Dental Science

KEYWORDS: Significant results were obtained in the apical region of the roots with Pro AF Baby Gold pediatric rotary endodontic file.

COMPARATIVE EVALUATION OF CANAL TRANSPORTATION AND CANAL CENTRING ABILITY IN PRIMARY ROOT CANALS USING PRO AF BABY GOLD AND KEDO-S PEDIATRIC ENDODONTIC ROTARY FILES WITH CONE BEAM COMPUTED TOMOGRAPHY- AN INVITRO STUDY

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ABSTRACT

Background: Cleaning and shaping the root canal is an important phase in endodontic therapy. A prepared root canal should have a shape that flares from apical to coronal regions, maintaining the apical foramen and not changing the original canal curvature.

Aim: To compare canal transportation and canal centring ability in primary root canals using Pro AF Baby Gold and Kedo-S pediatric endodontic rotary files with Cone Beam Computed Tomography.

Materials and methods: 20 teeth were divided equally in two experimental groups of 10 each. Instrumentation was performed in Group I with Pro AF Baby Gold and Group II with Kedo-S. CBCT images were obtained before and after instrumentation with NewTom equipment (NNT software). The amount of canal transportation and centering ability. Data were analysed statistically using the independent sample t-test at a significance level of $p<0.05$. All data were processed by SPSS 24.0 software (SPSS Inc., Chicago, IL).

Results: Significant results were obtained in the apical region of the roots with Pro AF Baby Gold pediatric rotary endodontic file.

Conclusion: Pro AF Baby Gold have shown to produce less canal aberrations when compared to Kedo-S rotary files when used in root canals of primary dentition.

Introduction

Root canal treatment is indicated for primary teeth displaying signs of irreversible pulpitis or pulp necrosis.1 In traditional paediatric endodontics, root canal preparation is performed with hand instruments. However, this manual technique may lead to canal aberrations, perforations, inadequate cleaning, transportation, instrument failure, and long chair time for children.2,3 Since its development, nickel titanium (NiTi) rotary instrumentation is widely used in adult endodontics as an efficient technique.[4,5]

Use of the NiTi rotary instruments in primary teeth was initiated by Barr et al. [2000] and others2,6,7 have elaborated since then the use of NiTi instruments in paediatric endodontics. Barr et al. [2000] stated that using NiTi instruments for root canal preparation in primary teeth is faster, cost effective, and has resulted in uniform and predictable fillings. But NiTi files designed for permanent dentition was used for performing bio-mechanical preparation during pulpectomy. Recently, pediatric endodontic NiTi rotary endodontic file system, Kedo-S and Pro AF Baby Gold, have been developed to over come the difficulties encountered with adult rotary files. According to Silva et al. [2004]6, the reduction of the instrumentation time with NiTi files is an important clinical factor for paediatric endodontic therapy since it allows for faster, safer and more effective root canal preparation, additionally reducing the fatigue of the patient and the dental team. During biomechanical preparation the original root canal anatomy should be maintained i.e the instrument should be perfectly centered into the canal space with minimal amount of canal transportation.

Literature on the canal centricity and canal transportation in primary teeth after instrumentation with pediatric rotary endodontic files is limited. Hence the present study was planned and aimed to compare the canal centricity and canal transportation during the preparation of primary molar root canals using Pro AF Baby Gold and Kedo-S pediatric rotary files in in-vitro conditions. The null hypotheses tested were that (a) no difference exists between the canal centricity associated with various pediatric NiTi rotary files systems. (b)no difference exists between the canal transportation of various pediatric NiTi rotary files systems.

Material and Methodology

This in vitro experimental study was carried out in the Department of Pediatric and Preventive Dentistry, Sharad Pawar Dental College, Sawangi (Meghe), Wardha in collaboration with NandedDiagnostics, Nanded for evaluating canal centricity and canal transportation. Institutional ethical committee clearance was obtained from DattaMeghe Institute of Medical Sciences (Deemed to be University), Sawangi (Meghe), Wardha with reference number DMIMS (DU)/IEC/2017-18/67[46].

A total of 20 primary molars meant for extraction due to unfavorable prognosis atleast with 7 mm root canal length were collected and cleaned with 5.25% sodium hypochlorite for 1 hour after ultrasonic scaling and then stored into 0.1% thymol solution at 4° C for not more than 3 months. Teeth were numbered from 1 to [20].

