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A COMPARATIVE EVALUATION OF APICAL TRANSPORTATION AND CANAL CENTRING ABILITY OF DIADENT DIA-X FILE SYSTEM AND WAVE ONE GOLD FILE IN THE APICAL REGION OF CURVED MOLARS USING CONE-BEAM COMPUTED TOMOGRAPHY : AN IN VITRO STUDY

Endodontic

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ABSTRACT

Aim: To compare the centric ability and apical transportation of newer rotary NiTi file system, DIA-X and reciprocating file system Wave One Gold. **Methodology:** 40 Human permanent mandibular molars extracted were selected. The crown of each selected tooth was sectioned at the level of the cementum enamel junction using a diamond disc to standardize the root length to 12mm. Pre instrumentation images were taken by CBCT scanning. A glide path was performed through a size 10 K-file. Group One- The canals were prepared using WaveOneGold file system. Group Two- The canal was prepared using DiaDent Dia X file system (According to manufacturer's description). After canal shaping post instrumentation CBCT scans were performed same as pre instrumentation scans. Pre and post-operative CBCT scans were compared, and the transportation in the mesiodistal direction was calculated. The horizontal sections were used, and the dimensions were measured by calculating the shortest distance from the periphery of the un-instrumented canal to the periphery of the tooth in both mesial and distal directions and then compared with the values measured from the prepared canals. The canal centring ratio at each level will be calculated using the formula. **Statistical analysis:** Expression of Apical Transportation & Canal Centering in the form of Mean & SD for each group. Mann Whitney test was used to compare the mean Apical Transportation & Canal Centering at different distances between two groups. The level of significance was set at $P<0.05$. **Results:** The mean Apical Transportation value at all three levels i.e., apical(3mm), middle(5mm) and coronal(7mm) WOG files showed lesser canal transportation in comparison to DIA-X files, and the results were statistically significant. The mean canal centering value at all three levels i.e, apical(3mm), middle(5mm) and coronal(7mm) WOG files showed greater canal centering ability in comparison to DIA-X files the results were statistically significant. Group 1: WOG showed the highest canal centering ability and least apical transportation compared to Group 2: DIA-X . This study focused on behavior of NiTi files in curved canals and their ability to remain center inside, following the natural anatomy of the canal. **Conclusion:** WOG can be used efficiently inside the canal with tolerable value of canal transportation. DIA-X files had considerably higher canal transportation compared to WOG.

KEYWORDS

centric ablility, WaveOneGold, DiaDent Dia-X, Nickel Titanium, Apical Transportation,CBCT

INTRODUCTION

The field of endodontics has advanced and changed over time, much like many other medical and dental disciplines. This evolution, which has been going on for a while, has been really significant and sophisticated. The way endodontics and endodontic surgery are performed has been revolutionized by the use of the microscope, ultrasonic units, highly accurate microchip computerized apex locators, flexible nickel-titanium files in rotary engines, and a greater emphasis on microscopic endodontic surgery. With fewer procedural errors, less patient irritation, shorter treatment times, and increased precision, these advancements have elevated endodontic practice to new heights and dimensions and are now considered to be some of the greatest discoveries of the twenty-first century[1].

The developments in the field of metallurgy has been a boon to endodontics due to the introduction of newer alloys and their manufacturing methods, which has led to fewer iatrogenic mishaps and lesser chair side time. The simple fact that "a curve develops sections that, if not managed during enlargement, will induce transportation, ledge formation, and even perforation".[2]

Dentsply Sirona's WaveOne Gold (WOG) file system has an eye-catching alternate off-centered parallelogram-shaped cross-section made of a heat-treated gold metal alloy (gold wire), sectional layout, and two 85-degree cutting edges[3]. The WOG file is used in a reciprocating action and has anticlockwise engagement angles of 150 and clockwise disengagement angles of 30[3].

Convex triangular cross section, progressive decreasing taper design, superior corrosion resistance, and coated surface are all features of the recently introduced DIA Dent DIA-X files.

It is important to comprehend how different rotary NiTi files act differently due to variances in their design and kinematics when analyzing the shaping effect of various file systems and their performance.

The aim of the present study was examining these new niti systems' potential for "apical transportation and canal centering". The current study was conducted since there aren't many studies that compare these two file systems.

