

## Comparative Study of Canal Transportation and Centering Ability of Hyflex CM, Twisted files and Wave One System using Cone Beam Computed Tomography (CBCT): An *in vitro* study



Dental Science

KEYWORDS:

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### ABSTRACT

An *in-vitro* study was done to compare canal transportation and centering ability of Rotary HyflexCM, WaveOne, Twisted files using Cone Beam Computed Tomography (CBCT) in curved root canals. Mesio-buccal roots from maxillary molars having at least 15° curvature were allocated into three groups (n=10). In first group Rotary HyflexCM, in second, WaveOne and in third, Twisted files were used for canal preparation. Pre-instrumentation and post-instrumentation images were obtained at three levels 2, 3 and 4 mm above the apical foramen were compared and assessed using CBCT for determining the root canal shape. Statistical analysis was performed using One-Way ANOVA followed by Post-HOC test. P-value <0.05 was considered significant. HyflexCM maintained the canal curvature with minimal deviation in comparison to WaveOne and Twisted files systems with significant difference (P = 0.00). HyflexCM files showed lesser transportation and better centering ability than WaveOne followed by Twisted files.

### Introduction

According to Peter O.A. et al (2003), prepared canal should follow the plane of original canal without altering the position of the apical foramen [1]. Ideally, the root canal shaping should create continuous tapered preparation from coronal portion to apex while maintaining an original path of canal and keeping the apical foramen size as small as possible [2].

All instruments and instrumentation techniques have a proclivity to transport and change the original canal shape, especially when curvature is pronounced and being negotiated for the first time [3]. When the canal is transported from its physiologic location, the root structure may become weaker and chances of perforation, ledge creation, blockage may increase, and also root canal obturation may be impaired, resulting in microleakage [4].

Over the years, these considerations resulted in the development of new NiTi root canal preparation instruments which showed tremendous improvement in the quality of root canal shaping with calculable results and less iatrogenic damage, even in severely curved root canals [5]. These have undergone a unceasing evolution in terms of different designs for the cutting blades, alteration in helical angles, numbers of flutes, cross-sectional configurations, and tip designs and bringing important modifications to manufacturing process; all these factors increased their reliability, effectiveness and safety [6,7].

Recently, thermal treatment of NiTi alloy has been used to enhance the mechanical properties of NiTi alloy. One of the most proclaimed NiTi rotary instruments like Hyflex CM (Coltene-Whaledent, Allstetten, Switzerland) are made from a new type of NiTi wire, i.e. CM wire (controlled memory), that has been subjected to a proprietary thermo-mechanical processing. It has been manufactured by a unique process that manages the material's memory, making files extremely flexible, and achieving good adaptation to the canal space but without the shape memory, typical of other NiTi files [8,9].

Twisted file (TF) (SybronEndo, Orange, CA, USA) is a new rotary system developed by the manufacturer through special thermo-mechanical treatment. TF differs from other rotary NiTi files as in that the metal wire is first ground into a triangular cross-sectional shape and then twisted after grinding. It has been reported to have higher fracture resistance than other files [10]. At first this system was available in one size with variable tapers (#25/0.04, 0.06, 0.08, 0.10 and 0.12) later, sizes 30/0.06, 35/0.06, 40/0.04 and 50/0.04 were added in the system. TF production executes a specific R-phase heat treating which allows twisting of NiTi wire. This proprietary technology is used to optimize the molecular phase and properties of NiTi. Therefore, resulting crystalline structure modification, which

has been proven to be superior to traditionally processed materials, maximizes flexibility of file so that it may maintain the original canal shape better; minimize canal transportation even in severely curved root canals and resistance to fracture [11].

Recently, Wave One (Dentsply Maillefer, Switzerland), a reciprocating file system with a dedicated motor mechanism has been introduced. Wave One files are made-up of a special NiTi alloy called M-wire that is created by an innovative thermal treatment process [12]. The benefits of M-wire are increased flexibility of the instruments and resistance to cyclic fatigue. The system is designed to be used with a dedicated reciprocating motion [13]. The large rotating angle in a cutting direction (counter-clockwise) determines that the instrument advances into the canal and engages dentin into its flute to cut, while the smaller rotating angle in an opposite direction (clockwise) allows the file to immediately disengage and safely advance along the canal path, thus reducing the screwing effect and file separation with ease [14]. Since it's a single file system, therefore, decreased shaping time, eliminates procedural errors, also possibility of contamination owing to its single use.