A. Pre-operative evaluation

Two arch shaped polyvinyl siloxane impression material index (Figure 1) were prepared to contain 10 teeth each, with numerical numbers written on the putty index corresponding to tooth number. Arch form index was made so that it simulates the normal arch form which helps to shoot CBCT in maximum field of view i.e.11cm x 5cm. The crown portion of the teeth were embedded in Polyviniyl Siloxane (Photosil, Zhermack) impression material. Pre-operative CBCT (NewTom, GIANO) scan was done for all the teeth. The same putty index was utilized post-operatively for CBCT evaluation. (Figure 2)

CBCT specifications used were: Axial thickness of 0.15 mm,
Field of view (FOV) was 11 x 5 cm (HiRes),
Exposure time of 9 seconds,
Tube current (mA) 3 mA, and
Energy/potential (kV) 90 kV

The odontometric measurement (measurement of dental hard tissue) of cross-section of the roots on mesial (M1) and distal (D1) sides of the root canals were assessed using measurement tool in the NNT software (NewTom) (Figure 2). These measurements were done at 1, 3 and 6 mm from CEJ and were recorded. For this cross-sectional images were made at each specified level using NNT viewer software (provided by the manufacturer). A tangent was drawn, which was touching the external surface of each root on mesial and distal aspects. This was done to obtain a reference point on external surface of root. From this reference point the perpendicular line was drawn till the inner wall of root canal to measure the thickness of hard tissue. The length of this perpendicular line was taken into consideration as M1 and D1.

The molar teeth were randomly and equally divided into 2 groups i.e. Group A and Group B.

Group A (n=10) was instrumented with 3rd generation NiTi pediatric rotary files (Pro AF Baby Gold)

Group B (n=10) was instrumented with 2nd generation NiTi pediatric Rotary files (Kedo-S).

B. Preparation of teeth

Before starting this step, each tooth was embedded in separate 2cm x 2cm polyvinyl silicone blocks (Figure 1) such that the apical foramen is visible from the lower side of the block for determination of working length.

Root canal access opening was done using sterile round burs (BR-46, BR-41) and de-roofing of the pulp chamber was done with the help of safe end tapered bur (EX-24), to achieve a straight line access to root canal orifice. New sterile burs were used for each tooth. The canal orifice was located with the help of a DG16 instrument (Densply, Sirona). Copious irrigation of the pulp chamber was done with 2 ml of 5.25% sodium hypochlorite. A #10 K-file (Mani, Japan) was placed, while sodium hypochlorite was still in the pulp chamber, into the root canal such that it can be just seen at the apical foramen. The final working length was adjusted at 1 mm short of apex. A # 15 No. K-file (Mani,Japan) was introduced into the root canal

Group 1–Following recommended protocol for Pro AF Baby Gold NiTi pediatric rotary file, endomotorhandpiece (X-Smart, DentsplyMaillefer, USA) was set at 300 RPM, 2N torque and in auto-reverse mode. Preparation was started with B0 (#15/.10) orifice enlarger. It was first used for enlarging 4 mm of the canal cervically. Irrigation with 1 ml 5.25% sodium hypochlorite followed by 1 ml normal saline irrigation and recapitulation was done with #10 K-file (Mani, Japan). This was followed by introduction of B1 (#20/.04) file (Pro AF Baby Gold) along with 17% EDTA till the working length. Irrigation with 1 ml 5.25% sodium hypochlorite followed by 1 ml normal saline irrigation and recapitulation was done with #10 K-file (Mani, Japan). Then Pro AF Baby Gold B2 (#25/.04) file was used for the canal preparation in presence of 17% EDTA. Irrigation with 1 ml 5.25% sodium hypochlorite followed by 1 ml normal saline irrigation and recapitulation was done with #10 K-file (Mani, Japan). The canals were instrumented in pecking motion till the working length is achieved and withdrawn in lateral brushing motion.

Group 2– Initial patency with #15 No. K-File (Mani,Japan) was checked passively with watch winding motion. Following recommended protocol for Kedo-S NiTi pediatric rotary file, endomotorhandpiece (X-Smart, DentsplyMaillefer, USA) was set at 300 RPM, 2.2N torque and in auto-reverse mode. Kedo-S D1 (Red - 0.25 tip diameter) file was used for the canal preparation along with 17% EDTA. Kedo-S D1 file was used to file the canal for 2 times in brushing motion till the working length and in between the filing process canal was irrigated with the help of 1 ml 5.25% sodium hypochlorite and 1 ml 0.9% normal saline.