MATERIALS AND METHODOLOGY

Sample Collection

Forty extracted molars were collected from the Department of Oral and Maxillofacial Surgery, Krishnadevaraya College of Dental Sciences and stored in a 2% thymol solution until use. Inclusion criteria were Molars extracted due to compromised periodontal condition. Teeth with mature apices, curved canals (20°–40° of curvature). Exclusion criteria were Teeth with immature apices, Resorbed roots, Calcified canals, Teeth with curvature above 40°. Canal curvature was determined by using Schneider's method[4].

Preparation of the curved canals

The crown of each selected tooth was removed at the level of the cementum enamel junction using a diamond disc to obtain a root length standardized at measuring 12 mm in length. The specimens were embedded in acrylic resin[5]. To hold the teeth in position for CBCT scanning. Pre instrumentation images were taken by CBCT scans at 3mm,5mm,7mm. All teeth were scanned with their roots being perpendicular to the beam of CBCT device starting from the apical end of the root. A glide path was performed through a size 10 K-file (Dentsply Maillefer, Ballaigues, Switzerland). The working length was determined by subtracting 1 mm from the length at which the file tip extruded apically. RC Help (Prime Dental Products Pvt. Ltd.) was used in all canal preparations, and the root canal was irrigated with two ml 2.5% sodium hypochlorite solution after each instrumentation. The teeth were divided into two groups after initial biomechanical preparation till 20# K-file.

Group one(n=20) - the canal was prepared using Wave One Gold PRIMARY reciproc (#025, 0.07%). 350 rpm speed in 170° CCW and 50° CW direction and completes 360° in 3 cycles.

Group two(n=20) - The canals were prepared using DIA -X file system with the sequence of D1(#18, 0.02%), D2(#18, 0.04%) for shaping of the canal and D3(#20, 0.06%), D4(#25,0.07%) for finishing of the canal at a rotational speed of 300 rpm along with torque values of 200 g/cm.

CBCT analysis

Post-instrumentation CBCT scans were carried out in the same spot as pre-instrumentation scans following canal shaping(Fig.1, Fig.2). In order to determine the transportation in the mesiodistal direction, preoperative and postoperative CBCT scans were examined. The dimensions were determined using the horizontal sections and compared to the values obtained from the prepared canals by determining the shortest distance between the periphery of the pre-instrumented canal and the periphery of the tooth in both mesial and distal directions. The formula was used to get the canal centring ratio for each level

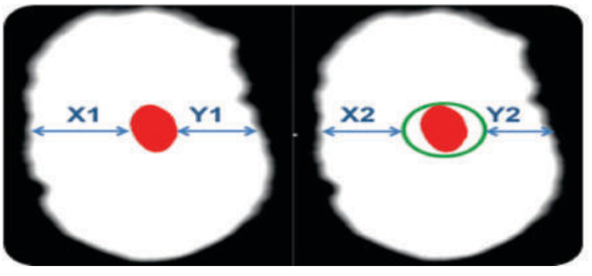

Fig .1 Horizontal sections of pre and post treatment CBCT analysis

Centric ability = (X1−X2)/(Y1−Y2) or (Y1−Y2)/ (X1−X2)
Transportation at each level was calculated using the formula:
Transportation = (X1−X2) − (Y1−Y2)
X1 represented the shortest mesial distance from outside of the curved root to the periphery of the un-instrumented canal.
X2 represented the shortest mesial distance from outside of the curved root to the periphery of the instrumented canal.
Y1 represented the shortest distal distance from outside of the curved root to the periphery of the un-instrumented canal.
Y2 represented the shortest distal distance from outside of the curved root to the periphery of the instrumented canal.
Up to 0.15 mm of root canal transit has been judged appropriate.

