Original Article

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COMPARATIVE EVALUATION OF FRACTURE STRENGTH OF ROOT CANAL TREATED TEETH BETWEEN WAVE ONE AND THE HYFLEX FILE SYSTEMS FILE SYSTEM: AN IN VITRO STUDY

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ABSTRACT:

Introduction: The purpose of this study was to evaluate the fracture strength of roots instrumented with the Wave one reciprocating file (Dentsply Maillefer, Ballaigues, Switzerland) and Hyflex CM (coltene/whaledent inc, usa) and filled with the warm vertical compaction technique.

Materials and Methods: In total, 60 mandibular premolar teeth were sectioned at or below the cementoenamel junction to obtain roots 13 mm in length. The roots were balanced with respect to buccolingual mesiodistal diameters and weight. They were distributed into 2 experimental groups and 1 control group (n = 20): no instrumentation (control group), instrumentation with WaveOne with obturation, instrumentation with Hyflex CM with AH Plus sealer (Dentsply DeTrey, Konstanz, Germany) was used along with single cone points. One week later, a vertical load was applied to the specimen's canal until fracture occurred. Data were statistically analysed using 1-way analysis of variance (P = .05).

Results: The median fracture load was 415.74 N for the Waveone, median fracture load of 393.83N. However, the differences were not statistically significant (P=0.08).

Conclusions: Instrumentation with the WaveOne and Hyflex CM system showed highest fracture resistance strength of standardized roots with respect to cross-sectional diameter and weight.

Key Words: Fracture Strength, instrumentation, vertical root fracture, Wave One reciprocating file

INTRODUCTION

Vertical root fracture (VRF) is a challenging complication that has potential impact during or after root canal treatment.[1-2]. Various factors such as loss of tissue, dehydration of dentin, undesirable effects of irrigation solutions, and excessive pressure during filling procedures physical trauma, repetitive heavy and stressful chewing have been found to be causative factors in the development of VRFS (vertical root fracture) coronal and radicular tooth structure loss predisposes endodontically treated teeth to fracture, due to prior pathology or endodontic and/or restorative treatment procedures.[3-6]

Recently, it has been reported that root canal filling procedures may also propagate cracks in the apical region.[7]

However, fewer studies assumed that the load generated during cold lateral compaction is generally less than the

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load required to fracture the roots except in cases of very weak roots [8,9] Thus, it has remained unclear whether root canal filling can cause VRF. [10]

Over the last decades, technological advancements in rotary nickel-titanium instruments have led to new design concepts and easier, faster, and better root canal shaping[11] Advances in nickel-titanium (NiTi) instruments have added a new dimension to root canal treatment. Recently, single-file systems in rotary and reciprocating motion were introduced. Various file systems differing in their design features such as the NiTi core diameter, cross-sectional shape, rake angle, and flute depth may affect the behaviour of the file and, therefore, may influence the generation of cracks.[12] Hyflex control memory NiTi has been manufactured utilizing a unique process that controls the material's memory. Hyflex rotary instruments (Coltene-Whaledent, Allstetten, Switzerland) are another type of novel NiTi system. Hyflex instruments have a symmetrical cross-sectional design with 3 cutting edges.[13]

Excessive taper may result in excessive removal of dentin and weakening of the root[14] However, the effect of using rotary instruments and increased taper on root fracture susceptibility remains controversial [15-17] Cross-sectional anatomy of root canals varies; flat, oval and C-shaped canals are commonly found.[18] Although rotary systems tend to produce rounder canal preparations and smoother canal walls.[19]

The Reciproc and WaveOne files are used in a reciprocal motion that requires special automated devices. Reciproc files are available in different sizes (ie, 25.08, 40.06, and 50.05), whereas WaveOne consists of the sizes 21.06, 25.08, and 40.08. The reciprocating movement relieves stress on the instrument by special counterclockwise (cutting action) and clockwise (release of the instrument) movements and, therefore, reduces the risk of cyclic fatigue caused by tension and compression. The angles of reciprocating are specific to the design of the particular instruments.[20] The purpose of this in vitro study was to compare the effect of Wave One file and Hyflex CM instrumentation on the fracture strength of roots that were filled.

