ORIGINAL RESEARCH

Evaluation and Comparison of Dentin Thickness, Centering Ability, Canal Transportation, and Instrumentation Time of Pro AF Baby Gold and Pedoflex Files in Primary Root Canals Using a Cone Beam Computed Tomographic Analysis: An *In Vitro* Study

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Abstract

Introduction: Pediatric rotary systems have the advantage of improved canal centricity and conservative canal preparation with better obturation quality. Pro AF Baby Gold and Pedoflex files are two exclusive pediatric rotary file systems that were introduced in recent times.

Aim and objective: The aim of the present study is to compare and evaluate the dentine thickness, centering ability, canal transportation, and instrumentation time of Pro AF Baby Gold and Pedoflex files using cone beam computed tomography (CBCT).

Materials and methods: A total of 40 extracted human primary molar teeth with a minimum 7 mm root length were included in the study and randomly divided into two groups: group I, Pro AF Baby Gold; group II, Pedoflex files. Teeth were imaged preoperatively with CBCT, then root canal preparation was done in both groups with respective files, followed by postoperative CBCT imaging to evaluate the dentin thickness, centering ability, and canal transportation of both groups. Instrumentation time was noted using a stopwatch.

Results: There is a statistically significant difference in the instrumentation time; Pedoflex took a shorter time when compared to Pro AF Baby Gold files. Regarding canal transportation, there was no significant difference between the two files, with Pedoflex showing a better value than the other files. Regarding centering ability, there was no significant difference between the two files, with Pro AF Baby Gold having a better value than the other files ($p < 0.001$).

Conclusion: From the findings of our present study, it was found that both systems were able to effectively shape curved root canals in terms of canal transportation and centering ability.

Keywords: Canal transportation, Centering ability, Cone beam computed tomography, Nickel-titanium rotary files, Pedoflex, Pro AF Baby Gold.

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Introduction

A crucial area of dentistry, known as pediatric endodontics, aims to keep the baby teeth in their natural, functioning state. To maintain space, function, and esthetics, primary teeth that are pulpally involved should be treated with effective restoration and debridement. The primary molar's intricate, ribbon-shaped root canal morphology makes it difficult for pulpectomy to create a three-dimensional seal successfully. Traditional hand instruments require a lot of time for mechanical preparation compared to rotary instrumentation, which can efficiently prepare root canals. Hand instruments can result in iatrogenic errors (canal transportation, apical blockage, ledging, zipping, etc.).[1] Rotary instruments facilitate patient cooperation by reducing the time needed to shape the canals, which is one of the biggest obstacles in pediatric endodontics.[2]

When preparing root canals for permanent teeth, nickel-titanium (NiTi) rotary instrumentation is frequently utilized to preserve the original canal space. After Bhat et al. (2000) reported the first case utilizing ProFile 0.04 taper rotary instruments, biomechanical preparation with rotary files in primary teeth became increasingly common. Since then, pediatric dentists have begun to use a variety of rotary NiTi systems for instrumenting primary root canals.[3]

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Before 2016, primary teeth's root canals could not be prepared using separate files; the preparation files for permanent teeth could also be utilized for primary dentition. Two newly

released rotary files that were created especially for pediatric use are the Pro AF Baby Gold and Pedoflex files. The instrument should be precisely centered in the canal space with the least amount of canal transportation possible during biomechanical preparation to preserve the original root canal anatomy. There is little research available on the topics of canal centricity and canal transportation in primary teeth following instrumentation using pediatric rotary endodontic files. Therefore, the current study was designed to compare canal centricity and canal transportation in the *in vitro* setting while primary molar root canals were being prepared using Pro AF Baby Gold and Pedoflex pediatric rotary files.

Materials and Methods

To assess canal centricity and canal transportation, an *in vitro* experimental study was carried out in the Pedodontics and Preventive Dentistry department of the Chhattisgarh Dental College and Research Institute in Rajnandgaon. The Institutional Ethics Committee gave its approval.

Groups that were used in the study:

- Group I: Pro AF Baby Gold file system.
- Group II: Pedoflex file system.

Sample Preparation

In this study, deciduous teeth with a root length of at least 7 mm were involved. Using a plastic mold, the specimens were set in an acrylic resin that autopolymerized. Wax was used to seal the root tips to prevent resin from entering the apical foramen and polymerizing.

After mixing the acrylic resin as directed by the manufacturer, it was poured into the mold. To guarantee specimen uniformity for tomographic imaging, each sample was placed into the unset acrylic resin with its long axis parallel to the mold's long axis.

