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"Does The Pecking Depth Influence The Rotary Ni-Ti Files During Pecking Motion??" - An in Vivo Study

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Abstract **Original Research Article**

A contact is established in between dentin surface and instrument inside the root canal, during cleaning and shaping. This creates a reaction torque in the instrument affecting its life span and also produce internal stresses in the dentin.Pecking motion,an in and out motion of instrument help in neutralizing these stresses.Different pecking depths affect the screw in forces generated in the instrument in different ways.Hence,the aim of this study was to evaluate the effect of various pecking depths of a rotating endodontic file on the screw-in forces generated while cleaning and shaping invivo. A total of 90 patients were selected and divided in to 6 groups. Cleaning and shaping was done by using Protaper Universal, Heroshaper and Two shape files with pecking depths of 4mm and 2mm.File distortion was seen under stereomicroscope. Scores were given and statistically analysed by Kruskal-Wallis test and Mann-whitney test. It was concluded that shorter pecking depth may cause lower file deformation when compared to longer pecking depth.

Keywords: Pecking motion, Pecking depth, Screw in forces, Stress generation on endodontic file, Endodontic file distortion, Two shape file, Heroshaper, Protaper universal.

INTRODUCTION

NiTi files are commonly used rotary systems by virtue of special properties such as superelasticity, shape memory and their superior shaping abilities compared to stainless steelfiles[1,2]. An important criterion during root canal treatment is proper preparation of root canal and apical foramen. Many stresses are developed in files due to contact between instrument and dentin [3,4]. Flexural and torsional stresses are elicited in file due to work hardening and metal fatigue, especially at maximum curvature of curved canals [5].

Manufacturers claim enhanced features in ProTaper Universal rotary files making them a state of the art in rotary file technology with convex, triangular cross section and variable helical angle [8]. Hero shaper shows a triple helical cutting edge with an inactive cutting tip [6]. MICRO-MEGA introduced "Two Shape" file with asymmetrical cross section and two cutting edges to reduce the risk of instrument fracture. But, NiTi instruments undergo impetuous failures without any distinguishable sign of plastic deformation [7].

"Screw in tendency", is a drawback of rotary instrumentation. It is affected by flute, pitch and cross sectional geometry of the file. It can be harmonized with pecking motion (an in-and-out movement) which significantly extends the life span of the instrument.8 It helps regularly disengaging the instrument and help return to its normal state before continuing the preparation [9]. It also reduces the stress on the file and help in better control of the rotational speed and torque.

Ha *et al*. evaluated the effect of different pecking depths on the stress generated by the screw-in forces of a rotating endodontic file in simulated canals and concluded that the shorter pecking depth may generate lower overall stresses for the root dentin as well as the instrument. So far, little information is available in relation between file deformity and pecking depth of the file in the literature. Hence, the aim of the study is to evaluate the effect of different pecking depths on the deformation of different rotary Ni-Ti files in rotary motion invivo.

MATERIALS & METHODOLOGY

Materials used in the study are

1. Lignocaine anaesthetic solution(Lignox) (Figure I)

2. Disposable syringe,(Dispovan,21gauge) (Figure II)
3. Endoprep RC,(Anabond) (Figure III)
4. 5% Sodium hypochlorite, (Figure IV)
5. Normal saline, (Figure V)
6. Protaper Universal file system,(Dentsply) (Figure VI)
7. Heroshaper file system,(Micromega) (Figure VII)
8. Two shape file system,(Micromega) (Figure VIII)
9. 10K and 15K hand files(Mani).
10. X- smart (Dentsply mallifer). (Figure IX)
11. Stereomicroscope for files examination.

The clinical study protocol was reviewed and approved by the Ethical Committee of Mamata dental college. Written informed consent was obtained from the participants. A total of 90 patients were selected for this in vivo study.The study subjects were recruited from a pool of patients referred to Department of Conservative Dentistry and Endodontics, Mamata Dental College, Khammam. Mandibular first and second molar teeth with 30° degree curvature were selected through radiographic observation in patients and divided into 6 groups based on type of file system and pecking depth used. Angle of curvature was assessed with Schneider's method.

