www.djas.co.in
ISSN No-2321-1482

DJAS 4(II), 88-93, 2016

ORIGINAL ARTICLE

Dental JOURNAL
of Advance Studies

COMPARISON OF CANAL TRANSPORTATION AND CENTERING ABILITY OF PROTAPER NEXT, HYFLEX CM AND WAVE ONE SYSTEM USING CONE- BEAM COMPUTED TOMOGRAPHY- AN IN-VITRO STUDY

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ABSTRACT

Objective: The aim of the study was to compare the canal transportation and centering ability of Rotary ProTaper Next, Hyflex CM and Wave One primary systems using cone beam computed tomography (CBCT) in curved root canals. **Materials and Methods:** Total 30 freshly extracted maxillary first molars having root canals with curvature between 10º- 20º were divided into three groups of 10 teeth each. All teeth were scanned by CBCT to determine the root canal shape before instrumentation. In Group 1, the canals were prepared with ProTaper Next files, in Group 2 with Hyflex CM files and in Group 3 with Wave One files. After preparation, post-instrumentation scan was performed. Pre-instrumentation and post-instrumentation images were obtained at 3 mm and 6 mm above the apical foramen and were compared using CBCT software. The amount of canal transportation and centering ability were assessed and statistically compared with one way analysis of variance and Tukey honestly significant test ($p<0.05$). **Results:** All instrumentation systems used resulted in some amount of canal transportation. Data obtained suggested that Wave One files caused significantly lesser transportation and remained better centered in the canal than Hyflex CM and Rotary ProTaper Next files. **Conclusion:** The canal preparation with Wave One files results in lesser transportation and better centering ability than Hyflex CM and ProTaper Next rotary files in curved root canals.

Key Words: Canal transportation, centering ability, CBCT, WaveOne File

INTRODUCTION

In endodontic treatment the shaping procedure holds an important place as it influences the subsequent canal irrigation, obturation, and even the overall success of the treatment itself.[1] The primary objectives in shaping and cleaning the root canal system as stated by Cohen et al. are to remove infected soft and hard tissue, give disinfecting irrigants access to the apical canal space, and create space for the delivery of medicaments and obturation and to retain the integrity of radicular structures.[2]

The root canal instrumentation should preserve the existing apical foramen with a flared shape from the apical to the coronal end and not change the original canal curvature.[3] The introduction of rotary nickel-titanium (NiTi) files have improved root canal shaping ability due to their high flexibility, enhanced cutting ability, greater efficiency, predictability and better centering ability.[3,4] However, during preparation of the curved canals, iatrogenic errors like ledges, zips, perforations and canal transportations can occur.[3] Cimis et al., stated that 46% of curved canals have varying degrees of apical transportation subsequent to instrumentation due to the tendency of the endodontic instruments to straighten the

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Received: 30th April 2016
Accepted: 23rd July 2016
Online: 11th September, 2016

root canal during the chemomechanical preparation.[1]

The ProTaper Next(PTN) (Dentsply Maillefer, Ballaigues, Switzerland) files are the convergence of 3 significant design features: progressive percentage tapers on a single file, M-wire technology, and the 5th generation of continuous improvement, the offset design[5] which in turn decreases the dangerous taper lock and screw effect by minimizing the contact between a file and dentin.[6]

The Hyflex CM (Coltene) is a combination of M-wire technology and control memory alloy (CM- wire) that is characterized by a symmetrical cross-sectional design showing three cutting edges except the instruments with size 25, .04 taper, which have a square cross section with four flutes. Due to their increased flexibility, Hyflex CM instruments possess a superior centring ability compared with conventional NiTi instruments and are best suited to prepare curved root canals.[7]

Recently, Wave One (Dentsply Maillefer), a reciprocating file system with a dedicated motor mechanism has been introduced, also made from M-wire.[8] A large rotating angle in the cutting direction (counter-clockwise) allows the instrument to advance in the canal and engage dentin to cut it. Whereas, a smaller angle in the opposite direction (clockwise) allows the file to be immediately disengaged and safely progress along the canal path, while reducing the screwing effect and file separation.[9]

Several methodologies have been proposed to assess the action of the endodontic instruments on the canal walls like radiographic imaging, cross-sectioning, longitudinal cleavage of the teeth and even computed tomography.[10] However, the cone-beam computed tomography (CBCT) imaging is a non-invasive technique for analysis of canal geometry before, during and after root canal preparation and to assess the efficiency of shaping procedures.[6]

AIMS AND OBJECTIVES OF THE STUDY:

The aim and objective is to compare the root canal transportation and centering ability of ProTaper Next, Hyflex CM and WaveOne systems in curved canals, using cone-beam computed tomography.

