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Comparative evaluation of the shaping ability of single file system versus multiple file system in root canals of mandibular molars: An *in-vitro* study

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Abstract
The aim of the study was to compare the shaping ability of two different Nickel-Titanium file systems in mesial roots of mandibular first molars.
Methods: Fourty freshly extracted mandibular molars were used for the study. A muffle-block was constructed as given by Aviad *et al*. [8] Photographs were taken of all three cross-sections of each tooth using a DSLR Camera (Nikon Digital, Tokyo, Japan) at a fixed position. The specimens were randomly divided into the following two groups: Group l: Prepared using Wave One rotary files. Group 2: Prepared using Pro-Taper rotary files.
Results: In our study the Wave One file system exhibited better centering ability than Pro-Taper Universal file system (p<0.05) at all the three different locations coronal, middle and apical thirds of the root canals.
Conclusion: It can be concluded that Wave One file system exhibited better centering ability and required very less time to prepare the curved canals compared with Pro-Taper file system.

Keywords: Centering ability, pro-taper, wave one

1. Introduction
An ideal endodontic instrumentation technique should uniformly prepare all the surfaces of the canal while simultaneously preserving the sound peripheral dentin [1]. The stainless steel (SS) K files have been the principal endodontic instruments to prepare the root canals, but a major limiting factor when dealing with curved canals has been excessive stiffness of the larger file sizes, thus increase the incidence of canal aberrations, such as zips, elbows, ledges and perforations.
The introduction of instruments fabricated from nickel titanium (NiTi) alloys has significantly improved the quality of root canal shaping greatly both in terms of quality and time, because of their increased flexibility as compared with their SS instruments. Moreover, in the past few years, important modifications to rotary instruments have been proposed to increase their reliability and effectiveness in controlling the preparation of curved canals. This trend has led to introduction of a plethora of NiTi instruments which are available in the market, with varying designs and nonstandard tapers, making it more difficult to select.
Pro-Taper Universal rotary files (Dentsply Maillefer, Ballaigues, Switzerland), designed by Dr Clifford Ruddle, Dr John West, and Dr Pierre Machtou which constitute a common NiTi rotary system, have a convex triangular cross‐sectional design and progressive taper that allows efficient movement and cutting ability to flare the canal more coronally [2]. Pro-Taper Universal rotary files are made from a conventional superelastic NiTi wire. In previous studies, the Pro-Taper Universal system showed more cracks than other rotary NiTi file systems [3, 4].
The novel Wave One NiTi single‐file system (Dentsply Maillefer) is another example of new brands offered in 2011. This system is intended for use with a special reciprocating file motion. It is composed of three single‐use files: Small (ISO 21 tip and 0.06 taper) for fine canals, primary (ISO 25 tip and 0.08 taper) for most canals, and large (ISO 40 and 0.08 tapers) for large canals [5]. Files are manufactured by grinding M‐Wire NiTi alloy.

Investigations of the shaping effect of these new Ni Ti systems with different design features and kinematics are important for understanding how the differences affect their performance; however, the effect of these new Ni Ti rotary systems on centering ability in root canals has not yet been compared. Thus, the aim of this study was to evaluate centering ability of Pro Taper and Wave One systems in curved mesial canals of mandibular molars.

Materials and Methods

Fourty freshly extracted mandibular molars, extracted for periodontal reasons collected from the Dental section, Community health centre Sankoo kargil ladakh were used for the study.

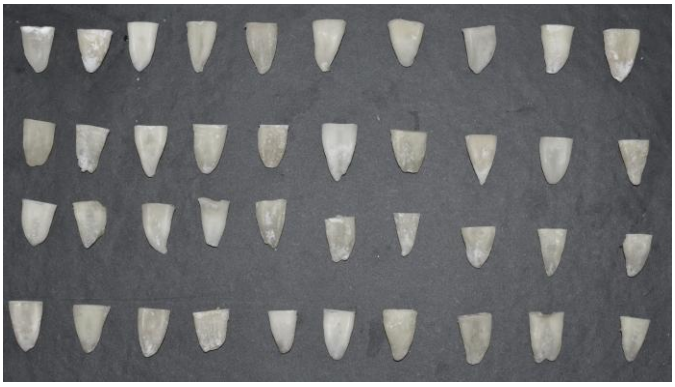

Fig 1: Study sample

Criteria for samples

Teeth with completely formed apices and mesio-buccal canal curvature between 20º and 35º assessed according to Schneider's technique [6]

Exclusion criteria for sample selection

- Teeth with canal curvature greater than 35°.
- Teeth with open apices.
- Teeth with calcified canals.
- Teeth with anatomical variations.
- Teeth with caries and restorations invading the pulp.