Preoperative Evaluation

The CBCT parameters employed were: a field of view (FOV) of 11 × 5 cm, axial thickness of 0.15 mm, 90 seconds of exposure, 3 mA of tube current, and 90 kV of energy/potential.

Root Canal Preparation

The access cavity was created using a no. 4 round bur after the initial caries removal. A safe-ended, tapered diamond fissure bur was used to remove the roof of the access cavity, and 3% sodium hypochlorite was used to irrigate the pulp chamber. Using 10 and 15 K files, the canal was examined, and an intraoral periapical radiograph was used to calculate the working length. Following the determination of the working length, rotary files were used for instrumentation according to the manufacturer's instructions.

Group I: Using Pro AF Baby Gold files, 20 molars were instrumented using lateral brushing, with torque and speed settings of 2 Ncm and 300 rpm, respectively, until the working length was reached.

Group II: Pedoflex files were used to instrument a total of 20 molars up to the working length. An endo motor with 1.5 Ncm torque and 350 rpm speed was used to brush the teeth laterally. Following instrumentation, the coronal third, middle third, and apical third levels of dentin thickness and canal transportation were evaluated for each specimen using a CBCT scan. On the mesial and distal surfaces of the root, dentin removal was quantified at three different levels: (1) 2 mm coronal from the apex at the apical level; (2) 4 mm coronal from the apex at the middle level; and (3) 6 mm coronal from the apex at the cervical level. Cone beam computed tomography software was used to compare all levels.

Assessment of Dentin Removal

Using a CBCT scanner, teeth were measured and scanned both before and after mechanical preparation.

The following were the measurements taken:

- The M1 was the measurement made before instrumentation, between the mesial wall of the canal and the external surface of the mesial portion of the root.
- The M2 was the measurement made following instrumentation, between the mesial wall of the canal and the external root surface of the mesial portion of the root.
- Before any instruments were used, the measurement D1 was made between the distal wall of the canal and the external surface of the distal part of the root.
- The D2 measured the distance, following instrumentation, between the distal wall of the canal and the external surface of the distal portion of the root.

Canal transportation was calculated with the following equation:

$$\text{Canal transportation} = (M1 - M2) - (D1 - D2)$$

Interpretation of values:

- If the value is zero, it indicates the absence of canal transportation.
- Transportation in the distal direction is indicated by a negative value.
- Transportation in the mesial direction is indicated by a positive value.

The following equation is used to calculate the centering ability ratio using the values obtained during the transportation measurement:

$$\text{Centralization ability ratio} = (M1 - M2)/(D1 - D2)$$

Interpretation of values:

- Perfect centralization was indicated by a result of 1.0.
- If the value is close to zero, it indicates poor centralizing ability of the instrument.
- Dentin thickness of the root canals was measured at three levels of the root (apical, middle, and cervical).
- Instrumentation time was noted using a stopwatch.

Results

Analytical and descriptive statistics were performed. All of the data are expressed using the mean and standard deviations. The normality of the data was investigated using the Shapiro–Wilk test. Since the data had a normal distribution, parametric tests were used to analyze them. The independent sample *t*-test was used to examine mean differences. The Statistical Package for the Social Sciences (SPSS) Version 24.0 (IBM Corporation, Chicago, United States of America) was used, and it maintained a significance threshold of $p < 0.05$.

Dentin Thickness

Pedoflex files and Pro AF Baby Gold did not significantly differ from one another at any level, according to statistical analysis (Table 1 and Fig. 1).

Centering Ability Ratio

Pro AF Baby Gold and Pedoflex files did not significantly differ from one another at any level, according to statistical analysis (Table 2 and Fig. 2).

Canal Transportation

Comparing the Pedoflex file system to the Pro AF Baby Gold file system, the results indicate reduced canal transportation. The comparison was not statistically significant, though. The mean canal transportation for the two groups was within the acceptable range, ranging from 0.002 to 0.145 mm (Fig. 3 and Table 3).

