Original Article

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Comparison of Root Canal Preparations Using Three Different Rotary Systems and Nickel-Titanium Hand Files by Cone Beam Computed Tomography

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ABSTRACT

Introduction: In the plethora of modern available rotary instruments, clinician should choose wisely the least invasive instruments as it strikes the balance of sufficient root canal preparation with minimal mishaps. The purpose of the study was to evaluate root canal transportation and centering ability by using three different rotary system and Nickel-Titanium (Ni-Ti) Hand files by cone beam computed tomography.

Methodology: The study was conducted in the Department of Conservative Dentistry and Endodontics, Mahatma Gandhi Dental College and Associated group of hospitals. A total of 80 extracted permanent maxillary first molar were selected and disinfected by 5.25% sodium hypochlorite. Crown portions of the teeth were removed to obtain mesiobuccal roots considering 11 mm root length as standard and roots were embedded into acrylic (Rapid Repair, Dentsply). The teeth were divided into four groups of 20 each. All teeth were scanned preoperatively by software CDSEE cone beam computed tomography (CBCT). The root canals were prepared using group A One shape rotary file, group B Hyflex CM rotary files, group C ProTaper nickel titanium rotary files, and group D Ni-Ti hand files. Post instrumentation scan was performed and images were superimposed to compare the transportation and centering ability with CDSEE CBCT software (Genoray America Inc) at every mm of total root length.

Results: Comparing all the four groups, there was no significant difference found between the groups with respect to transportation and centering ability. The mean values of transportation were found less for group D followed by group B. Mean centering ability was better for group B.

Conclusion: The Hyflex CM Ni-Ti rotary system and Ni-Ti hand files maintained the canal curvature well with minimal deviation in comparison to ProTaper and One shape rotary systems.

INTRODUCTION

A variety of instruments and techniques have been developed and practiced for cleaning and shaping the root canal. Over the last few years, endodontics has undergone a complete revolution with the introduction of the Ni-Ti alloy for the manufacture of hand and rotary endodontic instruments.[1] Recently, ProTaper Ni-Ti rotary systems are used worldwide as they are very popular even among general dentist. The progressive taper and advanced flute design reportedly provide the flexibility and efficiency to achieve consistent, successful cleaning, and shaping. HyFlex® CM rotary files, available from Coltène/ Whaledent, are "changing the DNA of Ni-Ti files". It is a unique breakthrough in Ni-Ti rotary files with a "Controlled Memory" (CM) effect.[2] A new one shape instrument (Micro-Mega, Besancon, France) has been introduced with three variable cross-sections along the blade. This one single instrument can be used to shape the entire root canal in continuous motion.

Cone beam computed tomography (CBCT) is a new innovation in imaging sciences. CBCT provides better results than other methods like radiographic imaging,[4] cross-sectioning[5] and longitudinal cleavage.[6,7] The purpose of this study was to compare the shaping abilities of three different rotary systems and Ni-Ti hand files in curved canal using cone beam computed tomography.

METHODS

The study was carried out in the Department of Conservative Dentistry and Endodontics, Mahatma Gandhi Dental College and Associated group of hospitals from September 2016 to December 2016 after approval by ethical committee of the Mahatma Gandhi Dental College, Jaipur. A total of 80 extracted permanent maxillary first molars were decoronated at the cementoenamel junction and mesiobuccal roots were obtained and stored in deionized water prior to instrumentation. Access cavities were prepared using round diamond burs (Mani Inc.,Tochigi-Ken, Japan) and endoaccess bur (Denstsply Tulsa, Switzerland).

To determine the working length (WL), a size 10 K-file was inserted into the remaining root canal until it was visible at the apical foramen under 2.5X magnification. The WL of the canal was calculated to be one mm less than the length obtained with this initial file. Root length was then standardized to 11 mm. Roots were then embedded into pink acrylic (Rapid Repair, Dentsply Maillefer, Tulsa, Switzerland) and after stabilizing 20 teeth on a flat platform, again acrylic was poured over it to make a rigid specimen which would resist displacement during subsequent procedures (Figure 1).

