COMPARATIVE EVALUATION OF FRACTURE RESISTANCE OF MANDIBULAR BICUSPIDS INSTRUMENTED WITH HAND FILES, TRUNATOMY, ROTARY FILE AND RECIPROCATING FILE SYSTEM: AN IN VITRO STUDY

by Jana Publication & Research

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ABSTRACT

INTRODUCTION: The primary goal of endodontic therapy is to eliminate the infected dental tissue and disinfect the entire root canal using various instruments and material. Nickle-Titanium rotary and reciprocating instruments enabled better canal shaping because of their flexibility. Root canal instrumentation with motorized endodontic files results in weakening the dentin integrity, leading to a reduction in the fracture resistance of treated tooth. Instruments used for root canal shaping have evolved from conventional 2% taper hand instruments to recently used rotary and reciprocating instruments with a greater taper (4%–9% taper). As these files have a design, which incorporates increasing tapers, it results in the aggressive removal of the radicular dentin reducing the fracture strength.

OBJECTIVE: To comparatively evaluate the fracture resistance of mandibular bicuspids instrumented with hand files, trunatomy, rotary and reciprocating file system- an in vitro study.

METHOD: 50 single rooted extracted human permanent premolars were collected and decoronated to obtain 14mm root length, samples were divided into 5 groups. In Group 1 Instrumented with hand file, Group 2 with Trunatomy file, Group 3 Protaper universal Group 4 with endostare3 and Group 5 using Waveonegold file system.. All the groups were obturate using lateral compaction with AH plus sealer. Samples were mounted with acrylic and subjected to compressive loading to evaluate the fracture resistance using a universal testing machine, one way ANOVA and Tukey HSD test were used for statistical analysis.

RESULTS: Highest mean compressive strength was recorded in Group 2 followed by Group 1, Group 5, Group 4 and Group 3.

CONCLUSION: Trunatomy files showed highest fracture resistance among all the groups result also supports use of lesser tapered instrument improves fracture resistance of endodontically treated teeth.

KEYWORDS: Rotary files, Reciprocating files, Trunatomy file system, Root canal treatment, Fracture resistance

INTRODUCTION

The goals of endodontic therapy are to restore the periapical tissues that ensure tooth function and remove the contaminated pulp and dentin from the root canal. Root canal shaping instruments have changed over time, from traditional 2% taper manual

instruments to modern rotary and reciprocating tools with taper (4%–9% taper). [1] However, preparation procedures tend to damage the root dentin, which may result in fractures or craze lines. [2]

Therefore, the goal of this research is to determine the bicuspids' resistance to fracture. In contrast to the hand nickel-titanium (Niti file), Pro Taper universal (PTU), Endo star E3, and Wave one gold file, the newly announced TruNatomy (TRN) files were used for instrumentation.

METHOD

Freshly extracted 50 permanent mandibular premolars for orthodontic and periodontal purposes were collected. Immediately following extraction, the teeth were cleaned with flowing water from the tap. A diamond disc was used to decoronate the teeth, resulting in a standard root length of 14 mm from the anatomical apex. All 50 teeth were divided into five groups (n=10), (one control group and four experimental group)

GROUP 1: 10 premolars were shaped with ISO2% K file (Mani, Japan) by manual instrumentation. Apical enlargement was done from ISO# 10 to #25 in sequence of 10, 15, 20, 25 (control group).

GROUP 2: Crown down technique using TruNatomy file – 10 premolars were instrumented with 4% TRN file system (Dentsply, Maillefer, Switzerland). Canal orifice was shaped using TRN orifice modifier, and glide path was achieved using #17 TRN Glider till working length. TRN small file and TRN prime shaping file was used to complete preparation till working length.

GROUP 3: Crown down technique using Pro Taper Universal (Dentsply, Maillefer, Switzerland)10 premolars were instrumented with PTU file. Root canal orifice was flared using Sx file, followed by shaping file (S1, S2) and finishing file (F1 and F2).

GROUP 4: Ten premolars were prepared by crown down using Endo Star E3 azure (Endo star, Poldent, UK). Sequence of file are: File 1 (ISO Apical size 30 and 8% taper) File 2 (ISO apical size 25 and 6%taper).

GROUP 5: Crown down using wave one gold (Dentsply Maillefer, Switzerland) 10 premolars were prepared with wave one gold primary file (25.07) in reciprocating motion at speed of 350rpm. Root canal orifices was flared using Sx.

In all groups irrigation was done with 5.25% sodium hypochlorite and EDTA gel for lubricating the canal. Final flush was done using 5ml of 17% EDTA for 1 minute followed by rinse with distilled water. For all the groups obturation was done by lateral compaction technique using gutta percha of corresponding file and AH plus sealer. Root surface of all samples was covered with two layers of adhesive tape and apical root end of each specimen (approx. 7mm) embedded in block of self-cure acrylic resin with base of acrylic block exposing 7mm of coronal portion of each root. Adhesive tape was removed from root surface, obtained space was filled with light body additional silicon impression material.