Instrumentation Time

It was discovered that the instrumentation times of the Pedoflex and Pro AF Baby Gold files differed significantly. Compared to Pedoflex, which had a mean instrumentation time of 0.67 minutes, Pro AF Baby Gold had an instrumentation time of 1.58 minutes (Table 4 and Fig. 4). An axial cross section of the root

Table 4: Comparison of instrumentation time between both groups respectively

	Mean	*SD*	*Unpaired t-test*	*p-value*
Group I (Pro AF Baby Gold)	1.58	0.22	$t = 14.936$	$p < 0.001$**
Group II (Pedoflex file)	0.67	0.15		

**, highly significant value or difference

Table 1: Summary of comparison of dentin thickness in primary molar teeth by independent sample *t*-test using Pro AF Baby Gold and Pedoflex rotary files

		Group I		*Group II*	
		Mean [standard deviation (SD)]		*Mean (SD)*	
Root	*Level*	*Mesial*	*Distal*	*Mesial*	*Distal*
Root 1	Cervical	0.80 (0.38)	0.72 (0.42)	0.69 (0.33)	0.7 (0.3)
	Middle	0.44 (0.21)	0.35 (0.18)	0.46 (0.23)	0.37 (0.19)
	Apical	0.26 (0.17)	0.26 (0.16)	0.3 (0.19)	0.27 (0.12)
Root 2	Cervical	0.795 (0.28)	0.74 (0.49)	0.62 (0.26)	0.63 (0.36)
	Middle	0.335 (0.21)	0.48 (0.29)	0.355 (0.22)	0.44 (0.25)
	Apical	0.315 (0.169)	0.29 (0.28)	0.3 (0.145)	0.29 (0.28)
Root 3	Cervical	0.78 (0.49)	0.77 (0.3)	0.61 (0.3)	0.52 (0.31)
	Middle	0.42 (0.26)	0.51 (0.29)	0.48 (0.29)	0.54 (0.34)
	Apical	0.31 (0.16)	0.29 (0.19)	0.34 (0.19)	0.33 (0.23)

Table 2: Summary of comparison of centering ability in primary molar teeth by independent sample *t*-test using Pro AF Baby Gold and Pedoflex rotary files

		Group I	*Group II*	
Root	*Level*	*Mean (SD)*	*Mean (SD)*	*p-value*
Root 1	Cervical	1.349 (0.79)	1.10 (0.58)	0.266
	Middle	1.511 (0.949)	1.436 (0.854)	0.793
	Apical	1 (0.6)	1.13 (0.58)	0.508
Root 2	Cervical	1.192 (1.09)	1.30 (0.92)	0.728
	Middle	0.911 (0.629)	1.067 (0.642)	0.442
	Apical	1.035 (0.672)	0.89 (0.53)	0.467
Root 3	Cervical	1.267 (1.02)	1.514 (1.104)	0.470
	Middle	1.023 (0.898)	1.088 (0.851)	0.815
	Apical	0.898 (1.28)	1.193 (0.546)	0.349

Table 3: Comparison of canal transportation in primary molars using Pro AF Baby Gold and Pedoflex rotary files

Root	*Level*	*Group I*	*Group II*	*p-value*
Root 1	Cervical	0.087 (0.355)	–0.002 (0.28)	0.382
	Middle	0.095 (0.279)	0.095 (0.214)	0.975
	Apical	0.0 (0.128)	0.027 (0.147)	0.533
Root 2	Cervical	0.05 (0.55)	–0.015 (0.35)	0.662
	Middle	–0.145 (0.221)	–0.085 (0.29)	0.471
	Apical	0.025 (0.23)	0.01 (0.235)	0.840
Root 3	Cervical	0.005 (0.6)	0.09 (0.39)	0.602
	Middle	–0.087 (0.328)	–0.052 (0.30)	0.729
	Apical	0.02 (0.206)	0.005 (0.163)	0.801