Some studies showed that NiTi instruments were safer with a reciprocating movement for the root canal preparation compared to continuous rotary motion. The reciprocating movement also increases cyclic fatigue span of instruments compared to the conventional rotation [15,16]. There is finite information regarding the influence of reciprocating motion on canal transportation and centering ability compared to continuous rotation. Centering ability is influenced by the design of the instrument (taper, flexibility, type of alloy and rotation) and root canal anatomy. The instrument receives lesser restraint and is more centered in cases of straighter root canals.

The present *in vitro* study aimed to compare the canal transportation and centering ability of the three aforementioned instruments, i.e. HyflexCM, TF and WaveOne, by means of CBCT.

### Materials and Method

The present study consisted of thirty freshly extracted mesio-buccal (MB) roots of maxillary molars with fully formed apices, uncalcified canals and without MB2 canals; having apical curvature within 15°-30° (according to Schneider method) [17]. After disinfection with 5.25% Sodium hypochlorite, samples were stored in 10% formalin solution before experiment.

The access cavities were made with a #4 high speed round carbide bur (Dentsply Maillefer, Switzerland); then canal orifices were negotiated. If a #15 K-file could be easily fed into the root canal, samples were excluded from the study. For establishing the working

length (WL), a size 10 K file (Dentsply, Maillefer, Switzerland) was placed into the canal until it was visible at the apical foramen. The WL was determined 0.5 mm short of this length and reference points were marked with an indelible marker on the teeth. For accessible placement of the teeth, the other roots were amputated at the furcation level. At this point, the coronal portions of all teeth were embedded in silicone mounting, leaving the roots mounted upwards to ensure that the teeth can be repositioned in the same manner, so as to avoid any procedural error. All Teeth were numbered and Pre-instrumentation scans were performed using CBCT in the high resolution dental mode at 75 kV, 5mA with a 5cm field of view and a single scout image True with a thickness of 0.09 mm were obtained.

Axial images at 2, 3 and 4mm above the apical foramen were acquired from pre-instrumentation scans for evaluation of apical transportation. The sagittal images were used for measuring the curvature of MB canals using OnDemand 3D software. All the canals showed curvature ranging from 15° to 30°.

The teeth were randomly divided into the following three groups (n=10):

In Group 1, Specimens (n = 10) were prepared with Rotary HyflexCM was used according to the manufacturer's instructions. Apical glide path was created and the instrumentation was done in the following recommended sequence: 0.08/25 (orifice opener), 0.04/20 till W.L and 0.04/25 till W.L, respectively. HyflexCM files were discarded if they did not regain their original shape after sterilization.

In Group 2, Specimens (n = 10) were prepared with Twisted file system according to manufacturer's recommendations which has a tip size of 0.25/0.08 in apical 3 mm.

In Group 3, Specimens (n = 10) were prepared with WaveOne system which has a tip size of 0.25/0.08 in apical 3 mm.

All the rotary files were used in slow in and out pecking motions, flutes were cleaned after three pecks each time and discarded after use in two canals. After the use of each file, canals were irrigated with 5 mL of 5.25% NaOCl solution in all the groups. Glyde (Dentsply Maillefer) was used as a lubricant during instrumentation.

**Assessment of Canal Transportation**

The pre-instrumentation and post-instrumentation CBCT axial images taken at 2,3 and 4mm above the apical foramen were transferred to Adobe Photoshop software. Protocol described by Hartmann et al was modified and applied to all images. Relevant image was selected, cropped 5x5cm, viewed at 100%. The root canal was then outlined using magic wand tool with tolerance set to 18. For Pre-instrumentation image, size of brush tool was adjusted to costume the size of the root canal and the canal was painted green. Tolerance was set to 32, the dentin border was outlined, and Pre-instrumentation dentin was painted yellow. All the above mentioned steps were repeated for post-instrumentation image except that dentine of post-instrumentation image was painted magenta, and root canal was left untouched. With the help of the move tool, mobile segment of post-instrumentation image was superimposed onto the pre-instrumentation image. Small rotation and translation movements were performed using transform tool. This was done to achieve perfect fit between pre and post-instrumentation images. The transfer was finally completed with "Apply image" function and the final superimposed image was zoomed to 1200%. The centres of the Pre and post-instrumentation root canal was calculated by using the slice tool in both mesiodistal and buccolingual directions. Canal transportation was evaluated by measuring the distance between white and black pixels. The distance was measured (in mm) with ruler tool. Fully overlapping black and white center markers indicates "absence of Canal Transportation".

