ORIGINAL RESEARCH

Assessment of Different File Systems for Working Time Based on Glide Path, Operating Kinetics, and the Fracture Resistance

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Abstract

Aim: This study was done to assess the time to achieve the working distance based on the size of the glide path, operating kinetics, and the fracture resistance of different file systems.

Materials and method: One hundred and eighty mandibular premolars were divided into two groups of 90 each. Group I was subjected to continuous 360° rotary motion and group II to adaptive motion. Twisted File (TF) and Endostar E3 file methods were practiced in groups. The time (seconds) to achieving desired working length was recorded. Failures were classified as torsional failure or flexural failure.

Results: The time taken by glide path size 15 in group I was 5.90 ± 4.06 seconds and in group II was 6.12 ± 4.16 seconds. The time taken by glide path size 20 in group I was 5.86 ± 3.12 seconds and in group II was 4.22 ± 2.10 seconds, with 25 size the time taken in group I was 5.32 ± 2.48 seconds and in group II was 3.16 ± 3.14 seconds. The time taken by group I was less as compared to group II, and the difference was significant ($p < 0.05$). There was a significant difference in time taken with different number files in both groups ($p < 0.05$). The mean time taken reaching the working length for continuous rotation was less as compared to TF adaptive motion; however, the difference was nonsignificant ($p > 0.05$).

Conclusion: We recorded higher instrument separation and deformation with the TF method and adaptive gesture. The TF system showed additional time to achieve the working distance as compared to the Endostar E3 system.

Clinical significance: The TF system showed higher instrument separation and deformation, and it requires additional time to achieve the working distance compared to the Endostar E3 system. Hence, the Endostar E3 system is effective in achieving required clinical results.

Keywords: Endostar E3, Fracture resistance, Glide path, Twisted File system, Working length.

The Journal of Contemporary Dental Practice (2021): 10.5005/jp-journals-10024-3004

Introduction

Invention of rotary files made up of nickel-titanium (Ni-Ti) has revolutionized the field of endodontics. The advancements in their manufacture designs led to improvement in their function in endodontic therapy.[1,2] These changes are capable of ensuring successful root canal preparation, effective, safest, consuming less time, quick method, and comfortable for dentist and patient. These file systems easily follow the curvature of the root canal.[3]

Their formation occurs through conventional machining. Modifications have been done in cross section and cutting surfaces of files.[4] However, in spite of doing modifications in cutting surfaces and cross sections, fracture of files cannot be prevented. The major shortcoming of these files system is generation of fatigue and shear failure resulting from flexural and torsional stresses ultimately causing fracture.[5] Torsional stresses are generated when the tip of the instrument is wider than the diameter of the canal and extensive region of interaction among the cutting edge of the instrument and the canal walls. Development of the glide path before using Ni-Ti files significantly reduces stresses. What should be the glide path size in order to minimize the stress formation is not known.[6]

Presently, numerous instrumentation systems are available in the market. These are manufactured with diverse Ni-Ti alloys and heat-treated or otherwise.[7] They possess superelastic (SE) and shape-memory (SME) properties with rotational or reciprocating kinetics, centric or eccentric motion.[8] The Twisted File (TF) with adaptive motion is used for obtaining better outcomes. Endostar E3 has taper of 8, 6, and 4% having similar three-file sequence as that with TFs.[9] It is available in colors blue, red, yellow, white, green, and black. It has a rounded safe tip, the blade is effective in removing dentin, and the shaft is 13 mm long for better visibility.

TF instruments change to reciprocation mode having designed clockwise (CW) and counterclockwise (CCW) angles that change from 600–0° up to 370–50°. The adaptive motion decreases the chances of intracanal failure.

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How to cite this article: Jena D, Bansal N, Batra D, *et al*. Assessment of Different File Systems for Working Time Based on Glide Path, Operating Kinetics, and the Fracture Resistance. J Contemp Dent Pract 2021;22(1):69–72.

Source of support: Nil

Conflict of interest: None

The present study was conducted to assess the time to achieve the working distance based on the size of the glide path, operating kinetics, and the Twisted File and Endostar E3 method rupture resistance.

Materials and Methods

This study was commenced in the Department of Conservative Dentistry and Endodontics, Institute of Dental Sciences, SOA Deemed to be University, Bhubaneswar, after obtaining institutional clearance. It consisted of 180 extracted mandibular premolars. These teeth were noncarious and were extracted as a part of orthodontic treatment. All premolars had less than 8° angles of curvature. The sample size was calculated based on the calculated effect size of 0.89 (based on previous study), 5% level of precision, 95% confidence level, and 80% power of the study.

All teeth had a mean length of 16 mm and were sectioned at the crown root junction. Teeth were divided into two groups. Group I was subjected to continuous 360° rotary motion and group II to adaptive motion. In both groups, TF system (SybronEndo) and Endostar E3 file system (E3 Azure) were used. Each group comprised of 90 teeth.