FIGURE 1- GROUPING OF SAMPLES

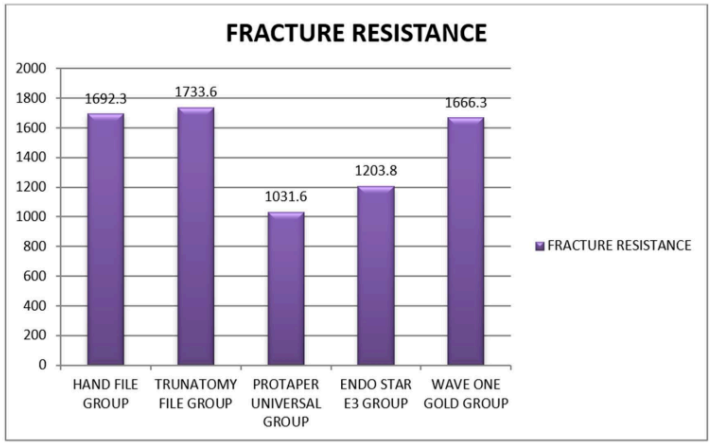
FRACTURE RESISTANCE TESTING

Fracture resistance was tested using a Universal Testing Machine (UTM). The blocks with mounted samples were positioned on the lower part of the machine, with the coronal side facing upward. A custom-made metal point, 0.5 mm in diameter, was secured to the upper section, and force was applied vertically along the root's long axis. Continuous compressive strength force was applied at crosshead speed of 1mm/min. All the samples loaded until fracture and maximum breaking loads were recorded in Newtons.

FIGURE 2- SAMPLE MOUNTED ON UNIVERSAL TESTING MACHINE

RESULTS

Trunatomy File Group demonstrates the highest mean fracture resistance at 1733.60, followed by the Hand file group with a mean of 1692.30. The Wave One Gold group displays a mean fracture resistance of 1666.30, while the Endo Star E3 group has a mean of 1203.80. The Protaper Universal group records the lowest mean fracture resistance at 1031.60, resulting in a total mean fracture resistance of 1465.52, respectively.



GRAPH 1. FRACTURE RESISTANCE

TABLE 1. DESCRIPTIVE STATISTICS

GROUP	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
HAND FILE GROUP	10	1692.3000	299.97372	94.86002	1147.00	2059.00
TRUNATOMY FILE GROUP	10	1733.6000	56.77480	17.95377	1610.00	1802.00
PROTAPER UNIVERSAL GROUP	10	1031.6000	192.33951	60.82310	627.00	1239.00
ENDO STAR E3 GROUP	10	1203.8000	322.98772	102.13768	673.00	1641.00
WAVE ONE GOLD GROUP	10	1666.3000	242.23132	76.60027	1259.00	1972.00
Total	50	1465.5200	373.69415	52.84833	627.00	2059.00

Trunatomy file group demonstrates the highest fracture resistance effect on mandibular premolars, and findings of this study support the use of minimally tapered instruments to enhance the fracture resistance of endodontically treated teeth.

DISCUSSION

Maintaining the original tooth form during root canal treatment is essential for achieving reliable clinical results. Teeth that undergo endodontic treatment can fail because of factors various factors for example access cavity preparation, the design, taper of instruments, and space needed for obturation procedures.[3]

In order to standardize the sample decoronation of the samples were done upto 14mm of root length. Apical diameter of root were kept 25mm.[4] Given the limits of this in vitro experiment, the root was able to move within a constrained region by simulating the periodontal ligament with a silicone layer in order to minimize the need for external reinforcement. These modifications can alter the force distributions it is harder to mimic the periodontal structure.[1]

As according to Zandbiglari et al., using more tapered instruments and excessive coronal expansion weakens the tooth considerably, increasing the risk of fracture.

Hand files showed higher fracture resistance than Trunatomy, PTU, Endostare3 and waveone gold file system, which is because of less taper of hand K files.[5]

Newly established TruNatomy files feature a varying backward taper, offering optimal conservation of PCD while maintaining original anatomy of tooth.[3] TRN files are made up of heat tempered NiTi alloy and feature a parallelogram cross-section. TRN utilizes a 0.8 mm NiTi wire, as opposed to a 1.2 mm wire, that helps maximize the conserving the PCD and tooth integrity.[1]

Newer analysis have demonstrated that changing reciprocating motion is an effective method for improving endodontic instrumentation by reducing the chances of file separation and canal distortion. Replacing continuous rotation with this reciprocating motion can be beneficial in reducing stress and the time needed for preparing curved root canals.[6]

WaveOne Gold (WOG) is a single-file and single-use technique used in reciprocating motion, which is developed from M-wire WaveOne instrument. When compared to the original WaveOne instruments, the WOG features modified cross-section with an off-centered parallelogram design and different tapers.[7]

Endostare3 file system has advantages of both rotary and reciprocating motion. When the instrument is under little to no stress, it rotates 600° clockwise, stops, and then resumes rotating in the same direction. However, when the file gets into the dentin or in root canal, the motion shifts to a reciprocating movement due to the increased stress.[8]

In the current study, fracture resistance of the roots was least after instrumentation with PTU. According to Bier et al., the files' taper helps in development of dentinal cracks. PTU files involve use of SX which has significantly more taper than the other rotary files systems used.[9]

5.25% sodium hypochlorite was the concentration employed in the investigation. Higher sodium hypochlorite concentrations are favoured over lower concentrations in clinical settings to strengthen the former's tissue dissolving and antibacterial properties. In this study obturation was done of all the samples because an endodontically treated tooth's resistance to fracture is increased by the application of obturating materials.[1] Epoxy resin-based sealers increase the retention of the filling material by causing mechanical locking with the canal walls. Thus, in the current investigation, a combination of GP and an AH Plus sealer was employed.[10]

Thus, takes together all these findings teeth instrumented by TRN files reveals the highest fracture resistance because of regressive taper and offers maximum preservation of pericervical dentin.

CONCLUSION

Within the limitation of this study the findings indicates that samples prepared by the TruNatomy file had a higher FR than those prepared by the Hand files, Protaper universal file, Endostare3 and WaveoneGold file system, findings of this research and other analysis concludes that utilizing minimum tapered instruments improves the FR of endodontically treated teeth.

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