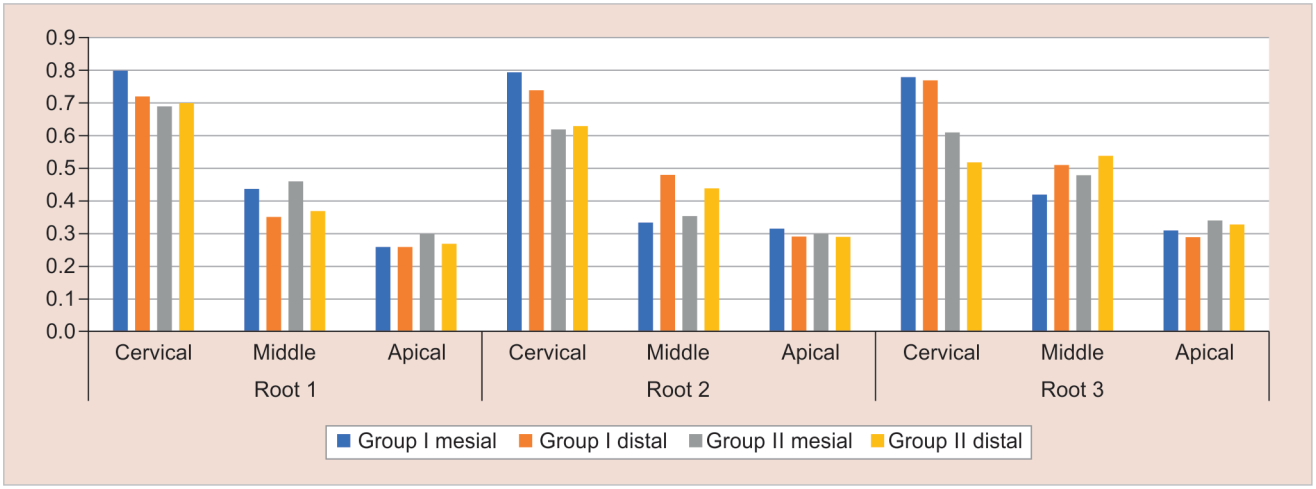

Fig. 1: Dentin thickness

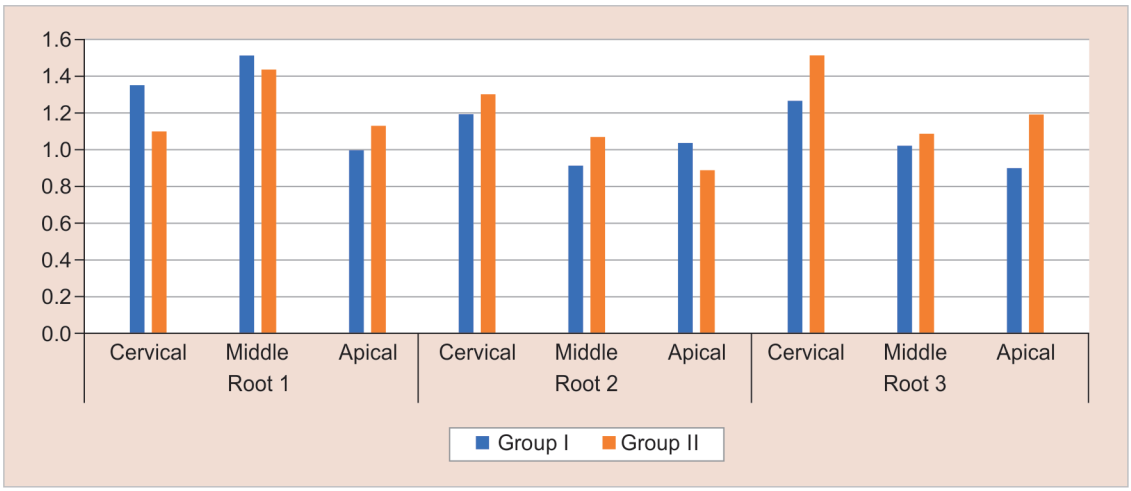

Fig. 2: Centering ability

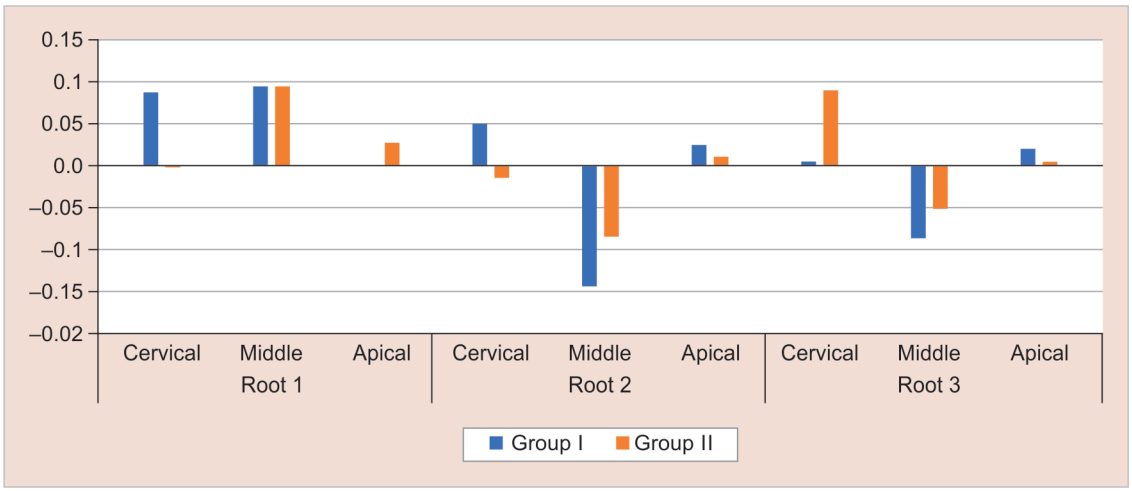

Fig. 3: Canal transportation

demonstrating pre- and postinstrumentation results of Pedoflex files showed that at that specific moment, they outperformed Pro AF Baby Gold files (Fig. 5).

Discussion

Compared to permanent root canals, root canals of primary teeth are thought to be anatomically more intricate and challenging. The purpose of this study was to shorten the time and number of files needed for the primary canal shaping process. In contrast to traditional radiography, cone beam computed tomography (CBCT) imaging provides a higher degree of accuracy and resolution for the evaluation of anatomic structures in three dimensions.[4,5]

Cone beam computed tomography has been recommended for both pre- and postinstrumentation evaluation of the canal, according to Nagaraja and Murthy. The amount and direction of canal transportation can be observed at any level without sacrificing the specimen.[6] Therefore, before and after instrumentation, dentin thickness was measured in our study using CBCT, which was also used to assess canal centering ability and canal transportation. The advanced NiTi-controlled memory wire in Pro AF Baby Gold and Pedoflex files is said to have a noncutting tip to reduce apical transportation and heat treatment for improved canal centricity. They were both chosen for the research. In this study, teeth with a minimum root length of 7 mm were selected to mimic a clinical pulpectomy procedure, in which a minimum of two-thirds of the root length is thought to be required.

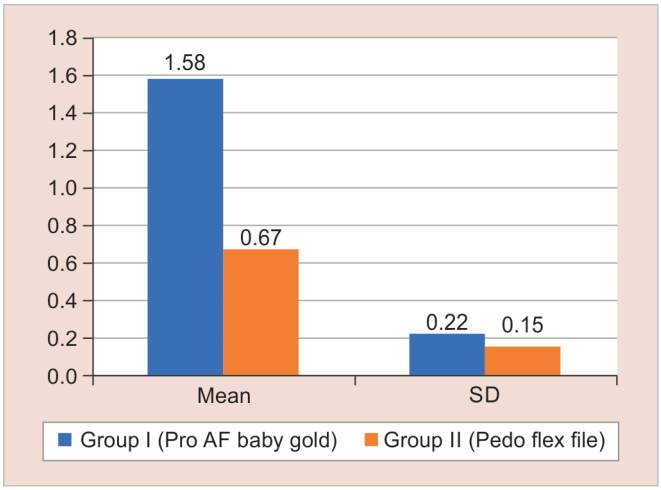

Fig. 4: Instrumentation time