MATERIALS AND METHODS:

This study was conducted in the Department of Conservative Dentistry and Endodontics, Maratha Mandal's Nathajirao G Halgekar Institute of Dental Sciences & Research Center, Belgavi, Karnataka , in association with Dentascan CBCT Imaging centre.

Specimen selection :

Mesiobuccal roots of 30 freshly extracted maxillary first molars with fully formed apices having angles of curvature within 10-20º (according to Schneider method) that were extracted for periodontal, prosthetic or orthodontic reasons were selected. The teeth were stored in saline at 4°C until use. However, teeth with calcified canals, root canals with double curvatures, open apices and curvatures less than 10º or greater than 20º were excluded from the study.

Preparation of the specimen:

The access cavities were prepared with round diamond burs. A size 10 K-file was then placed into the canal until it was visible at the apical foramen and the working length (WL) was established 1 mm short of this length. For more uniform samples, the crown was flattened with a diamond disk and a final WL of 12 mm was achieved for each specimen. The roots were then embedded into modelling wax for stability and to simulate the arch form. The teeth were then randomly divided into three experimental groups. All teeth were scanned by cone beam computed tomography (CBCT) to determine the root canal shape before instrumentation, both at 3 mm and 6mm from the apex. After initial scans, all root canals of experimented teeth were instrumented to the WL with sizes 10, 15, 20 K-files by using a step-back technique but the canals larger than ISO size 20 were discarded.

GROUP 1: (*n* = 10): The specimens were prepared with ProTaper Next files (Dentsply Maillefer) till X2 using 128:1 reduction geared hand piece powered by electric motor according to manufacturer's recommendations.

GROUP 2 (n=10) : All Hyflex CM instruments upto 06/20 file were used in a gentle in-and-out motion with a rotational speed of 500 rpm, and the torque was adjusted to 2.5 Ncm according to the manufacturer's instructions upto working length.

GROUP 3: (n= 10): The specimens were prepared with WaveOne Primary system, in slow in and out pecking motions, according to manufacturer's recommendations.

Gauze soaked in 70% ethyl alcohol was used to clean the flutes of the used instruments after three in and out movements. The canals were irrigated with 3 mL of 3% NaOCl solution in all the groups after the use of each file and Glyde (Dentsply Maillefer) was used as a lubricant for instrumentation. The final rinse was done with 1 mL of 17% ethylene diamine tetra-acetic acid (EDTA) for 1 min followed by a final flush of 3 mL NaOCl. All instruments of group 1 (ProTaper Next) and group 2 (Hyflex CM) were discarded after use in five canals, whereas of group 3 (Wave One) were discarded after use in two canals as per manufacturer's recommendations. Then post-instrumentation scans were made (Figure 1).

Evaluation of Canal Transportation:

The amount of canal transportation was determined by measuring the shortest distance from the edge of

Figure 1: Post instrumentation CBCT image got by using the Carestream 3D Imaging software

uninstrumented canal to the periphery of the root (mesial and distal) and then by comparing this with the same measurements obtained from the instrumented images (Figure 2).

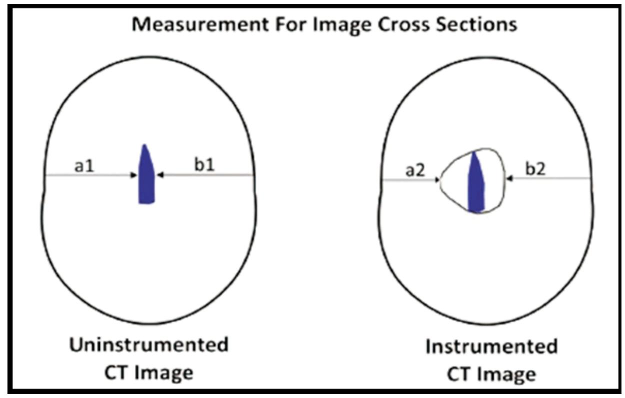


Figure 2: Diagrammatic representation showing measurements for image cross sections: uninstrumented and instrumented CBCT scan images

All values were measured by two evaluators and a mean value was taken.

