained in all three groups. Neolix has produced maximum cracks at all three levels (71.50%), followed by 2S (68.70%) and minimum cracks were observed with PTN (62.50%).(Table 1) There was statistically non-significant difference observed in apical third between PTN, 2S and Neolix (p=0.40). In middle third non-significant differences were observed in all the three groups (p>0.05). No microcracks were observed in coronal third for PTN. Non-significant differences were obtained between 2S and Neolix in coronal third (34.7% for Neolix, 28.7% for 2S). In apical third PTN showed 46.7% of cracks, 2S showed 53.3% and Neolix showed 60% cracks. (Table 2)

Table 1 Percentages of Cracks obtained in the specimen using three file systems

File system	N	Coronal	Middle	Apical
Protaper Next	15	0%	40%	46.7%
2Shape	15	28.7%	46.7%	53.3%
Neolix	15	34.7%	53.3%	60%

Table 2 Inter group comparisons for cracks in three groups

	Group	N	Mean percentage	p Value
Cracks obtained	Group I	15	62.50%	0.40 (NS)
	Group II	15	68.70%	
	Group III	15	71.50%	



Figure 1 Microcracks in Middle Portion in Different Groups

DISCUSSION

The goal of endodontic treatment should be preservation of the course of canal and complete disinfection of the root so as to avoid the loss of tooth. Complication resulting from failure to avoid mechanical stress during canal preparation may result in vertical root fracture (VRF) and ultimately tooth loss.⁵Onnink *et al.* were the first to report dentinal defects as a consequence of canal preparation. These microcracks may develop into fractures following procedures which are preparation, obturation & retreatment or by repeated stress ofocclusal forces.⁶It has been suggested that fractures did not occur

immediately after mechanical preparation but craze lines appear in 4%-16% which may result in fracture.⁷

With the revolution of endodontics, the Ni-Ti files have been evolved for both hand and rotatory instrumentation.⁸ Studies have shown that defects appear on root dentin wall after the initial treatment with Ni-Ti rotary instruments. Increased risk of fracture during or after endodontic therapy may be due to variety of factors such as tooth type, canal wall thickness, root canal diameter, cross sectional shape, root canal preparation instruments and preparation methods.⁸The present study was done to evaluate the dentinal damage caused by three Ni-Ti systems, ProTaper Next, 2Shape (2S) and Neolix systems after canal preparation.

Protaper Next has unique features of variable taper, off-centered rectangular cross section and M-wire NiTi material.⁹The offset cross-sectional design of the instrument provides rectangular cross section that consequently generates a swaggering motion. This reduces screwing effect and dangerous taper lock. Increased flexibility due to M-wire NiTi material exerts lesser effect force on canal walls and cause less cracks.³The present study showed fewer cracks in the root canal with no cracks seen in the coronal third. This was in accordance to study done by Mavani *et al*³ and Das *et al*.⁵ The middle third showed fewer cracks when compared to apical third of the examined specimens, which is again in accordance with the study done by Mavani *et al*³ and Das *et al*.⁵

2Shape is a T wire alloy. The files have a triple helix cross section with two main cutting edges and one secondary cutting edge. This allows for increased efficacy of the circumferential brushing movements for efficient selective cleaning.¹⁰Microcracks are observed in apical, middle and coronal third for 2S system in the present study. This observation coincides with studies done by Sahni *et al*¹¹ and Staffoli *et al*⁴ in which were observed most in apical third decreasing in middle and coronal third.

Neolix has a non-homothetic rectangular section along the blade enabling a progressive flexibility to better negotiate the curves and respect the canal anatomy. It has an inbuilt abrasive property flutes and edges associate a grater and cutting action thus avoids smear layer formation.¹¹The maximum were seen in apical third. The middle and coronal third showed lesser cracks as compared to apical third. This observance was in accordance to that obtained by Harandi *et al*² and Sahni *et al*.¹¹ The microcracks were obtained for all three groups. When intergroup comparison was done, the apical third showed more significant cracks in Neolix when compared to Protaper Next and 2Shape. The middle third showed cracks in all three groups with no significant differences amongst the three. The coronal third showed no cracks in Protaper Next. However cracks were seen for both 2Shape and Neolix but the difference was statistically non-significant. This was in accordance with Sahni *et al*¹¹ and Mavani *et al*.³

There is a high prevalence of VRF is seen in case of mandibular premolars and they bear a very high occlusal load during mastication.¹¹Hence it was chosen for the study. Since micro cracks were seen in all groups it could be concluded that none of the systems could prevent micro crack formation.¹² No previous study has been conducted regarding comparison of 2 shape system, Protaper Next and Neolix system according to

our literature search. The speed and torque of each system varies, inability to standardize the force applied during apical movement of the instrument were the limitations of the study.

CONCLUSION

Within the limitation of the study, amongst the groups, ProTaper Next system showed least cracks in rotary motion & was found to be better than other single file systems. Higher number of micro-cracks in the Neolix group may be the result of the sudden stress that is initially applied to dentinal walls. 2 Shape files show lesser cracks than Neolix and more than PTN.

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