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EVALUATE AND COMPARE THE CYCLIC FRACTURE RESISTANCES OF THREE DIFFERENT NI-TI ENDODONTIC FILE SYSTEM -AN INVITRO STUDY

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Abstract

Aims: The aim of the present study is to evaluate and compare the cyclic rotations needed to fracture three different rotary nickel titanium endodontic instruments namely Neo Endo S, Endo Plus and Hyflex EDM

Materials and Methods: Three NiTi rotary file systems (Neo Endo S, Endo Plus and Hyflex EDM) size #25, 0.6 % taper were used in the study. The instruments were inspected before used for any defects. A static cyclic fatigue testing device was customized for this study. It consists of a metal framework of iron and wood. The files were experimentally divided into three groups. The cyclic fatigue test of all the instruments was performed by one operator.

Statistical analyses were performed with one-way ANOVA (P=0.05).

Results: No of cyclic fatigue value of Hyflex EDM group was significantly higher than No of Cyclic fatigue values of endo plus and neo endo S groups. Group I showed more cyclic fatigue resistance as compared to group II and group III.

Conclusions: Within the limitations of this study HyFlex EDM exhibited the greater cyclic fatigue resistance when compared with the other two rotary file systems used in the study.

Keywords: Cyclic fatigue; NiTi, rotary files; EDM

Introduction

Endodontic treatment mainly consists of three main phases: proper access preparation into the pulp space, shaping and cleaning of the root canal system i.e., disinfection and obturation. For proper cleaning and shaping, endodontic instruments play a major role in achieving this. Niti rotary files become more widely used in endodontic for preparing root canals.

Endodontic instrumentation undergoing a phase of transition. Nickel titanium instruments were found to be efficient in root canal preparation. These instruments have gained popularity because of its elastic flexibility and resistance to torsional fracture. Thus, these instruments offer possibilities of improving the speed and efficacy of root canal instrumentation.

There is clinical concern that Niti rotary files have been reported to undergo fatigue failure which occurs unexpectedly without any sign of previous deformation and therefore visual inspection would not seem to be the ideal way of evaluating nickel titanium instruments in order to prevent fracture.

Advantages of NiTi rotary instruments are- more flexible and have increased cutting efficiency. The super elasticity of NiTi rotary files allows to produce the desirable tapered root canal form with a reduced tendency to canal transportation.[1,2]

Despite of these advantages, NiTi instruments may fracture within the root canal without any sign of previous permanent deformation.

Two different mechanisms have been identified for the fracture of rotary NiTi instruments: torsional failure and cyclic fatigue.

Torsional fatigue occurs when the tip of the instrument binds in the root canal while the file continues turning.

Cyclic fatigue occurs when an instrument is subjected to repeated cycles of compression and tension, as would occur during rotary instrumentation in a curved canal.

Hyflex EDM (Coltene Whaledent, Alstatten, Switzerland) instruments are manufactured through electrodischarge machining process. This causes a superficially isotropic surface on the material, which is said to increase the cyclic fatigue and torsional stress resistance of the instrument.[8]Due to the unique control memory mechanism of this instrument, it is easier to negotiate complex canal curvatures causing less iatrogenic complications and also exhibits reversion on heat sterilization.[4,7]The manufacturer also claims that the cyclic fatigue resistance of Hyflex CM is 300% compared to Hyflex EDM which is around 700% thus reducing the risk of fatigue failure.[9]

Neo endo S rotary file is designed to have a special S-shaped cross-section. This allows minimum radial wall contact which translates to reduced stress on the file. In addition, the excellent upward debris auguring ensures that

the debris isn't pushed apically or packed into the apical third. Further, proprietary heat treatment ensures that the file remains highly flexible and resistant to fracture. The cross-section of files is like the alphabet. The two-blade cutting surface increases the cutting efficiency. Proprietary heat treated NiTi wire with high fracture resistance[12]
Endo plus from Woodpecker is the Gold heat activation files that has the Pre-curved function. Files can back straight in hot water automatically after operation. Heat-treated gold rotary files keep the same philosophy as the first generation of files, with strong additional benefits like increased flexibility (24% on average) and greater resistance to cyclic fatigue.

Aim:
The aim of the present study is to evaluate and compare the cyclic rotations needed to fracture three different rotary nickel titanium endodontic instruments namely Neo Endo S, Endo Plus and Hyflex EDM.

Materials and Methods:
Characteristics of the instruments
Before testing, all instruments were inspected.
Three NiTi rotary file systems (Neo Endo S, Endo Plus and Hyflex EDM) size #25, 0.6 % taper were used in the study. The instruments were inspected before used for any defects. The files were experimentally divided into three groups and the following procedure were performed.
Group 1 – Hyflex EDM
Group 2 – Endo plus
Group 3 – Neo endo S
The rotary files were used with an endodontic X SMART PLUS (DENTSPLY) hand piece according to the manufacturer's instruction.

