

Fracture Resistance of Roots Instrumented with Different Ni-Ti Rotary Systems in Curved Root Canals

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ABSTRACT

The present study was conducted so as to compare the fracture resistance of roots instrumented with different NiTi rotary file systems in the mesial root canals of maxillary molars. 60 maxillary molars having curvatures of 25°-35° on mesial roots were sectioned below the cemento-enamel junction to obtain roots with dimensions of 11 mm in length. They were distributed into 4 groups (n = 15) according to the different instrumentation systems used viz. Group 1: no instrumentation was done, Group 2: Neoendo flex files, Group 3: Protaper universal files, Group 4: Confitaper files. Vertical load was enforced until fracture occurred. Data were statistically analyzed using one-way ANOVA test (P < 0.05). The values for mean load for the control group was 420.0±58 Newton (N), for the Neoendo flex group it was 376.5±63 N, for the Protaper universal files group it was 330.0±72 N and for the Confitaper files group it was 399.0±69 N. The differences in fracture load among group 4 and control group was not statistically significant while group 3 showed statistically significant reduction in fracture load. (P > 0.05.) Group 2 showed less reduction in fracture load. Confitaper files lead to minimal reduction in the fracture strength..

Keywords:

Protaper universal, Neo endo, confitaper, curved canals

1. Introduction

The primary objective of endodontic instrumentation is to clean and shape the root canal system. Canal preparation is adversely affected by the variability in the root canal anatomy. There has been significant reduction in the root strength after endodontic instrumentation. The root stresses generated due to instrumentation are higher in apical region and along canal wall than on the external surfaces. This fashion of stress distribution in apical region could lead to advancement of cracks and fracture propagation. Flaring and instrumentation of the root canal space leads to a debilitated root which could suffer vertical root fractures during the obturation and/or post and core procedures.

Various types of rotary Ni-Ti file systems are being manufactured with different designs of cutting blades, taper and tip. Rotary systems are clinically convenient than hand instruments but the effect of the design of the cutting blades could be contentious as they could generate elevated friction and stresses within the root canal. This, in turn weakens the tooth and can lead to fracture

of root and eventually failure of treatment. Literature suggests that excessive removal of root dentin during root canal preparation and/or post space preparation procedures definitely increases susceptibility to root fracture. Vertical root fracture has been reported as one of the most commonly seen and crucial clinical complications. Various factors such as design of the instrument, kinematics and mechanical behaviour of different rotary system could have a effect on the strength of the root.

Therefore, aim of this in vitro study was to evaluate the effect of different Ni-Ti rotary systems on fracture resistance of curved root canals of maxillary first molar.

2. Literature Review

1. Bilge Gulsum Nur et al¹ conducted a study on the fracture strength of roots instrumented with 3 single file rotary systems in curved mesial roots of maxillary molars and concluded that fracture resistance values of the samples instrumented with Reciproc files and WaveOne file system did not have significant difference when compared to the control group while OneShape rotary file systems showed improved resistance in comparison with the control group.

2. N.A. Shaheen et al² evaluated the fracture resistance of endodontically treated roots using different root canal preparation/obturation combinations including ProTaper, RaCe and hand preparation systems combined with Soft-Core/AH26, RealSeal and EndoREZ Obturators and concluded that no significant difference among the obturation systems was recorded however a significant difference with the control subgroup (ID) prepared with ProTaper was obvious.

3. Topic

The objective of conducting this study was to evaluate and compare the fracture resistance of root samples instrumented with different Ni-Ti rotary files in curved canals of mesial root of maxillary molars.

4. Methodology

For this study, 60 recently extracted maxillary molar teeth were selected with mesiobuccal roots (having a curvature of 25°–35°, this was done as per method of Schneider). The roots were divided into the following groups ($n = 15$)

Group 1: Control group- No instrumentation

Group 2: Root canal instrumentation with Neo endo system

Group 3: Root canal instrumentation with Protaper system

Group 4: Root canal instrumentation with ConfiTaper system

Placement of roots and evaluation of fracture load

Cylindrical plastic molds with dimensions of 25 mm (height) and 10 mm (diameter) were used for preparing acrylic resin blocks using elf-cured acrylic resin. The apical end of the roots (4mm) were placed in the acrylic resin blocks and allowed to set. Fracture test was done with the Instron testing machine operated at a crosshead speed of 1 mm/min. The load required to create fracture was noted and expressed in Newton (N).

5. Data Analysis

The data was analysed statistically with the aid of One-way ANOVA test followed by Tukey post-hoc test for multiple comparisons.

6. Results

The fracture resistance values for each group was as shown in table 1. The fracture load differences among group 4 and control group was not statistically significant while group 3 showed statistically significant reduction in fracture load.($P > 0.05$.) Group 2 showed less reduction in fracture load. Confitaper files lead to minimal reduction in the fracture strength.