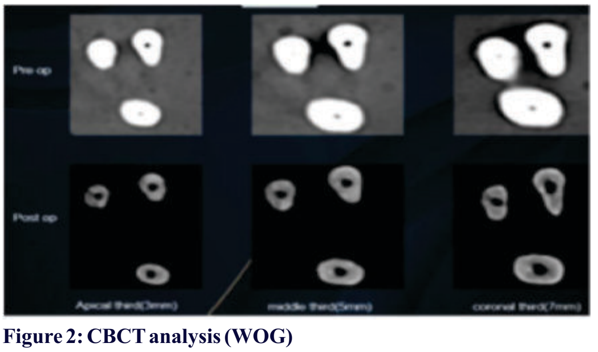

Figure 2: CBCT analysis (WOG)

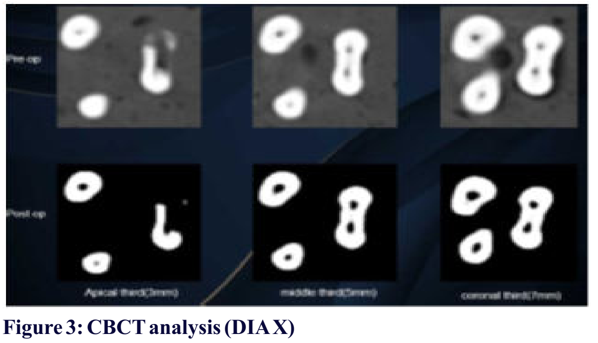

Figure 3: CBCT analysis (DIA X)

Statistical Analysis:

Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released 2013. Armonk, NY: IBM Corp., was used to perform statistical analysis.

Descriptive Statistics:

Descriptive analysis includes expression of Apical Transportation & Canal Centering in the form of Mean & SD for each group.

Inferential Statistics: Mann Whitney test was used to compare the mean Apical Transportation & Canal Centering at different distances between two groups. The level of significance was set at P<0.05.

RESULTS:

The Mean Apical Transportation values (Table 1)

At 3 mm distance Group 1 was significantly lesser [0.080 ± 0.079] as compared to Group 2 [0.250 ± 0.196]
At 5 mm distance Group 1 was significantly lesser [0.060 ± 0.070] as compared to Group 2 [0.180 ± 0.103]
At 7 mm distance Group 1 was significantly lesser [0.050 ± 0.053] as compared to Group 2 [0.120 ± 0.079]
The mean difference between two groups was statistically significant at p=0.04.

(Table: 1)

The mean Canal Centering values (Table 2)

Table 1. Comparison of mean Apical Transportation values b/w Two groups at various distances using Mann Whitney Test

Distance	Groups	N	Mean	SD	Mean Diff	p-value
3 mm Apical 3rd	Group 1	20	0.080	0.079	-0.170	0.04*
	Group 2	20	0.250	0.196		
5 mm Middle 3rd	Group 1	20	0.060	0.070	-0.120	0.01*
	Group 2	20	0.180	0.103		
7 mm Coronal 3rd	Group 1	20	0.050	0.053	-0.070	0.04*
	Group 2	20	0.120	0.079		

At 3 mm distance Group 1 was significantly higher [1.150 ± 0.669] as compared to Group 2 [0.570 ± 0.414]
At 5 mm distance Group 1 was significantly higher [1.217 ± 0.653] as compared to Group 2 [0.600 ± 0.460]
At 7 mm distance Group 1 was significantly higher mean Canal Centering [1.350 ± 0.474] as compared to Group 2 [0.714 ± 0.665]

(Table 2)

Table 2. Comparison of mean Canal Centering values of two groups at various distances using Mann Whitney Test

Distance	Groups	N	Mean	SD	Mean Diff	p-value
3 mm Apical 3rd	Group 1	20	1.150	0.669	0.580	0.04*
	Group 2	20	0.570	0.414		
5 mm Middle 3rd	Group 1	20	1.217	0.653	0.617	0.04*
	Group 2	20	0.600	0.460		
7 mm Coronal 3rd	Group 1	20	1.350	0.474	0.636	0.03*
	Group 2	20	0.714	0.665		

DISCUSSION

One of the crucial steps in endodontic therapy is the instrumentation of the root canal system. It entails removing necrotic tissues and diseased root dentine from the root canal system. In order to more readily accept irrigants and medicament proper cleaning and shaping must be performed. The structure and morphology of the root canal system create additional challenges that must be dealt with for effective cleaning and shaping[7]. In narrow, curved canals, an ideal flare is challenging to achieve[8]. However, "canal transportation" happens when too much dentine is removed from the canal in one direction as opposed to uniformly from each side of the tooth's main axis. Up to 0.15 mm of root canal transit has been judged appropriate, but anything more than that may be harmful to the apical seal after canal obturation[9]. For a correct enlargement to be provided, an instrument's ability to maintain centre position, also known as its canal centering ability, is essential.