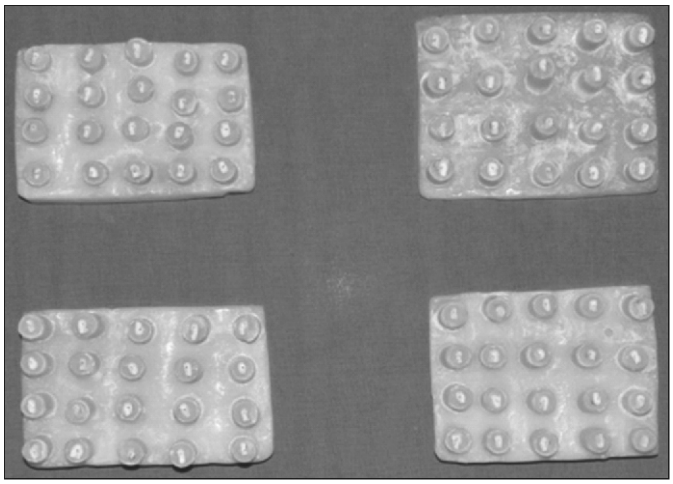

Figure 1: Prepared samples in acrylic block.

The teeth were randomly divided into four experimental groups of 20 each.

- Group A-Canal preparation by One shape file (Micro-Mega, Besancon, France)
- Group B- Canal preparation by Hyflex CM (Coltene-Whaledent, Allstetten, Switzerland)
- Group C-Canal preparation by ProTaper Rotary File (Dentsply Maillefer, Ballaigues, Switzerland)
- Group D-Ni-Ti Hand files (Dentsply Maillefer, Ballaigues, Switzerland)

All teeth were scanned preoperatively by CDSEE CBCT (Genoray America Inc) to determine the root canal shape before instrumentation. Exposure parameters were 105 kV and 94.8 mA. Nine levels were chosen for evaluation in CBCT. Sectioning was started at one mm from the apex up to the coronal orifice with each one mm increment in distance from previous increment. The images were stored in computer for future comparison between pre instrumentation and post instrumentation data using CDSEE software and Adobe Photoshop.

Evaluation of Canal transportation: To compare the degree of canal transportation, a technique given by Gambill et al[8] was used in which canal transportation was measured and compared by using the shortest distance from the edge of uninstrumented canal as well as instrumented canal to the periphery of the root (mesial and distal). 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 curved root to the mesial edge of the uninstrumented canal; b1 is the shortest distance from distal (furcation) edge of the curved root to the distal edge of the uninstrumented canal; a2 is the shortest distance from the mesial edge of the curved root to the mesial edge of the instrumented canal; b2 is the shortest distance from distal (furcation) edge of the curved root to the distal edge of the instrumented canal (Figure 2). According to this formula, a result of '0' indicates no canal transportation.

Evaluation of centering ability: According to Gambill et al[8] the mean centering ratio was calculated for each section as it shows the ability of the instrument to stay centered in the canal. If it is not equal, the lower figure is taken as the numerator of the ratio (a1-a2)/ (b1-b2) or (b1-b2)/ (a1-a2). According to this formula, a result of '1' indicates perfect centering. Canal transportation and centering ratio were evaluated at 9 levels from two mm from the apex to coronal part at an interval of one mm.