The following formula was used for the calculation of transportation:

$$(a1-a2) - (b1-b2)$$

Where,

a1 is the shortest distance from the mesial edge of the root to the mesial edge of the uninstrumented canal,

b1 is the shortest distance from distal edge of the root to the distal edge of the uninstrumented canal,

a2 is the shortest distance from the mesial edge of the root to the mesial edge of the instrumented canal, and

b2 is the shortest distance from distal edge of the root to the distal edge of the instrumented canal.

According to this formula, a result other than 0 indicates that transportation has occurred in the canal.

Evaluation of Centering Ability:

It was calculated by using the following ratio:

$$(a1-a2)/ (b1-b2) \quad \text{or} \quad (b1-b2)/ (a1-a2).$$

If these numbers were not equal, the lower figure calculated was considered as the numerator of the ratio.

According to this formula, a resultant value of 1 indicated perfect centering ability.

STATISTICALANALYSIS:

One-way analysis of variance followed by Post Hoc Tukey honestly significant difference (HSD) test was conducted to explore a significant difference in mean degree of canal transportation between the three shaping procedures. The level of significance was set at p = 0.05.

RESULTS

All studied techniques produced canal transportation. As seen from the data in table (1) and (2) and the graphs (1) and (2), the canal transportation values for the group 3 were statistically significantly lower than groups 1 and 2 at 3 mm from the apex with p value = 0.026019. But however, there was no statistically significant difference in the groups 2 and 1 in their canal transportation values.

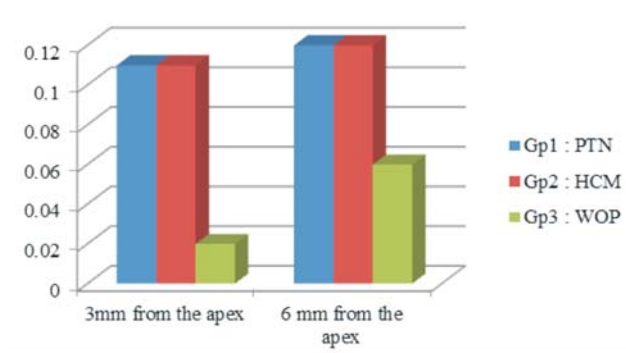
Table 1: Mean and standard deviations of the canal transportation values by the different groups at 3 mm and 6 mm from the apex.(in mm)

Groups	3 mm From The Apex		6 mm From The Apex	
	Mean	Standard deviation	Mean	Standard deviation
GP 1- PTN	0.11	0.099443	0.12	0.042164
GP2 – HCM	0.11	0.08756	0.12	0.078881
GP3 - WOP	0.02	0.042164	0.06	0.069921

Table 2: Mean and standard deviations of the canal centering ability values of the different groups at 3 mm and 6 mm from the apex

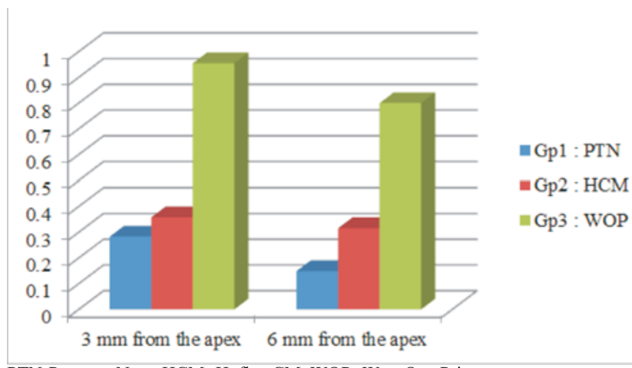
Groups	3 mm From The Apex		6 mm From The Apex	
	Mean	Standard deviation	Mean	Standard deviation
GP 1- PTN	0.2833	0.416106	0.1493	0.252451
GP2 – HCM	0.3583	0.392938	0.316	0.328167
GP3 - WOP	0.955	0.142302	0.7999	0.269989

Similarly, the canal centering ability for the group 3 was statistically significantly higher than the other two groups, both at 3 mm and 6 mm from the apex.(p value=0.000935 and p=6.89E-05 respectively).