Each time after retrieving, the files were inspected for deformation with a handheld magnification glass under light illumination. The distorted files were disposed off. The files which did not show deformation were discarded after second use. The files were also inspected for clogging in between the flutes. The files were made free of clogs with the help of a tissue paper. Primary investigator did instrumentation for maximum of five teeth at a time, to avoid error in relation to operator fatigue.

The teeth were then retrieved from polyvinyl silicone blocks and mounted on the Polyviniyl siloxane (Photosil, Zhermack) impression material arch form index, in the same sequence, which was used previously for pre-operative CBCT. Post-instrumentation root of the teeth was assessed by CBCT scan following similar settings. Mesial (M2) and distal (D2) odontometric measurements of the roots were recorded.

C. Assessment of Canal Centring ability (Figure 3)

The multi-planner root canal system after preparation were analyzed using CBCT scan. The canal centring ability was analysed by pre and post-operative CBCT scan.

Calculation of canal centring ability ratio was done using the values observed during the odontometric measurement of hard tissue thickness on mesial and distal aspect of each root canal pre-operatively and post-operatively:

Canal Centring ability ratio = (M1 – M2) / (D1 – D2)

M1- pre-instrumentation odontometric measurement of mesial side of root canal

M2- post-instrumentation odontometric measurement of mesial side of root canal

D1- pre-instrumentation odontometric measurement of distal side of root canal

D2- post-instrumentation odontometric measurement of distal side of root canal.

A value 1.0 indicated perfect centring ability of the file. When this value was near to zero, it implies a lower capacity of instrument to maintain its centring ability in the central axis of the canal.[45]

C. Assessment of Canal Transportation (Figure 3)

Transportation at each level was calculated using the following formula: (M1 – M2) - (D1 – D2)

Results:

Descriptive and analyticalstatisticswere done. All the data is expressed in mean and standard deviations. The normality of data was analyzed by the Shapiro-Wilktest. As the data followed normal distribution, parametric tests were used to analyze the data. The independent sample t-test was used to check mean differences wherever appropriate. The significance level was kept at p<0.05. SPSS (StatisticalPackagefor Social Sciences) Version 24.0 (IBM Corporation, Chicago, USA) software was used.

Table 1: Summary ofComparison of centring ratio in primary maxillary and mandibular molar teeth by independent sample t-test using Pro AF Babay Gold and Kedo-S pediatric rotary files.

Tooth	Root	Level	Group I		Group II		p value#
			Mean	S.D.	Mean	S.D.	
Maxillary Molar	Mesial	6 mm from CEJ	1.21	0.56	2.83	0.75	0.001†
		3 mm from CEJ	0.90	0.16	2.75	1.25	0.003†
		1 mm from CEJ	0.90	0.16	1.02	0.26	0.331
	Distal	6 mm from CEJ	0.85	0.69	0.36	0.37	0.144
		3 mm from CEJ	1.07	0.44	0.45	0.17	0.009†
		1 mm from CEJ	1.09	0.30	1.05	0.43	0.851
	Palatal	6 mm from CEJ	0.00	0.00	0.16	0.40	0.300
		3 mm from CEJ	0.50	0.50	0.50	0.44	1.000
		1 mm from CEJ	0.52	0.74	0.58	0.80	0.901
Mandibular Molar	Mesio-Buccal	6 mm from CEJ	1.33	0.57	3.00	0.81	0.031†
		3 mm from CEJ	0.88	0.19	2.12	0.62	0.023†
		1 mm from CEJ	0.88	0.19	1.41	1.06	0.446
	Mesio-Lingual	6 mm from CEJ	0.83	0.28	3.00	0.81	0.008†
		3 mm from CEJ	0.88	0.19	1.37	0.94	0.429
		1 mm from CEJ	0.88	0.19	0.85	0.17	0.817
	Disto-Buccal	6 mm from CEJ	1.00	1.00	0.45	0.41	0.363
		3 mm from CEJ	1.00	0.00	0.87	0.25	0.437
		1 mm from CEJ	1.16	0.28	1.04	0.34	0.631
	Disto-Lingual	6 mm from CEJ	1.00	0.00	0.41	0.41	0.065
		3 mm from CEJ	1.16	0.76	1.37	0.75	0.733
		1 mm from CEJ	0.88	0.19	0.91	0.17	0.846