Three levels were selected for the current study: 2 mm coronal from the apex, 4 mm coronal from the apex, and 6 mm coronal from the apex.

The measurements pertain to the apical, middle, and coronal regions of root canals, which are known to have curvatures that are highly susceptible to iatrogenic injuries. For the study to properly assess all the files assigned to distinct canals, such as narrow, medium, and wide, all three roots are considered.

When comparing the Pedoflex file system to the Pro AF Baby Gold file system, less canal transportation was observed. The comparison was not statistically significant, though. According to our findings, the Pedoflex rotary system was not as good at centering as the Pro AF Baby Gold file system. This difference was still not statistically significant.

The findings aligned with those of Bhatt et al., wherein the third-generation file (Twisted Files) at the middle and apical regions of primary molars demonstrated the highest centering ability with the least amount of canal transportation, followed by the second-generation (Mtwo Files) and finally the ProTaper Files.[7] Moreover, in 2017, Bhaumik et al. examined two fifth-generation files and the third generation of NiTi files, or "twisted files," in primary mandibular molars. They discovered that the third generation of twisted files had the least amount of canal transportation and stayed precisely centered in the apical third of the roots.[8] According to this study, the Pro AF Baby Gold's 1.58 minutes were statistically significantly longer than the Pedoflex files' 0.67 minutes. Since the quantity of files used determines how long preparation takes, Pro AF Baby Gold files required two files per canal, while Pedoflex files only required one file per canal. Consequently, it took less time to prepare the root canal with Pedoflex files.