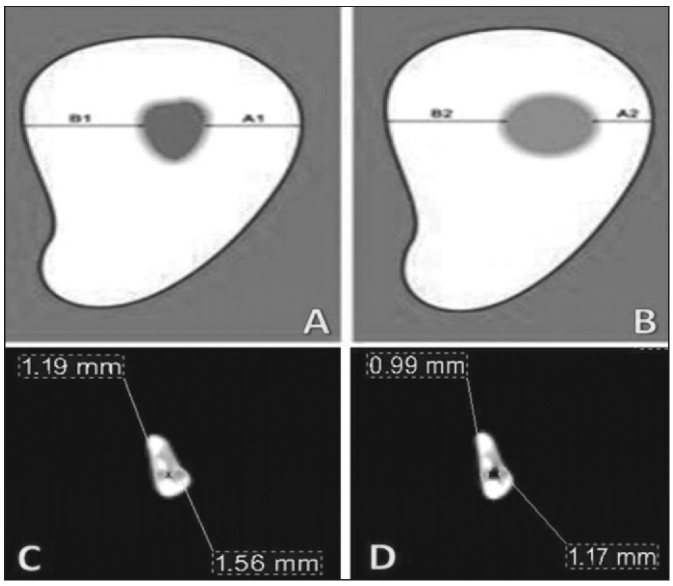

Figure 2: Schematic and CBCT images representing measurements taken in yuh 7 uninstrumented (AC) and instrumented canal (BD).

The data obtained were collected and entered into microsoft excel worksheet. Analysis of variance (ANOVA) test was applied and the statistical analysis was performed.

RESULTS

The results showed that there was slight transportation in all the four groups but group C ProTaper files showed maximum transportation followed by group A One shape file, whereas, group B HyflexCM showed less transportation followed by group D Ni-Ti hand files in which least transportation was seen. However, on applying ANOVA, the results showed that there was no significant difference between the groups with respect to transportation from 2 mm to 10 mm ($p>0.05$), despite of huge difference in mean transportation in group C and group D. Maximum transportation was observed in group C and least transportation in group D (Table).

Comparison of centering ability was recorded at different levels between four groups. There was no significant difference between the groups with respect to mean centering ratio at any of the distances except at four mm ($p>0.05$). On applying ANOVA there is a statistically significant difference in centering ability of group B as compared to other groups at four mm (p value = 0.037 < 0.05) as shown in table 2.

DISCUSSION

Successful root canal treatment is dependent on effective debridement and shaping of the root canal system.[9] Various instrumentation techniques are being used to prepare and shape the root canal, regardless of the instrumentation technique, dentine removal from the canal walls was observed due to cleaning and shaping procedures.[10] However, excessive dentine removal in one direction within the canal, rather than equidistantly in all directions, from the main tooth axis caused canal transportation. The factors associated with an increased risk of canal transportation include improper access cavities, use of stiff instruments, various instrumentation techniques, and insufficient irrigation during mechanical enlargement, angle and radius of a canal curvature, unseen canal curvatures in two dimensional radiography and experience of the operator. According to Iqbal MK et al[11] small degrees of transportation is associated with ability of the file to remain centered within the canal, which depends on the physical properties of used alloys as well as shape of the instrument tip.

Table1: Canal transportation at various levels

Levels	Group A Mean ± SD	Group B Mean ± SD	Group C Mean ± SD	Group D Mean ± SD	p value
2 mm	0.037 ± 0.056	0.031 ± 0.075	0.053 ± 0.075	0.031± 0.047	0.642
3 mm	0.060 ± 0.037	0.049 ± 0.053	0.074 ± 0.072	0.056 ± 0.053	0.528
4 mm	0.072 ± 0.043	0.046 ± 0.040	0.075 ± 0.064	0.049 ± 0.037	0.114
5 mm	0.072 ± 0.050	0.075 ± 0.076	0.082 ± 0.065	0.068 ± 0.063	0.915
6 mm	0.088 ± 0.055	0.068 ± 0.053	0.092 ± 0.069	0.052 ± 0.037	0.083
7 mm	0.104 ± 0.071	0.093 ± 0.064	0.133 ± 0.096	0.077 ± 0.048	0.148
8 mm	0.103 ± 0.067	0.098 ± 0.074	0.107 ± 0.112	0.063 ± 0.061	0.298
9 mm	0.098 ± 0.068	0.093 ± 0.066	0.1 ± 0.109	0.08 ± 0.067	0.857
10 mm	0.078 ± 0.077	0.072 ± 0.075	0.081 ± 0.068	0.05 ± 0.04	0.454