PTN-Protaper Next, HCM- Hyflex CM, WOP- WaveOne Primary

Graph 1: Graphical comparison of the mean canal transportation values of the different groups at 3 mm and 6 mm from the apex



PTN-Protaper Next, HCM- Hyflex CM, WOP- WaveOne Primary

Graph 2: Graphical comparison of the mean canal centering ability values of the different groups at 3 mm and 6 mm from the apex

DISCUSSION

When compared with stainless steel files, the NiTi files show superior resistance to torsional fracture and a marked degree of elastic flexibility. This increased flexibility is responsible for maintaining the original canal configuration during instrumentation to a greater degree than standard endodontic files,[10] resulting in lesser elbow formation, zipping and apical transportation.[11]

Mesiobuccal roots of extracted human maxillary molars were used in the present study because they usually present an accentuated curvature and mesiodistal flattening. These characteristics are additional difficulties during chemomechanical instrumentation and make shaping of these canals[10] highly prone to iatrogenic mishaps.[12] Parameters such as the canal length, the apical diameter, the angle and the radius of the canal curvature were balanced in order to obtain anatomically comparable groups.

Though microCT is accepted as the gold standard for the assessment of the canal transportation and centering ability of different file systems,[13] in this study CBCT was used as it is reproducible and allows protection of the specimens, apart from its various other advantages.

The centering ratio represents the ability of instruments to remain centered in shaped canals. According to the formula, the lower the scores, the better are the instruments centered in the canal.[9] Also, apical transportation values that are more than 0.3mm can endanger the outcome of treatment due to a noticeable decrease in the sealing ability of the obturation material.[13] However, none of the transportation values measured in this study surpassed this limit.

Recently, new systems that use reciprocating motion were introduced in the market, claiming to be able to shape root canals using a single file. These file systems make canal shaping simpler and faster. Also, reciprocation motion, as seen with the WaveOne file systems, is proposed to increase the canal centering ability as well as to reduce the risk of root canal deformity.[14,15,16]

In this study, the best results were got in the specimens treated with WaveOne primary files as they are a single shaping file system, made from M-Wire technology alloy with reciprocating action advantageous in terms of stresses and the time required for the preparation of curved root canals.[17]

Similar results as in this study can be found in the literature. In a study conducted by Dhingra et al. in 2014 to compare the canal curvature modifications after instrumentation with One Shape (Micro Mega) rotary file and Wave One primary reciprocating file (Dentsply Maillefer, Ballaigues, Switzerland), it was found that the canals prepared with Wave One file preserved canal shape, respected the anatomical shape of J-shaped canal and produced a continuously tapered funnel.18 Similarly in a study conducted by Tambe et al. in 2014, to compare the canal transportation and centering ability of Rotary ProTaper, One Shape and Wave One systems using cone beam computed tomography (CBCT) in curved root canals to find better instrumentation technique for maintaining root canal geometry, it was derived that Wave One files caused lesser transportation and remained better centered in the canal than One Shape and Rotary ProTaper files.[19]

However, further investigations are needed to understand whether the better performance of the instrument are due to other attributes like its variable cross-sectional design, M-wire alloy, its reverse cutting blades, reciprocating motion or a combination of these variables.[20]

CONCLUSION

So, within the limitations of this study,

- All the three groups showed some amount of canal transposition at 3mm and 6 mm from the apex.
- Wave one group showed the least canal transportation values and hence the best centering ability in curved canals.

So, proper knowledge of the different file systems and their working action is needed to select files for the different case scenarios and prevent undesirable iatrogenic errors especially in curved canals.

