

Original Research

Assessment of fracture of teeth instrumented by different file systems: A clinical Study

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ABSTRACT:

Background: To assess fracture of teeth instrumentation by various file systems. **Materials & methods:** A total of 40 freshly extracted, single-rooted mandibular premolars were enrolled. These samples were randomly divided into 4 groups (n = 10). Group 1 as the control, group 2 as universal ProTaper, group 3- Revo-S and group 4 as self-adjusting file (SAF), respectively. The results were analysed using SPSS software. **Results:** A total of 40 samples were included. They were divided into 4 groups as 10 in each group. The mean loads required for the fracture in Group 1 were 358.36 N, group 2 were 295.45 N, group 3 was 315.42 N, and in group 4 was 390.84 N. **Conclusion:** SAF showed better fracture resistance.

Keywords: Revo-S, Fracture, Instrumentation.

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INTRODUCTION

The primary goal of endodontic therapy is to eliminate the infected dental tissue and disinfect the entire root canal using various instruments and materials. Root canal preparation with rotary endodontic files removes more root dentin and may result in weakening of dentin integrity, leading to a reduction in the fracture resistance of treated tooth.

¹The strength of endodontically treated teeth are affected from several predisposing factors such as excessive loss of tooth structure due to caries or trauma, dehydration of dentin, access cavity preparation and instrumentation with rotary files, undesirable effects of irrigation solutions, excessive pressure during filling procedures and preparation of intra radicular post space. ²⁻⁴ Experimental studies have shown that excessive removal of dentin during root canal preparation, postspace preparation, and obturation procedures increase susceptibility to root fracture. ^{5,6} Clinically, these fractures may decrease the long-term survival rate. Vertical root fracture

(VRF) associated with endodontically treated teeth is one of the most difficult clinical complications that may occur due to instrument design, kinematics, and mechanical behavior or following root canal treatment procedures. ^{4,7}

An instrumentation technique that minimizes apical extrusion of debris would be advantageous. Many factors such as improper technique of irrigation, excessive instrumentation, the type of file used may affect the amount of apical extrusion. ⁸⁻¹⁰ Various instrumentation techniques have been advocated to minimize the extrusion of debris apically. Conventionally hand filing with K-files were employed, which extruded considerable amount of debris. With advances in preparation and instrumentation techniques, it is therefore important to identify the techniques which reduces the extrusion of the debris in an apical direction. ¹¹ Recently introduced self-adjusting file (SAF) (ReDent-Nova, Ra'anana, Israel) is designed as hollow and flexible file that adapts itself to the root canal shape. It

addresses higher percentages of the irregularly shaped root canals than the rotary/reciprocating files, providing a cleaner radicular dentin surface for successful three-dimensional obturation.¹² The SAF abrades the dentin (it has an abrasive surface), removing a thin uniform layer of dentin from the entire perimeter of the canal maintaining dentin integrity. Also, the samples instrumented with this file exhibit no crack formation and higher fracture resistance.^{12,13} Few studies have compared the efficiency of SAF with those of the reciprocating file systems.¹⁴ Hence, this study was conducted to assess fracture of teeth instrumentation by various file systems.

MATERIALS & METHODS

A total of 40 freshly extracted, single-rooted mandibular premolars were enrolled. These samples were randomly divided into 4 groups (n = 10). Group 1 as the control, group 2 as universal ProTaper, group 3- Revo-S and group 4 as self-adjusting file (SAF), respectively. Following instrumentation, the samples were filled by lateral compaction with Gutta-percha and AH Plus. A week later, after the sealer was completely set, a vertical load was applied to the specimen's canal in each group until fracture. The loads required for fracture were recorded. The results were analysed using SPSS software.

RESULTS

A total of 40 samples were included. They were divided into 4 groups as 10 in each group. The mean loads required for the fracture in Group 1 were 358.36 N, group 2 were 295.45 N, group 3 was 315.42 N, and in group 4 was 390.84 N. A significant difference in fracture resistance was observed among the groups (P < 0.01). Samples instrumented by SAF (Group 4) exhibited similar fracture strength when compared to the control group (P > 0.05) whereas the samples instrumented by rotary (Group 2 and 3) exhibited significantly reduced fracture strength compared to the control group (P < 0.01).