For the TF system, file number 1 followed by 2 and 3 was used. They had 8% taper, 6% taper, and 4% taper with apical sizes 25, 35, and 50, respectively. In Endostar E3, the sequences were number 1, 2, and 3 having apical sizes 30, 25, and 30 with 8, 6, and 4% taper. Based on three apical glide path sizes (15, 20, and 25), fifteen teeth were allotted to each path size. Thus, 45 teeth were subjective to the TF system and 45 to the E3 system in both groups. Push-pull motion with a watch-winding movement with 10 K file was used for preparing glide path sizes. In all teeth, working length was obtained. Conventional biomechanical preparation was performed following all standardized procedures. All teeth were evaluated for apical size of glide path using one set of respective file methods; hence, six sets of respective file systems were used (TF and Endostar E3).

A stopwatch was used to record the time (seconds) to achieving desired working length. Microscopic evaluation with scanning electron microscope (SEM, Carl Zeiss Evo Scanning Electron Microscope, Oxford Instruments India Private Limited, Mumbai) of deformed file segment was done in the department after each use to see deformation or separation, and the canal numbers used were noted. Based on the fracture type assessed under scanning electron microscope first under low power magnification (41×) and then in high power magnification (650×), failures were classified as torsional failure or flexural failure. All the steps were performed by single operator.

The results were assessed statistically using SPSS statistical software version 21.0 (IBM Corp., Armonk, NY, USA) with post hoc Tukey honest test, and the level of significance was set at 0.05.

Results

Table 1 shows the distribution of teeth in group I (continuous 360° rotation) and group II (adaptive motion). The size of apical glide track of 15, 20, and 25 was used in both groups, and 15 teeth were used by the TF and Endostar E3 file methods.

Table 2 shows that the time taken by glide path size 15 in group I was 5.90 ± 4.06 seconds and in group II was 6.12 ± 4.16 seconds. The time taken by glide path size 20 in group I was 5.86 ± 3.12 seconds and in group II was 4.22 ± 2.10 seconds, with 25 size the time taken in group I was 5.32 ± 2.48 seconds and in group II was 3.16 ± 3.14 seconds. The time required to reach working length by group I was less as compared to group II, and the difference was significant ($p < 0.05$).

Table 3 shows that the minimum time taken was by file number 2 (3.42 ± 1.74 seconds) in group I and file number 1 (2.12 ± 1.04) in group II. There was a significant difference in time taken with different number files in both groups ($p < 0.05$).

Figure 1 shows that the mean time taken reaching the working length for continuous rotation was less as compared to TF adaptive motion; however, the difference was nonsignificant ($p > 0.05$).

Table 4 shows that the TF system first file system in apical glide path no. 1 shows fracture of size 15 file. The type of motion was adaptive. Under low power magnification (41×), torsional failure was observed; however, in high power magnification (1,500 × 650), it was fatigue failure in cross-sectional view.

Table 1: Distribution of file systems

		Group I (continuous 360° rotation)		*Group II (adaptive motion)*	
System	*Size*	*TF system (no.)*	*Endostar E3 (no.)*	*TF system (no.)*	*Endostar E3 (no.)*
Apical glide path size	15	15	15	15	15
	20	15	15	15	15
	25	15	15	15	15

Table 2: Time required reaching the working length in both groups

Glide path size	*Group I (seconds)*	*Group II (seconds)*	*p-value*
15	5.90 ± 4.06	6.12 ± 4.16	0.02
20	5.86 ± 3.12	4.22 ± 2.10	0.05
25	5.32 ± 2.48	3.16 ± 3.14	0.01
Total	5.69 ± 3.22	4.50 ± 3.13	0.03

Table 3: Time required to reach the working distance for the diverse file sizes with dissimilar glide path in both groups

	Glide path size	*Group I (seconds)*	*Group II (seconds)*	*p-value*
File no. 1	15	4.12 ± 1.02	2.20 ± 1.12	0.01
	20	5.72 ± 3.24	2.10 ± 1.00	0.02
	25	5.76 ± 2.04	2.04 ± 1.02	0.01
	Total	5.20 ± 2.10	2.12 ± 1.04	0.01
File no. 2	15	3.60 ± 1.08	9.24 ± 4.20	0.001
	20	3.12 ± 2.04	6.22 ± 2.12	0.01
	25	3.56 ± 2.11	4.14 ± 2.02	0.05
	Total	3.42 ± 1.74	6.53 ± 2.78	0.04
File no. 3	15	10.24 ± 6.02	6.33 ± 2.11	0.001
	20	7.62 ± 3.04	3.92 ± 1.17	0.001
	25	6.36 ± 2.20	3.04 ± 1.10	0.001
	Total	5.69 ± 3.22	4.43 ± 1.46	0.02

Discussion

The TF adaptive file system changes the file motion on the basis of applied load under the influence of patented feedback algorithm.[10] Based on stress distribution, the motor responds as increase or

