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Research Article

A COMPARATIVE EVALUATION OF FLEXURAL FATIGUE RESISTANCE OF PROTAPER NEXT AND PROFILE VORTEX: AN *IN-VITRO* STUDY.

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ABSTRACT

Background: Introduction of nickel titanium file system for root canal therapy has changed the conventional approach but instrument fracture in curved and narrow root canal still remains a challenge for operator. **Aim & objective:** This study aimed to compare the cyclic fatigue fracture resistance of two recent rotary Ni Ti file systems: Protaper Next and Profile Vortex file system. **Methodology:**The cyclic fatigue testing was conducted with the files rotating freely at an angle of curvature 60^{o} with maximum radius of curvature at 5mm from the tip. Ten endodontic rotary files were selected in each of the two groups to be tested. The files were rotated at 400 rpm using the Tri auto mini endomotor with handpiece set at 2.5 Torque, until the fracture occurred. The time until fracture was recorded in seconds by using a stopwatch, and the number of rotations till fracture was then calculated and results were then statistically analyzed. **Result:**The results showed Protaper Next performed significantly (P < 0.001)better and had good survival time than Profile Vortex rotary file system during cyclic fatigue testing.**Conclusion:**It was concluded that Protaper Next files had greater resistance to cyclic fatigue than Profile Vortex file system.

Keywords: CyclicFatigue, Flexural fracture, Flexural resistance.

INTRODUCTION:

Introduction of Nickel titanium file system for root canal therapy has changed the conventional approach. But instrument fracture in curved and narrow root canal still remains a challenge for operator. The superelasticity of nickel titanium alloys allows fully recoverable deformation upto 8% strain as compared to 1% in stainless steel.[1] Moreover, these NiTi instruments have shown to provide more predictable, centered and faster canal preparation than stainless steel instruments.[2] The incidence of instrument separation hasbeen reported to vary from 1.7 to 14%.[3]Sattapan et al.classified the separation of NiTi rotary instruments due to "torsional failure" and "flexural fatigue".[4]The flexural failure occurs due to work hardening and metal fatigue. An understanding of factors that contribute to instrument fracture is important in preventing its occurrence. The present study evaluated the cyclic fracture resistance for Protaper Next NiTi file system with Profile Vortex NiTi file system.

Methodology

All files with tip size ISO 25 and taper 6% were selected for this study. Total 20 endodontic files were taken (10 for each group) with the stopper adjusted to obtain the desired length of 21.0mm for each instrument.

A simulated working model was created similar to that used in study done by Youssef et al (1999)and Cheung et al (2007).[5,6] Three cylindrical steel pin were taken, one supporting pin and two shaping pins were attached on a 5mm thick metal sheet which was held vertically with the help of a vise. The position of shaping pin was adjusted so as to get the desired angle of 60 degrees.The angle of curvature was calculated by Schneider's method, which defined the angle of curvature by drawing a line parallel to the long axis of the canal and the outer line from the apical foramen to intersect with first line at a point wherein the root canal

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began to leave the long axis of the canal.[7] Ten files from each experimental groups were tested with the angle of curvature being 60 degrees. The instruments were rotated at 400 RPM and torque 2.5 Nm using reduction gear handpiece (Tri Auto mini, J Morita Mfg. Corp.,Japan).

The time taken to fracture the endodontic instrument was recorded using a stopwatch. The numbers of revolutions taken by each tested endodontic file was calculated using the simple formula: No. of rotation until fractured = 400/60 x Time taken till fracture (in second) .The results of the study were analyzed using multiple comparison tests i.e. Holmes test, for evaluating cyclic fatigue of various tested NiTi endodontic instruments, with a level of significance (p) < 0.001.

Result

The time taken (in seconds) until file fracture and the number of revolutions for each file until got separated has been summarized in table 1 and table 2 respectively. A statistically significant difference (p< 0.001) was noted between Protaper Next and Profile Vortex Files during the flexural fatiguetest.

Table 1: Comparison of time taken for separation of various NiTi instruments.

S. No	Protaper Next(Time in Sec)	Profile Vortex (Time in sec)
1.	18	12
2.	22	14
3.	24	10
4.	24	10
5.	20	12
6.	26	14
7.	18	10
8.	18	12
9.	22	10
10.	24	14

Table 2: Comparison of number of cycles of NiTi instruments till fracture

S. No	Protaper Next (No. of cycles till fracture)	Profile Vortex (No. ofrevolutions until separated)
1	112.5	75.0
2	137.5	87.5
3	150.0	62.5
4	150.0	62.5
5	125.0	75
6	162.5	87.5
7	112.5	62.5
8	112.5	75.0
9	137.5	62.5
10	150.0	87.5

The results revealed that the Protaper Next file system survived more than Profile Vortex file system. This implies that, the fracture resistance was greater in Protaper Next file system than Profile Vortex file system. A higher number ofcycles to failure indicates greater resistance to cyclicfatigue of the tested instruments.

Discussion

NiTi alloys have more strength, are tougher, more resilient and have two important properties that are shape memoryand superelasticity.These material properties are due to a change in the crystal structure. The low temperature phase

called as 'martensitic' or daughter phase and the high temperature phase called as 'austensitic' or parent phase. This lattice organization can be altered by temperature or stress.

During endodontic treatment, stress is induced into the instrument, especially during instrumentation of curved canals. The austensitic phase transforms into the martensitic phase on stressing and in this form it requires only a light force to bend the instrument. After release of stresses, the metal returns to the austensitic phase and the instrument regains its original shape.[8,9] The improved flexibility and unique properties of NiTi have undoubtably provided better control while preparing curved canals and has made it possible to engineer greater taper instruments, thereby allowing better control in shaping the root canal.

The cyclic fatigue resistance of Protaper Next files was found to be superior than Profile Vortex because of the manufacturing of file using M Wire. It has been proved that M wire, a metallurgically improved version of NiTi which has been derived from proprietarythermomechanical process that reduces cyclic fatigue by 400% when comparing files of the same D_0 diameter, cross-section and taper.[10]

The study conducted by Elnaghy(2014) for evaluation of cyclic fracture resistance of Protaper Next files stated that the improved cyclic fatigue resistance of Protaper Next files could be associated with its non-uniform design and the reduced number of contact points between the instrument and the root canal walls.[11]

Various studies have been conducted to examine the propensity of Protaper Next files to fracture during use and reason for it.[12,13] It was reported that there is minimal crack formation initiation in these files and this tendency was a reason for greater fracture resistance of Protaper Next file.[14] It was also been observed that Protaper Next files had higher cyclic fatigue resistance than its own other variant Protaper Universal files at all the tested lengths.

Cheng Peng et al. 2015 studied the cyclic fracture resistance of protaper Next files and Files manufactured with conventional NiTi alloy and observed that cyclic fatigue resistance of Protaper Next files was higher than the conventional NiTifiles due to manufacturing of these files by M wire.[15]

The result obtained in current study were in agreement to the findings of the above mentioned researches. The preliminary findings of the present study must be confirmed by more research, which should evaluate other clinically relevant mechanical properties of the tested files I*n- vivo*.

Conclusion

Under the limitations of the present study, it was concluded that Protaper Next files had greater resistance to cyclic fatigue than Profile Vortex file system.

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