MATERIALS AND METHODS

In total, 60 extracted, intact, human mandibular premolars with single straight root canals were selected and stored in distilled water. The coronal portions of all teeth were removed by using a diamond-coated bur under water cooling, leaving roots approximately 13 mm in length. The teeth were examined with a stereomicroscope under10x magnification to detect craze lines or cracks. Teeth with such findings were excluded from the study and replaced by similar teeth. To ensure that roots with standardized dimensions and weights were used, the buccolingual (BL) and

mesiodistal (MD) dimensions of the root canals were measured using a digital caliper. Subsequently, the BL and MD diameters were multiplied. The weights of the roots were measured with a sensitive precision balance. We evenly distributed the roots to each group in an active sense based on their weights and the homogeneity of the groups. This parameter was by using the analysis of variance test. The roots were distributed into 2 experimental groups and 1 control group (n = 10).

Control Group: No Instrumentation or Obturation

The root canals were not shaped or filled. These were used as the control.

Group 2: Instrumentation with Hyflex CM Regenerative Files and obturation

The root canals were shaped with The canals were prepared with up to master apical file size X3 (#25/4% taper) to working length.

Group 3: Instrumentation with Wave One Files and obturation

The root canals were shaped with The canals were prepared with up Root canals were prepared with wave one file (Dentsply Maillefer, Ballagues, Switzerland) The canals were prepared with up to master apical file size of D2 (#25/8%taper) in slow in-and-out pecking motion until reaching the full working length according to the manufacturer's instructions. The flutes of the instrument were cleaned after 3 in-and-out-movements (pecks). Apical patency was maintained by passing #15 Kfile(Mani co. India) through the apical foramen between files.

During the preparation, after each instrument the root canals were irrigated with 2 ml of 2.5% NaOCl solution. After instrumentation, a final flush was done using 5 ml 17% EDTA for 1 minute, 5 ml 2.5% NaOCl for 1 minute followed by 5 ml distilled water.

Obturation – AH plus (Dentsply detrey, Konstanz, Germany) was coated with paste carrier – lentulo spiral(size1, 21mm red) into the root canal to the working length. Obturation of the roots was done with single cone # 25, 6 % taper (Diadent, Seoul, Korea). After completion of the filling, the excess material was removed and condensed with a cold plugger for 5 seconds, cavity was sealed with Glass Ionomer cement as final restoration.

After instrumentation and filling procedure the roots were kept at 37°C with 100% humidity for 7 days to allow complete set of sealer. The roots were kept wet in humidifier for 7 days to prevent dehydration.

Mounting of Roots and Fracture Measurement

Mounting of roots in acrylic resin block and fracture measurement by using instron testing machine. Acrylic resin blocks were prepared using cylindrical plastic molds (25mmhigh and 10mmin diameter). Self-cured acrylic

resin (Imicryl, Konya, Turkey) was used to prepare the blocks. The apical root ends were embedded vertically in 4 mm of the acrylic resin, exposing 9 mm of the coronal portion of each root. The roots were kept wet with a wet towel to prevent dehydration until they were ready for strength testing. Tesing of samples - Instron testing machine (Instron, Canton, MA) running at a crosshead speed of 1 mm/min was used to fracture the roots. A steel conical tip (tip diameter = 1.0 mm, tapered at 60º) was mounted and aligned with the center of the canal orifice parallel to the long axis of each specimen. The load necessary to fracture were recorded and expressed in N.