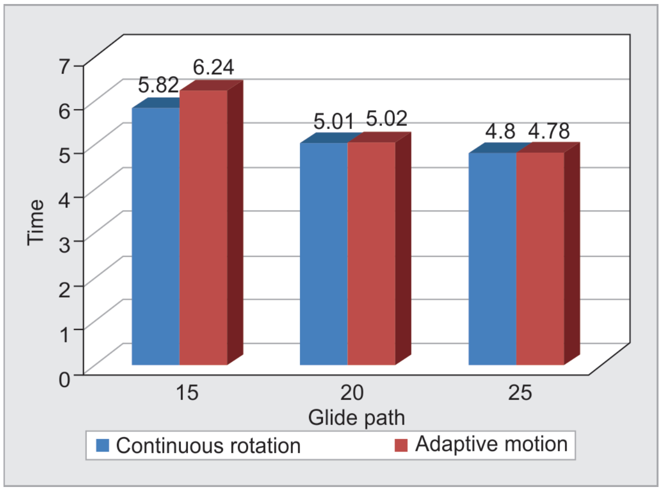

Fig. 1: Time required reaching the working length for the different types of kinetics

Table 4: SEM assessment of fractured instrument

	Parameters	*Value*
	System	TF system
	Apical glide path no. 1	Size 15
	Type of motion	Adaptive motion
Type of failure	Low power magnification (41×)	Torsional failure
	High power magnification (1,500 × 650)	Fatigue failure

decrease in motion, providing advantage of both rotary motion and reciprocation at exactly the right moment. They have higher flexibility, better file durability, and maximum debris removal capacity. The color-coded system is intended for efficiency and ease of use.[11]

There can be torsional and fatigue fractures of the Ni-Ti file system. The cause of torsional fracture is due to blockage of top or any other part of the instrument in the canal, whereas the handle continues to turn and there is accretion of torsional stress within the material.[12] When the instrument exceeds its elastic limit, fracture occurs on the instrument tip. Fatigue or flexural fracture occurs due to metal fatigue, which is maximum during instrumentation in curved canals.[13] The present study was conducted to assess the working distance based on operating kinetics, size of glide path, and fracture resistance of file system.

In this study, the distribution of teeth was done based on the type of motion, i.e., continuous 360° rotations (group I) and adaptive motion (group II). We took 180 mandibular premolars, which were distributed into both groups equally. Both groups utilized the Twisted File and Endostar E3 file methods. Each system was tested with 15 teeth individually. The size of apical glide path of 15, 20, and 25 was used.

Ramyadharshini et al.[14] tested Twisted File (TF) adaptive and uninterrupted rotary movement using the TF and Endostar E3 file systems in 120 premolars using the size of glide path of 15, 20, and 25 at apex. The period to achieve the operational distance by the TF system was more than the Endostar E3 system. With sizes 20 and 25 acquired, fewer time was needed to achieve the working distance as compared to size 15 glide path. Maximum deformation was seen with TFs as compared to the Endostar E3 file system. Adaptive motion showed most of the deformation than continuous rotary motion.[1] TF showed fracture during adaptive motion. The authors found that continuous rotary and adaptive motion revealed no significant difference.

We found that the mean time taken to reach the working length for continuous rotation was less as compared to the TF adaptive motion. We observed that both TF and Endostar E3 file systems exhibited deformation after use of 15 canal in continuous motion.

It was found that deformation with first-sequence file was observed after 15 canal use for glide path at apex with 25 size, during adaptive movement. We observed that during continuous rotary motion, there was no deformation of any file system. It was observed that adaptive movement was connected with an advanced frequency of distortion and at a prior phase rather than uninterrupted rotary motion. Plotino et al.[15] in their study advocated that there is less canal shaping time with reciprocating single-file system than with a rotary full-sequence method.

We observed that reciprocating and continuous rotary motion displayed no substantial variance in shaping time. As with uninterrupted rotary movement, there is no process of instrument release, and hence, it lacks a faster shaping time. The TF system first file system in apical glide path no. 1 shows fracture of size 15 file. The type of motion was adaptive. Under low power magnification (41×), torsional failure was observed; however, in high power magnification (1,500 × 650), it was fatigue failure in cross-sectional view. Kim et al. and Franko et al. suggested the use of rotary file system, which exhibits reciprocating motion and displays enhanced presentation.[16,17]

The limitation of the study is that only two types of file systems were compared. This study does not evaluate the presentation of root canal files of varied cross sections and in adaptive motion.

Further studies are required to explore the presentation of root canal files of diverse cross sections and in adaptive motion Ni-Ti material treatments. With the background of TF adaptive motion technology of glide path, finding with rotary files should be evaluated.

Conclusion

We recorded higher instrument separation and deformation with the TF system and adaptive movement. The time required to achieve the working distance with the TF system was more as compared to the Endostar E3 system, irrespective of the motion.

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