In prior investigations, two different types of models were employed: simulated canals and removed teeth[10,11]. Using removed teeth provides conditions that are more comparable to clinical settings than resin blocks do. The hardness and abrasion properties of acrylic resin and root dentin are different from one another[12], and the heat generated may cause the resin to soften[13]. Therefore, we used extracted teeth to compare these file systems.

The mesiobuccal root of molars was chosen for this investigation because it commonly displays remarkable curvatures. For achieving results that encompass a wide range of conditions, the American Association of Endodontists Endodontic Case Difficulty Assessment classifies the angle of curvature at 20°–40° as moderate curvature. This study took canal curvature (20°–40°) into account.

The apical, middle, and coronal thirds of the root canals are represented by the three levels (3, 5, and 7 mm), which are also the locations of curvatures that are more susceptible to iatrogenic mistakes.

Despite its higher cost, we chose to employ CBCT in this study because it gives better precision and resolution with less radiation exposure. The CBCT imaging method also allows for an accurate, reproducible, three-dimensional analysis of any potential dentin alterations, such as dentin thickness. CBCT also shows root canal volume before and after preparation without hurting the specimens[7].

The present study observed that Wave One Gold file system showed better centring ability than Dia X file systems. This can be attributed to several factors such as the microstructure of the alloy, taper, cross-sectional design, kind of movement, and composition of the system that affect the shaping ability of NiTi instruments[14].

In comparison to WOG, DIA-X is said to have aggressive cutting and extensive dentin removal. Transportation is greater with DIA-X than with WOG at all levels, 3 mm(apical), 5 mm(middle), and 7 mm(coronal) mesiodistally, which is statistically significant. This might be explained by the manufacturing of the DIA-X files which have a convex triangular cross-section and used in circumferential brushing motion. The convex triangular cross-section has a larger surface area and perimeter as well as three points of contact with the canal walls, which also increases torsional fatigue.

Conversely, in WOG a smaller cross-sectional area makes the file more flexible and adapt to the shape of the canal[15]. Due to the novel cross-sectional design that produces only two-point contacts with the canal walls and increases flexibility by reducing its cross-sectional area, the parallelogram cross-section design also demonstrates less stress concentration during torsional testing, indicating more resistance to torsional failure[15]. Numerous studies have demonstrated that more flexible instruments resulting in more centered root canal preparations[16].

Reciprocating motion lessens torsional and flexural strains, improves the canal's capacity to centre itself, and lessens the instrument's taper lock within the canal. Therefore, WOG reported a superior centering ratio with less canal transportation and a relatively less aggressive volume of removed dentin comparatively better than DIA-X files.

Though there is literature on the reduction of fatigue resistance and extended life span of WOG instruments, but there is requirement of investigations regarding canal shaping ability of single file systems. These are necessary because fast approaches toward the apex with fewer instruments and sharp cutting edges produces aberrations[17].

The results from our study is in accordance with study by Lu Shi et al where WOG files showed better canal centering ability in comparison with Protaper Gold[18]. According to Jellil[19] et al and Vallabhaneni[20] et al Single-file reciprocation (WOG) files reportedly maintained original canal morphology, which was in accordance with our study.

As there is paucity in literature on shaping ability of DIA-X file system, the present study was carried out, and it was reported that DIA-X file system has greater tendancy of apical transportation than WOG file system. Further clinical research is needed to conclude the shaping ability of DIA-X file system.

CONCLUSION

Within the limitations of the present study, it can be concluded that:
Group 1: WOG showed the highest canal centering ability and least apical transportation compared to Group 2: DIA-X at all three levels.

This study focused on behavior of NiTi files in curved canals and their ability to remain center inside, following the natural anatomy of the canal. Thus, it can be concluded that WOG can be used efficiently inside the canal with tolerable value of canal transportation. DIA-X files had considerably higher canal transportation compared to WOG.

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