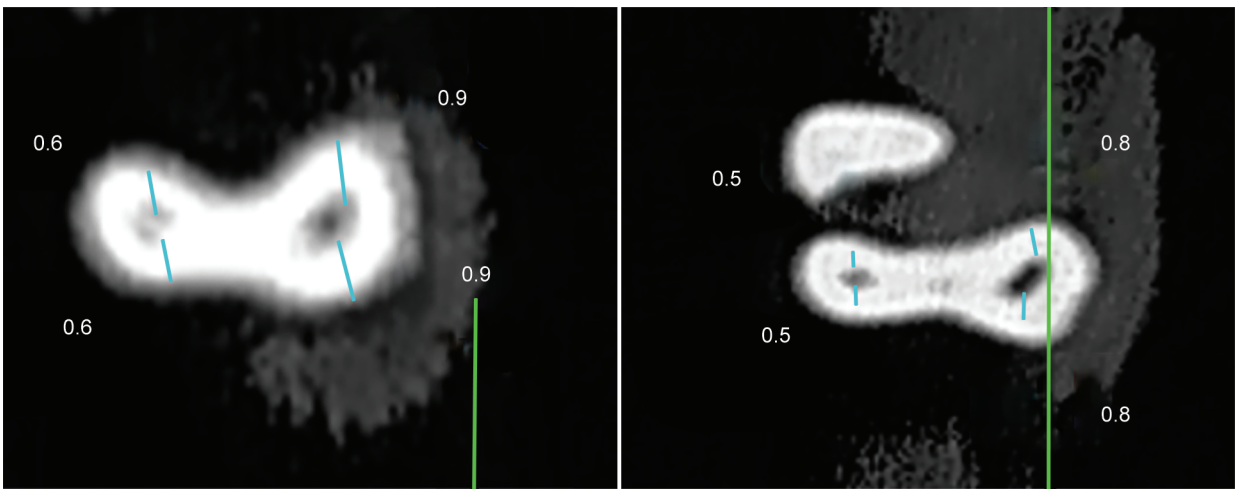

Fig. 5: Axial cross section of the root showing pre- and postinstrumentation results group I and group II respectively

Conclusion

In light of this study's findings, it was discovered that both systems could successfully shape root canals in terms of centering and canal transportation. Both systems created well-centered preparations, transported materials in a minimally acceptable manner, and prepared root canals with adequate flare without removing excessive dentin.

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References

1. Vaishali Naidu D, Sharada Reddy J, Patloth T, et al. Cone-beam computed tomographic evaluation of the quality of obturation using different pediatric rotary file systems in primary teeth. Int J Clin Pediatr Dent 2021;14(4):542–547. DOI: 10.5005/jp-journals-10005-2000
2. Jindal L, Bhat N, Mehta S, et al. Rotary endodontics in pediatric dentistry: literature review. Int J Health Biol Sci 2020;3(2):9–13.
3. Jeevanandan G, Govindaraju L. Clinical comparison of Kedo-S pediatric rotary files vs manual instrumentation for root canal preparation in primary molars: a double-blinded randomized clinical trial. Eur Arch Paediatr Dent 2018;19(4):273–278. DOI: 10.1007/s40368-018-0356-6
4. Vizzotto MB, Silveira PF, Arús NA, et al. CBCT for the assessment of second mesiobuccal (MB2) canals in maxillary molar teeth: effect of voxel size and presence of root filling. Int Endod J 2013;46:870–876. DOI: 10.1111/iej.12075
5. AAE and AAOMR joint position statement: use of cone beam computed tomography in endodontics 2015 update. J Endod 2015;41:1393–1396. DOI: 10.1016/j.joen.2015.07.013
6. Nagaraja S, Murthy BS. CT evaluation of canal preparation using rotary and hand NI-TI instruments: an in vitro study. J Conserv Dent 2010;13(1):16. DOI: 10.4103/0972-0707.62636
7. Bhatt A, Rajkumar B, Gupta V. A comparative evaluation of three different Ni-Ti rotary files using crown down technique. an ex-vivo study using CT scan. Bangladesh J Med Sci 2017;16(2):212–218. DOI: 10.3329/bjms.v16i2.31940
8. Bhaumik T, Roy M, Das UK, et al. Comparison of apical transportation and centering ability of ProTaper Next, Hyflex CM and twisted files by using cone beam computed tomography. J Res Med Dent Sci 2017;3(12):29–34.