The groups were as follows
- Group 1- Protaper universal files with 4mm pecking depth (n=15).
- Group 2 - Protaper universal files with 2mm pecking depth (n=15).
- Group 3 - Heroshaper files with 4mm pecking depth (n=15).
- Group 4 - Heroshaper files with 2mm pecking depth (n=15).
- Group 5 - Two shape files with 4mm pecking depth (n=15).
- Group 6 -Two shape files with 2mm pecking depth (n=15).

Before the experiment, all the files were observed under the stereomicroscope, to rule out any visible defect in the files (Figure XI to XVIII). Local anaesthesia was administered to all patients (Figure IXX). Access opening was done under rubber dam isolation (Figure XX). Working length was determined with 15k file by using radiogaraphic analysis and glide path preparation was done (Figure XXI). Bio mechanical preparation done in all groups with the given files,accordingly (Figure XXII).

In 4mm pecking depth group, the files penetrated 4mm deeper into the apical direction in each pecking motion i.e, 6mm forward and 2mm backward. Similarly, in 2mm pecking depth group, 6mm forward and 4mm backward movements resulted in 2mm pecking depth. (Figure XXIII).After biomechanical preparation, files were examined under stereomicroscope for any distortion. (Figure XXIII to XXIX).

The following score was given according to the degree of deformation or defects, based on Sotokova classification given in 1988:-

1. No changes
2. Bent instrument.
3. Tip deformation.
4. Straightening
5. Cutting edge changes
6. Reverse twisting
7. Change in length
8. Fracture of file.

STATISTICAL ANALYSIS

Statistical analysis was done between six groups using the Kruskal-Wallis test and multiple groups using the Mann–Whitney test with the help of Statistical Packages for Social Sciences version 18.0 (SPSS Inc., Chicago, USA). Level of significance is set as $p<0.05$ (Tables I,II,III).

RESULTS

Table -1 show different types of defects in different file systems. Both Heroshaper and Two shape shows maximum defects at 4 mm pecking depths but only two shape file system shows bent type of defects.

Table-2 shows Kruskal-Wallis test, applied for different types of defects .Both total defects in all file systems and bent defects shows significant difference 0.024, 0.003 respectivley.

Table-3 shows Mann-Whitney test, applied for defects which gave significant difference in Kruskal-Wallis Test. In case of total defects, significant difference was noticed between Protaper (4mm), Two shape (2mm) systems, which is 0.017.Heroshaper (4mm) group and Two shape(2mm) systems have shown a significant difference of 0.006 .Two shape (4mm) group and Two shape 2mm group have shown 0.019 difference..Thus, 4mm pecking depth group has shown more defects than 2mm groups.

In case of bent defect, significant difference was noticed between Protaper (4mm) group and two shape (4mm) group which is about 0.022. Pro taper 2mm group and two shapes 4mm group have shown 0.022 differences.