Equipment's used in the study

1. X-Smart plus Endomotor (Dentsply, Maillefer, Ballaigues, Switzerland).
2. DSLR Camera (Nikon digital, Tokyo, Japan).
3. Diamond discs (0.3mm diameter).
4. Radiographic jig.
5. Modified Bermante muffle system.
6. Digital Vernier calliper.

Materials used in the study

1. WAVE ONE rotary files (Dentsply, Maillefer, Ballaigues, Switzerland).
2. Pro-Taper Universal rotary files (Dentsply Maillefer, Ballaigues, Switzerland).
3. #10 K file (Dentsply, Maillefer, Ballaigues, Switzerland).
4. #15 K file (Dentsply, Maillefer, Ballaigues, Switzerland).

Selection of root canals

The teeth were disinfected in 5% sodium hypochlorite solution for 30 min. The teeth were then cleaned of calculus, soft tissue tags, debris and attached bone by a periodontal curette and washed with distilled water. The teeth were kept in normal saline until used. Radiographs were taken to evaluate the mesial roots. In each tooth specimen, any one canal of the mesial root was standardized to 9mm length by removing the crown using diamond discs. The canals were controlled for apical patency with ISO no #10 k –files (Dentsply Maillefer, Ballaigues, Switzerland). Only teeth whose canal width near the apex was approximately size 15 were included; this was evaluated with size 15 K-file. Working length was established at 9 mm, and was determined by subtracting 0.5 mm from the length at which the tip of a size #10 K-file could be visualized.

A radiographic platform, as described by previous researchers was used to take standardized radiographs prior to instrumentation with the k-file size #10 has been inserted into the buccal or lingual canal in order to determine the degree and radius of the curvature using periapical Kodak Insight films (Eastman Kodak Company, Rochester, NY).[7] The X-ray tube (Siemens, Heliodent, Germany) was aligned perpendicular to the root canal. The exposure time (0.125; 70Kv, 7mA) was the same for all radiographs. The degree and radius of canal curvature were obtained from these preoperative radiographs with a computer program Corel draw X6 software tools using Schneider technique [22].

Preparation of model

A muffle-block was constructed as given by Aviad *et al.* [8] After sealing the apices with wax, the canals were mounted in the muffle-block using self-cure acrylic resin (Orthoplast; Vertex, Zeist, the Netherlands). After complete polymerization of the resin, the block was removed from the model, the wax removed and the apical foramen exposed. The blocks were sectioned horizontally at three sites (coronal, middle and apical) by a thin cutting disk (0.3-mm thick) at two levels: one 3 mm from the apex and the other 6 mm from the apex. The disk was mounted on an electric saw (CIR-SAW, Confident Dental Equipments Ltd, India) for cutting the blocks. Photographs were taken of all three cross-sections of each tooth using a DSLR Camera (Nikon Digital, Tokyo, Japan) at a fixed position. The sections were reassembled in the muffle. The specimens were randomly divided into the following groups:

Group 1: Wave One Primary;
Group 2: Pro-Taper Universal.

All canals were prepared by a single experienced operator. Copious irrigation with 5.0 ml of 5% NaOCl solution using side-vented close ended needles. Finally, the canal were irrigated with 5.0 ml of a 17% EDTA for 3 minutes, followed by 5 ml of 5% NaOCL. All the canals were rinsed with 10 ml of 0.9% sterile saline. A manual glide path was established in both the groups up to #15 hand K-files.

Group 1: In this group, one canal of mesial root of twenty madibular first molars was prepared using the Wave One Primary file system according to manufacturer reference guide (size 25, taper 8%).

Group 2: In this group, one canal of mesial root of twenty madibular first molars was prepared using the Pro-Taper Universal system according to manufacturer reference guide up to F2 instrument (size 25, taper 8% over the first 3 mm from apical tip).

After instrumentation, all sectioned canals were separated, and then photographed in the same manner as pre-instrumentation photographs. The shaping ability of the rotary instruments was evaluated using the computer program Corel draw X6 software.

Pre-and post-instrumentation measurements were recorded to evaluate the canal transportation and centering ratio based on the method described by Gambill *et al*. [9]

Assessment of the canal preparation

Centering ability: Centering ability of the instruments towards the original canal was evaluated by the ratio of (*a1-a2*) ÷ (*b1-b2*) or (*b1-b2*) ÷ (*a1-a2*) according to the method developed by Gambil *et al*, in this formula, a1 and b1 represent the thickness of the internal and external sides of the canal wall, respectively, mesiodistally, before instrumentation and a2 and b2 after instrumentation [9] If these numbers were not equal, the lower number was considered as numerator of the ratio. A result with ratio 1 indicates that the canal has remained centered and a result less than 1 indicates deviation of the canal outward, and result of more than one show that the canal deviates inward.