Table 1: Mean load in groups

Instrumentation	Mean load for fracture in newton (N)
Control	358.36
Pro Taper	295.45
Revo- S	315.42
Self- adjusting file (SAF)	390.84
P- value	<0.01

DISCUSSION

The Protaper systems (hand and rotary) have a progressive taper and a modified guiding tip. Greater cutting efficiency is achieved by the reduced contact area between the dentin and the cutting blades due to its convex triangular cross sectional design. Their design also favors debris removal and prevent the instrument from screwing into the dentinal walls of

the canal. One of the significant advantage of the Protaper system is less number of instruments thereby saving time and operator fatigue.¹⁵ Hence, this study was conducted to assess fracture of teeth instrumentation by various file systems.

In the present study, a total of 40 samples were included. They were divided into 4 groups as 10 in each group. The mean loads required for the fracture in Group 1 were 358.36 N, group 2 were 295.45 N, group 3 was 315.42 N, and in group 4 was 390.84 N. A significant difference in fracture resistance was observed among the groups (P < 0.01). A study by Pawar AM et al, studied sixty freshly extracted, single-rooted mandibular premolars were acquired and decoronated to obtain 15 mm segments. These samples were randomly divided into six groups (n = 10). The mean fracture load differed significantly among the groups (P < 0.01; one-way ANOVA). Tukey's post-hoc tests revealed that the fracture resistance was similar in the control and SAF groups (P > 0.05) and was significantly higher than that of the 2 rotary and reciprocating groups (P < 0.01).¹⁶

In the present study, samples instrumented by SAF (Group 4) exhibited similar fracture strength when compared to the control group (P > 0.05) whereas the samples instrumented by rotary (Group 2 and 3) exhibited significantly reduced fracture strength compared to the control group (P < 0.01). Another study by Nassar S et al, 45 extracted single-rooted human premolar teeth were selected and sectioned at or below the cemento-enamel junction to obtain roots 15 mm long. The samples were divided into four experimental groups and one control group (n = 9): instrumentation with nickel-titanium (NiTi) Hand Files (control group), instrumentation with TRN files, instrumentation with PTN files, instrumentation with PTG files, and instrumentation with WO files. They reported that teeth instrumented with NiTi hand files exhibited the highest fracture resistance when compared to all the rotary and reciprocating file systems. Among rotary and reciprocating instruments, root prepared with TRN files showed the most significant resistance to fracture compared with PTN, PTG, and WO files.¹⁷ SAF has been reported to cause no dentinal microcracks.^{18,19} It is a hollow file composed of NiTi lattice. It is devoid of any metal core or flutes and blades; it does not cut the dentin. Instead, has an abrasive surface that abrades the dentin, restricting the removal of the intact dentin.¹ Kim et al., reported that the stress generated by the SAF was approximately 10 MPa,²⁰ which can be attributed to the very few-to-no microcracks created using SAF, thus increasing the fracture resistance of the treated teeth. Yoldas et al.,¹⁸ and Liu et al.,²¹ in their study found that the samples instrumented with SAF and hand files exhibited no microcracks in the radicular dentin.

Another study by Nur BG et al, showed that the mean fracture load was 412 ± 72 Newton (N) for the control group, 395 ± 69 N for the Reciproc group, 373 ± 63 N

for the WaveOne group and 332 ± 68 N for the OneShape group. The fracture load differences among three experimental groups were not statistically significant ($P > 0.05$.) Whereas, the fracture loads of control and OneShape groups were significantly different ($P = 0.012$).²² Resistance to fracture is an important factor both for subsequent restoration and function in endodontic treatment.²³ Over the last decades, Ni-Ti rotary instruments have been used in endodontic treatment and applied with rotational force on root canal walls, therefore they create microcracks, craze lines or VRF in root dentin.¹⁸ The extent of such complications is related to the mechanical behavior of different preparation systems and geometric shape (the tip design, constant or progressive taper, constant or variable pitch) of Ni-Ti rotary instruments.²⁴ During root canal preparation, the contact between instrument and dentin walls provides the canal shaping. These contacts can cause many momentary stress concentrations in dentin, especially highest root stresses are actually located at the most curved midrootcanal wall area.²⁵ Existence of such high stresses in these roots are expected to increase dentinal defects during instrumentation and thus VRF risk.²⁴

CONCLUSION

From the above results, the author concluded that SAF showed better fracture resistance.

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