Fig-I: Lignocaine anaesthetic solution

Fig-II: Disposable syringe

Fig-III: Endoprep Rc

Fig-IV: Sodium hypochlorite

Fig-V: Normal saline

Fig-VI: Protaper universal file system

Fig-VII: Heroshaper file system

Fig-VIII: Two shape file system

Fig-IX: 10 K & 15 k files

Fig-X: X smart

Steriomicroscopic examination prior to experiment

Protaper universal file system

Fig-XI

Fig-XII

Fig-XIII

Heroshaper file system

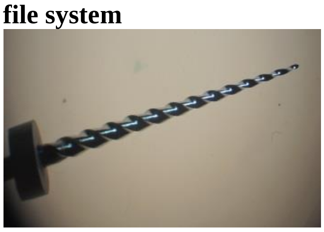

Fig-XIV

Fig-XV

Fig-XVI

Two shape file system

Fig-XVII

Fig-XVIII

Fig-IXX: Local anaesthesia administration

Fig-XX: Access opening

Fig-XXI: Working length determination

Fig-XXII: Biomechanical preparation

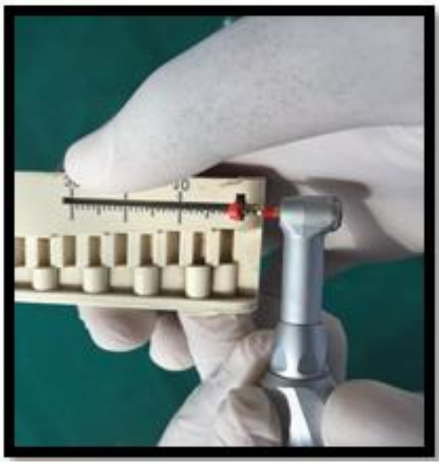

Fig-XXIII: Pecking depth adjustment

Steriomicroscopic examination after experiment

Protaper universal file system

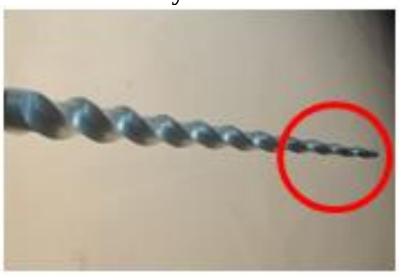

Fig-XXIV: Cutting edge changes

Fig-XXV: Straightening

Heroshaper file system

Fig-XXVI: Straightening

Fig-XXVII: Tip changes

Two shape file system

Fig-XXVIII: Tip changes

Fig-XXIX: Bent

Tables-I: Different types of defects in different file systems

Group	Total no of files	Number of files with defects	Number of files without defects	Bend (%)	Tip changes (%)	Straightening (%)	Cutting edge changes (%)	Partial reverse twisting (%)
1.Protaper 4mm(P4)	15	13 (86.6%)	2(13.4%)	-	6 (40%)	3 (20%)	4 (26.6%)	--
2.Protaper 2mm(P2)	15	10 (66.7%)	5 (33.3%)	-	3 (20%)	2 (13%)	5 (33.33%)	-
3.Heroshaper 4mm(H4)	9	9(100%)	-	-	5 (55.55%)	2 (22.22%)	2 (22.22%)	-
4.Heroshaper 2mm(H2)	9	7 (77.77%)	2 (22.23%)	-	3 (33.33%)	-	4 (44.44%)	-
5.Twoshape 4mm(T4)	6	6(100%)	-	2 (33.33%)	4 (66.66%)	-	-	-
6.Twoshape 2mm(T2)	6	2 (33.33%)	4 (66.67%)	-	2 (33.33%)	-	-	-

Table-II: Kruskal-Wallis test

Defect	Groups	Chi-Square	P value
Any Defect	Group 1 to 6	12.907	0.024*
Bend	Group 1 to 6	18.310	0.003*
Tip Change	Group 1 to 6	5.385	0.371
Straightening	Group 1 to 6	4.718	0.451
Cutting Edge change	Group 1 to 6	6.322	0.276
Partial Reverse Twisting	Group 1 to 6	0.000	1.000

Table-IIIa: Mann-Whitney test for any defect

Defect	Groups	Z value	P value
Any defect	Group P4 vs P2	1.273	0.203
	Group P4 vs H4	1.120	0.263
	Group P4 vs H2	0.554	0.580
	Group P4 vs T4	0.918	0.359
	Group P4 vs T2	2.385	0.017*
	Group P2 vs H4	1.906	0.057
	Group P2 vs H2	0.568	0.570
	Group P2 vs T4	1.581	0.114
	Group P2 vs T2	1.361	0.174
	Group H4 vsH2	1.458	0.145
	Group H4 vs T4	0.000	1.000
	Group H4 vs T2	2.763	0.006*
	Group H2 vs T4	1.198	0.231
	Group H2 vs T2	1.663	0.096
	Group T4 vs T2	2.345	0.019*