Statistical Methods: Statistical software SPSS (version 20.0) and Microsoft Excel were used to carry out the statistical analysis of data. Descriptive statistics of data including mean, standard deviation, minimum and maximum values were reported. *The normality test of Kolmogorov-Smirnov (*K-S*)* and *Levene's variance homogeneity test* were applied to the data. The data were normally distributed, and there was homogeneity of variance amongst the groups. Analysis of variance (ANOVA) and the post hoc Tukey-HSD test were used for analysis of data. Graphically the data was presented by bar diagrams. A P-value of less than 0.05 was considered statistically significant. All P-values were two tailed.

Results

A total of 40 samples, 20 from each groups were taken. Distribution of samples has been shown in Table 1 below:

Table 1: Groupwise Distribution of Samples

S. No.	Groups	Description	No. of samples
1.	1	Canals were shaped using Wave One system	20
2	2	Canals were shaped using Pro-Taper	20

In our study the Wave One file system exhibited better centering ability than Pro-Taper Universal file system (p<0.05) at all the three different locations coronal, middle and apical thirds of the root canals (Table 2). No instrument fracture or signs of deformation was detected.

Table 2: Mean (SD) of canal centering in different canal sections

Group 1	Group 2
265.37	420.12

Table 3: Mean (SD) of total time (sec) required for canal preparation in study groups

		Mean	P-value
Coronal	Group 1	1.041	<0.001*
	Group 2	1.619	
Middle	Group 1	1.490	<0.001*
	Group 2	1.619	
Apical	Group 1	1.483	<0.001*
	Group 2	1.500	

The mean time taken for canal preparation with Wave One was significantly lesser than the time taken by the Pro-Taper files (P<0.05).

Discussion

The goal of instrumentation is to produce a continuously tapered preparation that maintains the canal anatomy, without any deviation from the original canal curvature, facilitating optimal irrigation, debridement, and placement of local medicaments and permanent root filling, at the same time retaining the integrity of the radicular structures [10]. Although several techniques have been developed to minimize preparation errors deriving from root canal instrumentation there are still difficulties in effectively preparing curved canals because of their complex internal anatomy.

Instruments that can follow the path of the canal and are able to remain centered in the canal, are good choices for root canal preparation [11].

The aim of our study was to compare the centering ability of two file systems, Wave One, and Pro-Taper, in mandibular molar teeth.The Pro-Taper file up to F2 and Wave One Primary file Size 25 files were selected in this study according to the recommendations of the manufacturer because this size is designated for majority of canals. Although increasing the apical preparation size may improve the cleaning efficiency and irrigation of the apical portion of the root canals, the risk of canal transportation also increases because the flexibility of the root canal instruments decreases [12].

The results obtained suggested that the two systems used in this study for canal centering ability showed significant variations. It has been highlighted from various literatures that the canal centering ability is better for Ni-Ti instruments, instruments with less cross-sectional area and instruments with non-cutting tips [13, 14]

In our study the Wave One file system exhibited better centering ability than Pro-Taper Universal file system %<0.05) at all the three different locations coronal, middle and apical thirds of the root canals.

Thus the findings that Wave One instruments resulted in significantly better canal centering ability than Pro-Taper instruments can be explained by the following reasons: the reciprocating motion with Wave One facilitates centered instrumentation more than a continuous rotating motion does, as aggressive continuous rotating motion tends toward the external wall of the canal, especially in the apical third [15]. Secondly, Wave One is made from M-wire alloy whereas Pro-Taper is made from conventional martensitic NiTi. M-wire NiTi is characterized by superior flexibility compared with conventional NiTi [16]. M-Wire has physical and mechanical properties that can render root canal instruments more flexible and fatigue resistant than those made from conventionally martensitic NiTi [17] Thirdly, the differences may be explained by the different design features of the instruments used. Wave One instruments have variable cross-sections along the working part that change from a modified convex triangular cross-section at the tip end and a convex triangular cross-section at the coronal end [18]. The results of our study are in agreement with several previous studies [19, 20]. Burklein *et al*. [21]. Found no significant difference between the single‐file technique and a full NiTi file sequence technique. The shaping ability of NiTi instruments is a multifactorial phenomenon that is related to the method of manufacture, microstructure of the alloy, taper, cross‐sectional design, type of movement, and system composition [22].

In our study, there was a significant difference in preparation time among NiTi systems, where the Pro-Taper Universal takes more time to prepare as compared to Wave One system. This is logical because the procedure with the Pro-Taper Universal required four instruments, whereas the Wave One

system is a single‐ file system, and the use of a single‐ file NiTi system with reciprocating motion reduces the time of preparation in curved root canals [23, 24].

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