Group	Mean \pm SD
Group 1:Control	420.0 \pm 58
Group 2:Neo endo flex	376.5 \pm 63
Group 3:Protaper universal	330.0 \pm 72
Group 4:Confitaper	399.0 \pm 69

Table 1: Fracture load values

7. Discussion

Endodontically treated teeth are seen to be more prone to vertical fractures in comparison with vital teeth. Endodontic therapy comprises of various procedures such as caries excavation, access cavity preparation and biomechanical preparation . As there is loss of tooth structure and dehydration of the dentin, these all procedures ultimately weaken the tooth. Excessive pressure is exerted on the remaining tooth structures during further procedures such as obturation, post space preparation and placement of post.³There is direct proportionality relation between Vertical root fracture resistance and the amount of the remaining dentin structure. The risk of vertical root fracture increases in over-instrumented teeth.

There are various factors like anatomic variations, time elapsed after extraction, storing conditions and age of teeth that may have an effect on the final results of a study.^{4,5}Standardization of the samples plays vital role in the studies assessing fracture resistance. If samples are not distributed equally, these parameters can affect the results of in vitro studies.⁶ After considering the clinical scenario,upper molar teeth with similar dimensions and curvatures ranging in 25° – 35° were selected. In this study, fracture resistance of root samples instrumented with different NiTi rotary file systems was tested.

File design can have a significant role in the production of dentinal defects and thereby affect the fracture resistance of roots. Stress concentration generated by Stiffer files seem to be higher. Stiffness is related to taper,method of manufacturing, cross-section, size and the material out of which the instrument is made.Thus due to forces exerted on root canal walls, there can be cracks,crazelines,vertical root fracture.⁸ The intensity of such complications is dependent on the mechanical behavior of the NiTi rotary file systems used and their geometric shape⁹.During root canal preparation, when there is a contact between the dentin walls and the rotary instrument, canal shaping occurs. This can lead to momentary stress concentrations in the dentin of the root.Thehighest root stresses are generally seen in the midrootcanal wall..¹⁰ This

eventually lead to an elevated occurrence of defects in dentinal structure during instrumentation and this may further enhance the risk for vertical root fractures.

Neo endo flex files (Orikam) are Endodontic NiTi Rotary Files that utilize a proprietary heat treatment which makes it a tough file with unique flexibility. Flutes do not open up when stress levels are reached and it doesn't present shape memory. The Cross Section is Triangular with sharp cutting edges and a non-cutting Safety Tip. Most cases require just 2 to 3 files. The recommended speed is 350 RPM and torque: 1.5 Ncm.

The ProTaper system (Dentsply/Maillefer) represents a new generation of NiTi instruments. This instrument was designed by Prof. Pierre Machtou, Prof. John West and Dr. Clifford Ruddle in co-operation with Dentsply/Maillefer. Can be used at 200 to 300 rpm. Protaper universal files are available in 21-, 25-, and 31-mm lengths. The unique features of the files include progressive taper, modified guiding tip, modified cross-section, varying pitches and helical angel and modified handle of the file. Shaping files exhibit progressive tapers which enable flexibility and selectively instrument the dentin in specific regions. Brushing action of the files creates lateral space and thus permits the cutting blades to move deeper passively into the canal. Finishing files are responsible for the correct apical fit for the corresponding ProTaper Universal master cones or obturators. Every finishing file exhibits a decreasing taper that ensures flexibility, decreases the probability of over-preparation and reduces the potential for taper lock.

Confitaper NiTi files (Confident sales Pvt. Ltd.) is a NiTi rotary file system that comes as a pack of 3 instruments 18.4%, 20.4% and 25.6%. they exhibit good elasticity and fracture resistance thus adaptable to most canal anatomies. X wire material ensure elasticity of files and thus enhances fracture resistance. It has a guiding tip with rounded end design which minimizes canal deviations and procedural errors. It shows high cutting efficiency and better elimination of debris owing to its triangular cross section.

In the present study it was seen that the fracture load required for the teeth instrumented with confitaper files was not statistically different from that of sound teeth with no instrumentation. This could be due to the high elasticity and enhanced flexibility of the files which leads to minimal loss of dentin in curved canals. Neo endo showed further reduction in the values of fracture load. Protaper universal files showed maximum reduction in the fracture load values thus suggesting maximum loss of tooth structure in curved canals. The difference between protaper files and neo endo files was statistically significant. Neo endo files belong to the third generation of rotary files thus possess M wire technology which gives it improved flexibility thereby helping in shaping the curved canals.

8. Conclusion

Within the limitations of this in vitro study, it can be concluded that Confitaper files show minimal reduction in fracture strength compared to other file systems used in this study. Neo endo showed considerably less reduction in fracture strength when compared to Protaper universal file system

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