Table 2: Centering ability at different levels

Levels	Group A Mean ± SD	Group B Mean ± SD	Group C Mean ± SD	Group D Mean ± SD	p value
2 mm	0.23 ± 0.33	0.40 ± 0.30	0.29 ± 0.32	0.36 ± 0.27	0.728
3 mm	0.48 ± 0.22	0.55 ± 0.31	0.50 ± 0.29	0.54 ± 0.23	0.794
4 mm	0.40 ± 0.22	0.605 ± 0.29	0.42 ± 0.23	0.42 ± 0.215	0.037*
5 mm	0.51 ± 0.29	0.61 ± 0.29	0.50 ± 0.21	0.52 ± 0.215	0.780
6 mm	0.54 ± 0.25	0.545 ±0.22	0.48 ± 0.205	0.51 ± 0.26	0.780
7 mm	0.46 ± 0.26	0.52 ± 0.18	0.45 ± 0.24	0.46 ± 0.21	0.734
8 mm	0.50 ± 0.28	0.53 ± 0.26	0.49 ± 0.24	0.505 ± 0.31	0.962
9 mm	0.45 ± 0.27	0.47 ± 0.22	0.44 ± 0.31	0.465 ± 0.291	0.989
10 mm	0.33 ± 0.31	0.45 ± 0.185	0.33 ± 0.25	0.46 ± 0.24	0.335

*$p<0.05$ - significant

To evaluate the centering ability and canal transportation, different instruments and techniques have been developed for root canal before and after preparation. A number of methods are available which have been brought in use in the present study. Cone beam computed tomography is a new innovation in imaging sciences. The effective CBCT slices used in the present study were of one mm thickness which provided a non-invasive technique for assessment of canal morphology before and after shaping.

In terms of canal transportation, no significant differences were found in transportation at any levels between the groups but it was observed that canal transportation was consistently lower for Hyflex and Ni-Ti Hand while consistently higher for ProTaper and One shape file. The highest canal transportation observed with ProTaper system in this study can be attributed to file design as ProTaper file has progressive taper along its cutting surface and the cutting edges are sharp.[10]

Root canal preparation with different techniques have been evaluated and studies reported that rotary Ni-Ti instruments shows less transportation of canals than stainless steel hand files.[12,13,14]

Assessment of centering ability at all the levels for all the four groups was less than ratio one and no statistically significant difference was observed between the groups in the present study except at four mm. A significant difference ($p<0.03$) in canal centering ability at 4mm was observed which revealed that Hyflex CM rotary file and Ni-Ti hand files remained centered in the canal with minimal transportation as compared to ProTaper and One shape file. The effectiveness of the Hyflex CM instruments to remain centered during canal preparation according to the manufacturer is due to presence of CM (controlled memory) wire, manufactured using a special thermomechanical process that provides the memory of the material, thus making the files extremely flexible. This increased the ability of the file to follow the anatomy of canal very closely, and reduces the risk of ledging, transportation and perforation.

The results of the present study are in accordance with a study conducted by Kumar BS et al[15] which showed that Hyflex CM files provided a centred preparation while maintaining the original shape of the curved canals. Previous studies such as of Zhao D et al[16] reported that Hyflex CM instruments caused less apical transportation than K3 file at the apical third of canals. Testarelli L et al[17] observed that Hyflex CM file is bendable and flexible. The ISO size of all three file systems was standardized (#25) in the present study but the tapers were different. Taper of the file is important to maintain the centrality and minimal canal transportation. A limitation of the study was that wide range of root canal curvature (12^0-50^0) was chosen. Further studies can be undertaken on a narrower range of curvature.

CONCLUSION

With CBCT scanning, it can be concluded that Hyflex CM Ni-Ti file and Hand Ni-Ti showed minimal deviation with least transportation whereas the ProTaper and One Shape rotary files showed more transportation. Further studies are needed to evaluate the shaping ability of these file systems by standardizing the taper size of all the files, for better evaluation of files.

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