RESULTS:

Fig. 1 Samples tested by using Instron testing Machine (ACME Engineers, India)

TABLE 1. Cross-sectional Diameters, Multiplication of the BL-MD Diameters, Weights, and Fracture Loads of the Roots

Group	No. samples	BL(mm)	MD(mm)	Multiplication of the BL-MD Diameters($mm^{2)}$	Weights(g)	Fracture load(N)
Control	20	5.88	3.93	5.88 x 3.93	433 g	**118.70**
Hyflex CM	20	6.07	4.19	6.07 x 4.19	406 g	**393.83**
Wave One	20	6.02	4.08	6.02 x 4.08	448 g	**415.74**

Median fracture load of control group was (118.70N), for Hyflex Regenerative file CM (393.83N) and for WaveOne (415.74N). Control group shows least resistance as compared to other files where as median fracture load of Hyflex CM file was not found to be significantly different from the median fracture load of Wave One File (p=0.808).

DISCUSSION :

Standardization of the samples is an important factor in mechanical testing. Dimension variations of the roots, extraction time, and storing conditions might affect the results of a study [4] In previous fracture load studies (4, 15, 21, 22). BL and MB dimensions were measured, but the weights of the roots were omitted. In the current study, the same procedure was followed by to eliminate dimension variations as potential confounding factors. The weight and crosssectional diameter of the roots were tested statistically, and no significant differences were found between groups.

According to the present results, the weights of the roots have a medium correlation with fracture loading. However, multiplication of the BL-MD diameter has a low correlation with fracture loading. These results corroborate those of Ertas¸ et al [23] however,this may not have been enough to standardize these samples. This was a limitation of our study although further studies could be conducted to clarify this issue.

Thus, the findings of this study can compared with studies in which the fracture resistance of the roots has been evaluated. Hend Mahmoud Abou El Nasr et al 2014 [24] found that Waveone instruments induced the least amount of cracks and exhibited greatest resistance to fracture compared with Protaper F2 files. Because of using Waveone file for instrumentation is to reduce the number of instruments inside the canal helps in less amount of dentin removal therefore reciprocating motion is claimed to be safer for dentin than conventional rotation.

In the present study, filling of the root canals with an epoxy resin–based sealer, AH Plus, did not significantly strengthen the roots compared with the instrumented but not filled and intact roots (P > .05). These results corroborate those of previous studies.[15, 25]

Bilge Gulsum Nur et al in 2015[26] investigated that fracture resistance of the roots instrumented with WaveOne and Reciproc file systems were similar to the control group and it was observed that OneShape rotary file systems enhance the fracture strength of standardized curved roots when compared with untreated specimen.

Prashant Monga et al in 2015[27] They found continuous rotating instruments (Protaper and K3XF rotary system) could produce dentinal crack formation. Root canal instruments with Reciprocating movement (Wave one system) appear to

be a better option than continuous rotation movement.

Similarly, the results of this studies are in accordance with Hakan Arslan et al 2014[28]investigated that flaring of the root canals using the Protaper Universal, Endoflare, Revo-S, and HyFlex instruments. They found that the use of the Gates Glidden drills resulted in higher rate of crack formation as compared to the Protaper Universal, Endoflare, Revo-S, and HyFlex flaring instruments and similar to those of the control group in terms of crack formation. This may be due to file design generates a swaggering motion, which decreases the screw effect, and torque on any given file by minimizing the contact between the file and the dentin and reduces crack formation.

Ismail Capar Davut et al 2014[13] showed that Protaper Next and HyFlex instruments caused fewer cracks (28%) than the Protaper Universal instrument (56%) there were no significant differences in crack formation between the Protaper Next and HyFlex groups.

All of the instrumentation systems used in this study created cracks in the root dentin. Vertical root fractures are the end results of the propagation of a crack.Although in the present study the instrumentation systems were not compared with respect to crack formation, with respect to the fracture resistance of the roots, there were no statistically significant differences among the groups. Further studies are required to assess the short- and long-term impacts of instrumentation on the presence of cracks and vertical root fractures.

CONCLUSIONS:

Within the limitation and standardization conditions of this study, it can be concluded that the fracture resistance of the roots instrumented with the WaveOne files or obturated with epoxy resin–based sealer(AH plus) was compared Hyflex CM regenerative file system showed similar resistance to vertical root fracture as compared to the control group.

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