#P-value, † significant at p <0.05

Table 2: Comparison of canal transportation in deciduous maxillary and mandibular molar

Tooth	Root	Level	Group I		Group II		P-value#
			Mean	S.D.	Mean	S.D.	
Maxillary Molar	Mesial	6 mm from CEJ	0.01	0.06	0.20	0.04	<0.001†
		3 mm from CEJ	-0.02	0.04	0.18	0.11	0.001†
		1 mm from CEJ	-0.02	0.04	0.00	0.06	0.377
	Distal	6 mm from CEJ	0.01	0.03	-0.15	0.08	0.001†
		3 mm from CEJ	0.00	0.05	-0.16	0.08	0.001†
		1 mm from CEJ	0.01	0.06	0.00	0.10	0.780
	Palatal	6 mm from CEJ	-0.01	0.08	0.01	0.07	0.300
		3 mm from CEJ	-0.07	0.07	-0.06	0.05	1.000
		1 mm from CEJ	0.02	0.14	0.05	0.15	0.901
Mandibular Molar	Mesio-Buccal	6 mm from CEJ	0.03	0.05	0.20	0.08	0.031†
		3 mm from CEJ	-0.03	0.05	0.12	0.05	0.023†
		1 mm from CEJ	-0.03	0.05	0.02	0.12	0.446
	Mesio-Lingual	6 mm from CEJ	-0.03	0.05	0.20	0.08	0.008†
		3 mm from CEJ	-0.03	0.05	0.12	0.05	0.429
		1 mm from CEJ	-0.03	0.05	-0.05	0.05	0.817
	Disto-Buccal	6 mm from CEJ	0.03	0.05	-0.12	0.09	0.363
		3 mm from CEJ	0.00	0.00	-0.02	0.05	0.437
		1 mm from CEJ	0.03	0.05	0.00	0.08	0.631
	Disto-Lingual	6 mm from CEJ	0.00	0.00	-0.15	0.10	0.065
		3 mm from CEJ	0.00	0.10	0.02	0.09	0.733
		1 mm from CEJ	-0.03	0.05	-0.02	0.05	0.846

#P-value derived from independent sample t-test; †significant at p < 0.05

Discussion:-

Several methods have been used in the past for evaluating canal centricity namely radiographs, scanning electron microscope (SEM), photographic evaluation and software based assessment. In these techniques, repositioning of the samples for post scanning is difficult. This may result in error in readings.[8,9,10,11]

A non-invasive method, Cone Beam Computed tomography (CBCT), has been used in past, for evaluation of centring ability of the files. CBCT provides highly accurate and quantifiable multiplanner images at various cross-sections. According to Pansheriya et al10 in 2018 and Acar B et al10 in 2015, among the above mentioned methods for evaluating canal centricity, CBCT was found to be a better and feasible method to perform. With this non-invasive method, repeatable and acceptable results are obtained. The amount of canal transportation and its direction can be viewed at any level.[8,13,14]

Therefore in the present study CBCT evaluation for canal centricity was performed. Similar methodology for evaluating canal centricity was used by Honardar et al,14 Jain et al,15 and Maitin et al.[8]

Studies conducted by different authors, took root apex as a reference point for evaluating canal centricity (at different levels from apex).14,15 However, considering the continuous physiological root resorption associated with primary roots, CEJ was considered as a reference point for this study. This also helped in standardizing the protocol for evaluating canal centricity. Levels at which canal centricity was evaluated were – 1 mm from CEJ, 3 mm from CEJ and 6 mm from CEJ.

Canal centering ability or ratio is related to canal transportation. Whenever there is a well centered file, its canal centering ratio is close to 1 and canal transportation is close to zero. As there is canal transportation, the canal centring ratio is affected. Similar values are reflected in the results.[14,15]

In the present study, on comparing centring ability in the maxillary teeth, third generation pediatric NiTi rotary file (Pro AF Baby Gold file) have maintained better canal centricity at all the levels over second generation pediatric rotary files. Mesial roots at 6 mm and 3 mm from CEJ showed better centring ability with Pro AF Baby Gold with mean ratio of 1.21±0.56 and 0.90±0.16 respectively, when compared to Kedo-S at same levels with mean ratio 2.83±0.75 and 2.75±1.25 respectively (Table 1). In distal roots of maxillary molar (Table 1), Pro AF Baby showed better canal centricity at 3 mm from CEJ with mean ratio of 0.88±0.19. The palatal canals were under-prepared and thus the canal centricity has insignificant difference with both the file systems (Table 1). Similarly, Canal Transportation at 6mm from CEJ and 3mm from CEJ levels of mesial and distal roots of maxiallary molars have shown significant difference.