**Assessment of Centering Ability**

Sagittal images acquired from CBCT scans of all samples, before and

after instrumentation were evaluated using OnDemand 3D software to determine straightening. Protocol given by Estrela et al was used for measuring the canal curvature. 2 semistraight lines of equal length were drawn, first line represented continuity of apical region & second line followed middle & coronal thirds of canal. Mid points of each line were determined and from this spot two lines perpendicular to semi straight lines were drawn until they met at a central point which is named circumcentre. The angle formed at circumcenter determined the curvature of canal and was expressed in degree. The difference in curvature of canals before and after instrumentation determined the amount of straightening.

**Statistical Analysis**

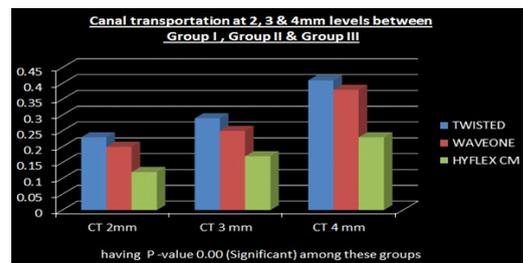
The statistical software SPSS (Statistical Package for Social Science, version 16.0) was used for data analysis. Mean and standard deviation were calculated from sample for each study group. The mean values were compared by using **One-Way ANOVA followed by Post-HOC test for Multiple Comparisons** to identify group-wise significant differences. P-value < 0.05 are considered as significant at 95% confidence level.

**Results**

The centering ratios and transportation values of three different rotary instrument groups are presented in Table 1. The results of this study revealed that Group 1, HyflexCM (p < 0.05) rotary instrument remained centered in the canal with minimal transportation as compared to Twisted and WaveOne rotary systems at all the three levels. The use of HyflexCM resulted in significantly less straightening as compared to Group 2, Twisted and Group 3, WaveOne rotary systems (Graph 1).

**Table 1:** Absolute values of mean canal transportation (mm SD) for respective distances from the apex after preparation with HyflexCM, WaveOne and Twisted file rotary systems

MEAN CANAL TRANSPORTATION	N	LEVEL (distance from the apex)	MEAN SD
HYFLEX-CM	10	2 mm	0.12
	10	3 mm	0.17
	10	4 mm	0.23
WAVEONE	10	2 mm	0.20
	10	3 mm	0.25
	10	4 mm	0.38
TWISTED FILE	10	2 mm	0.23
	10	3 mm	0.29
	10	4 mm	0.41



**Graph 1:** Graphical representation of Canal Transportation between Group I, II and III

**Discussion**

The maxillary first molar is largest tooth in volume and most complex tooth in root and canal anatomy. A single MB canal is oval and wider buccolingually, a concavity exists on distal aspect of the MB root, which makes this wall thin [18]. Moreover, on average, curved MB canals often have greater canal transportation than most other canals. The present study focused on the evaluation of the shaping potential of flat and curved MB canals of maxillary molars with the novel instruments HyflexCM, TF and WaveOne.

### **Canal transportation**

The results of this study revealed that HyflexCM rotary instrument remained centered in the canal with minimal transportation as compared to Twisted and WaveOne rotary systems at all three levels.

According to the manufacturer, this is due to the presence of CM wire and it is manufactured using a special thermomechanical process that controls memory of the material making files extremely flexible. The amount of apical transportation increased from 2mm level to 4mm in all three groups. This could possibly be due to the taper of the files which caused them to transport more coronally.

### **Canal straightening**

The use of Hyflex CM resulted in significantly less straightening as compared to Twisted and WaveOne which probably could be because of the unique thermo-mechanically processed NiTi alloy that has increased flexibility and controlled shape memory.

### **Conclusion**

Within the limitations of the present study it can be concluded that:

- HyflexCM NiTi rotary system well maintained the canal curvature with minimal deviation in comparison to Twisted and Wave One rotary systems with significant difference.

Twisted and WaveOne rotary files showed significantly more transportation than HyflexCM files.

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