REFERENCES

1. Agarwal RS, Agarwal J, Jain P, Chandra A. Comparative Analysis of Canal Centering Ability of Different Single File Systems Using Cone Beam Computed Tomography- An In-Vitro Study. J Clin Diagn Res 2015; 9(5): ZC06-ZC10.
2. Cohen S, Hargreaves KM. Pathways of Pulp. 9th ed. St.Louis, Mo.:Elsevier Mosby;2006.
3. Carper ID, Ertas H, Ok E, Arslan H, Ertas ET. Comparative study of different novel Nickel Titanium Rotary systems for Root canal preparation in severely curved root canals. J

Endod 2014;40(6):852-6.

4. Silva D, Gomes AC, Silva JM, Neves AA, Zaia AA, Silva EJN. Evaluation of foraminal transportation during foraminal enlargement with different instrumentation systems. Braz J Oral Sci 2014;13(4):246-50.

5. Ruddle JC, Machtou P, West JD. The Shaping Movement 5th Generation Technology. Dentistry Today. 2013 April. Available From www.Endoruddle.Com

6. Jain D, Medha M, Patil N, Kadam N, Yadav V, Jagadale H. Shaping ability of fifth generation Ni-Ti rotary systems for root canal preparation in curved root canals using cone-beam computed tomographic: An in vitro study. J Int Oral Health 2015;7 (Suppl 1):57-61.

7. Beurklein S, Beorjes L, Scheafer E. Comparison of preparation of curved root canals with Hyflex CM and Revo-S rotary nickel–titanium instruments. Int Endod J 2014;47:470–6.

8. Tambe VH, Nagmode PS, Abraham S, Patait M, Lahoti PV, Jaju N. Comparison of canal transportation and centering ability of rotary protaper, one shape system and wave one system using cone beam computed tomography: An in vitro study. J Conserv Dent 2014;17(6):561-5.

9. Lim YJ, Park SJ, Kim HC, Min KS. Comparison of the centering ability of WaveOne and Reciproc nickel-titanium instruments in simulated curved canals. Restor Dent Endod 2013;38(1):21-5.

10. Hartmann MSM, Barletta FB, Fontanella VRC, Vanni JR. Canal Transportation after Root Canal Instrumentation: A Comparative Study with Computed Tomography. J Endod 2007;33:962–5.

11. Luiten DJ, Morgan LA, Baumgartner JC, Marshall JG. A comparison of four instrumentation techniques on apical canal transportation. J Endod 1995;21(1):26-32.

12. López FU, Fachin EV, Fontanella VRC, Barletta FB, So MVR, Grecca FS. Apical Transportation: A Comparative Evaluation of Three Root Canal Instrumentation Techniques with Three Different Apical Diameters. J Endod 2008;34:1545–8.

13. Uzunoglu E, Turker SA. Comparison of canal transportation, centering ratio by cone beam computed tomography after preparation with different file systems. J Contemp Dent Pract 2015; 16(5):360-5.

14. Roane JB, Sabala CL, Duncanson MG. The 'balanced force' concept for instrumentation of curved canals. J Endod 1985;11:203–11.

15. Roane JB, Sabala C. Clockwise or counterclockwise. J Endod 1984;10:349–53.

16. Southard DW, Oswald RJ, Natkin E. Instrumentation of curved molar root canals with the Roane technique. J Endod 1987;13:479–89.

17. De-Deus G, Moreira EJ, Lopes HP, Elias CN. Extended cyclic fatigue life of F2 ProTaper instruments used in reciprocating movement. Int Endod J 2010;43:1063–8.

18. Dhingra A, Kochar R, Banerjee S, Srivastava P. Comparative evaluation of the canal curvature modifications after instrumentation with One Shape Rotary and Wave One Reciprocating files. J Conserv Dent 2014;17(2):138–41.

19. Tambe VH, Nagmode PS, Abraham S, Patait M, Lahoti PV, Jaju N. Comparison of canal transportation and centering ability of rotary protaper, one shape system and wave one system using cone beam computed tomography: An in vitro study. J Conserv Dent 2014;17:561-5.

20. Maitin N, Arunagiri D, Brave D, Maitin SN, Kaushik S, Roy S. An ex vivo comparative analysis on shaping ability of four NiTi rotary endodontic instruments using spiral computed tomography. J Conserv Dent 2013;16:219–23.

Source of Support: Nil, Conflict of Interest: None Declared