Table-IIIb: Mann-Whitney test for bent defects

Bend	**Group P4 vs P2**	**0.000**	**1.000**
	Group P4 vs H4	0.000	1.000
	Group P4 vs H2	0.000	1.000
	Group P4 vs T4	2.294	0.022*
	Group P4 vs T2	0.000	1.000
	Group P2 vs H4	0.000	1.000
	Group P2 vs H2	0.000	1.000
	Group P2 vs T4	2.294	0.022*
	Group P2 vs T2	0.000	1.000
	Group H4 vsH2	0.000	1.000
	Group H4 vs T4	1.797	0.072
	Group H4 vs T2	0.000	1.000
	Group H2 vs T4	1.797	0.072
	Group H2 vs T2	0.000	1.000
	Group T4 vs T2	1.483	0.138

DISCUSSION

Walia *et al*. introduced NiTi instruments in 1988, which are considered to have superior properties that assist clinician to reduce procedural mishaps[10] File fractures ,still, are persistant as they can undergo unexpected without caution,within elastic limit[2]. File separation is an enigmatic incident resulting in underfilling of root canal followed some times by treatment failure especially in curved canals [11]. The files which are made by NiTinol alloy have 2 to 3 times more elastic flexibility in bending and superior resistance to torsion compared to stainless steel files [12].

Sotokawa classified defects of file into mild and severe. Bent instrument/tip deformation, stretching/straightening, cutting edge changes constitute mild deformities while partial reverse twisting ,change in length and fracture of instruments are severe deformities[2]. Sattapan *et al*. Stated that fracture of NiTi files can occur with or without any visible defects of previous permanent deformation [13]. During cleaning and shaping, various stresses cause fatigue on a file which can be either flexural or torsional fatigue [2].

When a file is used in curved canal, each rotation causes an instrument to undergo one complete stress cycle of tension and compression. “Screw in tendency” is an unwanted phenomenon in Niti files which result in file being pulled into the canal during usage[1]. This results in taper lock effect followed by instrument separation [14].

The pecking motion is an in-and-out motion which is intended to be a controlled movement against the screw-in forces (SFs) by the rotating instruments. It is essential for reducing the risk of fracture through distribution of the flexural stress of the instrument. In this study, two different types of pecking depths are used, 2mm and 4mm. According to Ha *et al*. shorter pecking depth of 2mm generated lower stresses for the instrument than 4mm pecking depth [1].

In this study 3 different types of Niti files have been used which are Protaper universal, Heroshaper and Two shape. Protaper has a convex triangular cross section with pitch and helix angle balance. It reduces contact with the canal wall to prevent instrument screwing in to the canal[15]. Heroshaper has triple helix cross section in which the helical angle of the cutting edges varies from the tip to the shank, avoiding screwing effect [6]. Two shape files are made by T wire technology with a proprietary heat treatment process. It has an asymmetrical cross section with two cutting edges that help in reducing the risk of instrument fracture. The spiral cutting edges of the rotary instruments, can cause difficulties for the clinician in making constant pecking depths.This screw-in phenomenon apparently occurs more frequently when using a rotary instrument with active cutting edges[14].

In present study, Heroshaper,Two shape (4mm) pecking depth group, shows maximum defects(100%). Among all the groups, only total defects and bent defects are significant when compared to other defects at 4mm pecking depth. Protaper universal system show less defects when compared to Heroshaper and Two shape file system. A study done by Makade *et al*. stated that Protaper accumulates unfavourable stresses because of its rapid transformation to martensitic phase compared to heroshaper which is contradictory to our study[16]. But according to Gupta *et al*. Protaper showed more cyclic fatigue resistance when compared to Heroshaper[17].

In the present study, two shape file system at 4mm pecking depth show maximum defects compared to 2mm pecking depth. Two shape is a recently introduced file system based on T wire technology,a method which allows an increased resistance to cyclic fatigue and a better negotiation of curvatures[18]. Till now, there are no known studies in the literature about comparing cyclic fatigue resistance regarding this file system. So,further studies are required to confirm our present study results.

CONCLUSION

Shorter pecking depth may cause lower file deformation when compared to longer pecking depth as it improves the life of the file with less risk for fracture.Instrumentation during root canal therapy, sometimes associated with unwanted circumstances. Hence,a successful operator learns from his/her experiences and applies them to future challenges. Ultimately the beneficiary will be the patient,who will receive the best care.

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