Figure 1: Cyclic fatigue testing device

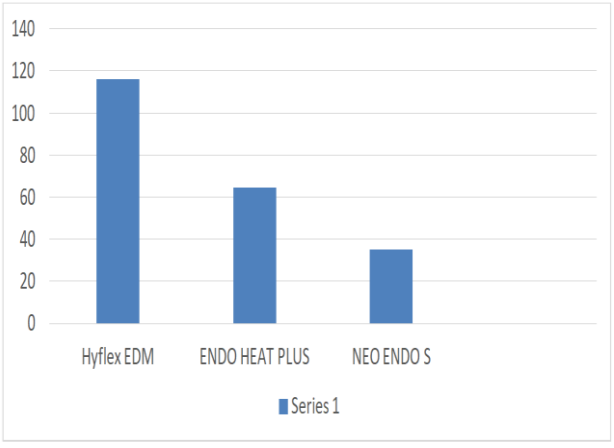
Figure 2: X smart Endo motor and testing device

- A static cyclic fatigue testing device was customized for this study. It consists of a metal framework of iron and wood.
- The canal system, which resemble the root canal, comprised two adjustable stainless steel that can accommodate any instrument to its exact size and taper. It was constructed with a 60° angle of curvature and the curvature starting at 5 mm from the tip of the canal. The endo motor handpiece was mounted over the support, which ensure the correct positioning and placement of files to the same appropriate depth for all samples.
- The working length (WL) was defined after exploration of the artificial canals with stainless steel K-files #10 (WL=17 mm)

The overload and distribution of undesirable forces in the files were controlled respecting three gently in-and-out pecking motion, with short amplitude strokes. At each cycle, the flutes were cleaned with gauze and the canal was irrigated with distilled water and the detergent lubricant solution. Upon reaching WL, the file was cleaned and reserved for further cyclic fatigue test until the file fracture.
The average instrumentation time (in sec) of each file to prepare the artificial canals was recorded by a digital timer by a single operator. The number of cycles that the instrument made to prepare the canal (NCI) was calculated according to the following formula: NCI=rpm × instrumentation (sec)/60 sec.
The cyclic fatigue test of all the instruments was performed by one operator.
Statistical Analysis: Statistical analyses were performed with one-way ANOVA (P=0.05).

Table: 1

File systems	Mean	F value	P value	significance
HyFlex EDM	**116.23 ±4.41**			
Endo Heat Plus	**64.85±3.34**	**1963.7**	**0.001**	**significant**
Neo Endo S	**35.28±2.32**			



Graph 1: Mean time to fracture different types of file systems

Results:

- No of cyclic fatigue value of HEDM group was significantly higher than NCF values of endo plus and neo endo s groups. GROUP I SHOWED MORE CYCLIC FATIGUE RESISTANCE AS COMPARED TO GROUP II AND GROUP III.
- GROUP I> GROUP II>GROUP III.
- GROUP I SHOWED MORE CYCLIC FATIGUE RESISTANCE AS COMPARED TO GROUP II AND GROUP III.

Discussion:

One of the most important complications during root canal preparation while using Niti rotary files is that the file fracture without any deformities during the clinical procedures. Fracture of the Niti rotary files during clinical procedure, mainly fracture because of cyclic fatigue.[5]

Gundogar M and Ozyurek [2]T showed that HyFlex EDM files had higher cyclic fatigue resistance as compare to other files as its has extreme fracture resistance, controlled memory, increased cutting efficacy, maintain the canal's original shape.

Pedulla et al [1]states that HyFlex EDM files has higher cyclic fatigue resistance and angle rotation to fracture as compared to the other file and concluded that Hyflex EDM instruments (controlled memory wire) have higher cyclic fatigue resistance and angle of rotation to fracture but lower torque to failure than other two files (M-wire for both files). Although the same taper was used in the study 25. 06%, between the groups, there was a statistically significant difference between these instruments in terms of cyclic fatigue resistance. Previously, it has been reported that the cyclic fatigue resistance mainly depends on the cross-sectional area and flexibility of the file. Differences in cross-sectional designs of these instruments might explain the present results. Moreover, the cyclic fatigue resistance of a file is also affected by its helical angle and number of threads. It can be speculated that the variable pitch design of instruments might have provided increased cyclic fatigue resistance.

Hyflex EDM instruments are manufactured through electrodischarge machining process. This causes a superficially isotropic surface on the material, which is said to increase the cyclic fatigue and torsional stress resistance of the instrument. Due to the unique control memory mechanism of this instrument, it is easier to negotiate complex canal curvatures causing less iatrogenic complications and also exhibits reversion on heat sterilization. [The manufacturer also claims that the cyclic fatigue resistance Hyflex EDM which is around 700% thus reducing the risk of fatigue failure.[9]

In the current study, a standardized artificial root canal machined was used for the cyclic fatigue test. The limitation of this method is that the artificial canal allows the file extreme flexibility apically at the point of the curvature, because of the width of the canal. However, the simulated artificial canal minimizes the effect of other mechanisms of instrument fracture, aside from cyclic fatigue. Since all the instruments were rotated at manufactures instructions, the number of cycles to fracture were not calculated.

Conclusion:

Within the limitations of this study HyFlex EDM exhibited the greater cyclic fatigue resistance when compared with the other two rotary file systems used in the study. EDM technology provided better preservation of NiTi file surface after clinical usage in severely curved canals when compared with conventional grinding method. Hyflex EDM files have a better resistance to cyclic fatigue.

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