In mandibular molars, at 6 mm from CEJ, mesio-buccal canals (Table 1) had mean centring ratio of 1.33±0.57 for Pro AF Baby Gold files and 3.00±0.81 for Kedo-S files. Similarly, mesio-lingual canals (Table 1) had mean centring ratio of 0.83±0.28 and 3.00±0.81 for Kedo-S. It was concluded that Pro AF Baby Gold was better than Kedo-S in terms of canal centring ability. The disto-buccal and disto-lingual canals were under-prepared and thus the canal centricity has insignificant difference with both the file systems (Table 1). Similarly, Canal Transportation at 6mm from CEJ level of mesial-buccal and mesio-lingual roots of and 3mm from CEJ level of mesio-buccal roots of mandibular molars have shown significant difference.

(Table 2) The results were in accordance with Bhatt et al,17 in which the highest centring ability with least amount of canal transportation was shown by 3rd generation file (Twisted files) at middle and apical region of primary molars followed by 2nd generation (Mtwo files) and then ProTaper files. Also, Bhaumik et al18 in 2017 compared 3rd generation of NiTi files (Twisted files) and two fifth generation files in primary mandibular molars, found that third generation twisted files showed least canal transportation and also remained perfectly centered (1±0) in the apical third of the roots. Canal centricity was better with third generation rotary files, as there is less transportation of the canal. (Table 2)

However, some studies showed contrasting results. Ramazani et al19(2015) concluded that 2nd generation file (Mtwo) showed similar results at all the levels within the primary canals. Study done by Schafer et al20 (2006) demonstrated the primary canal prepared with Mtwo file, 2nd generation, maintained more canal centricity and less transportation. Also Honardar et al15 in 2014 it was found that no significant difference were seen on comparison of 3rd and 2nd generation rotary files pertaining to canal centricity and canal transportation in primary molars. The result obtained are different from that of the present study may be because of the physiologic resorption of the roots of primary tooth.

In the present study, as seen in the table 1 and table 2, Pro AF Baby Gold showed an increased tendency of canal centricity with less canal transportation as compared to Kedo-S with a statistically significant difference. This is supported by a study in 2016 by YuGu et al in which they have concluded that amongst the heat treated NiTi instruments, the CM wire based instruments created more favorable canal centered preparation in S-Shaped canals.[21]

It is also seen in the results that the values are mostly significant in relation to the mesial canals which are narrow when compared to distal and palatal canals, which may require larger files for preparation. In the present study root canal preparation was done till #25/.04 file only. The results suggest of that; wider files should have been used. Pro AF Baby Gold has 25/.06 and 30/.04 files and Kedo-S has E1 for wider canals.

The study proved that the use of 3rd generation NiTi pediatric rotarty files, Pro AF Baby Gold showed a better result over 2nd generation NiTi pediatric rotary files i.e. Kedo-S in terms of canal centricity and cleaning efficacy rejecting the null hypothesis. The use of specialized pediatric rotary files will reduce the chance for iatrogenic errors.

Fully formed non-resorbed roots should also be taken into consideration for future studies as apical extrusion with closed apex will be comparatively less when compared to resorbed roots.

Conclusions

In conclusion, the null hypothesis was rejected, as significant differences were found among the instruments used. Canal Centricity and canal transportation results are better with Pro AF Baby Gold at all the levels of the canal but was significantly better in apical region when compared to Kedo-S.

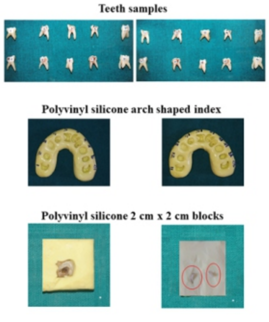

Figure 1 : Preoperative sample preparation

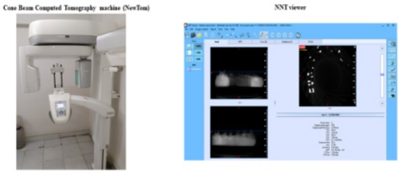

Figure 2 : Cone Beam Computed Tomography

Figure 3 : Odontometric measurement of cross section of roots using CBCT

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