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EFFICACY OF PEDIATRIC ROTARY FILES VERSUS CONVENTIONAL HAND FILES IN PULPECTOMY OF PRIMARY MOLARS

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Abstract

Background: The present study aimed to compare conventional K-hand files and pediatric Kedo-S rotary files using cone beam computed tomography. **Materials and methods:** Twenty extracted mandibular molars with intact distal roots were randomly divided into 2 groups (10 in each group), the teeth were instrumented by K- files & Kedo-S files and were scanned before and after instrumentation using cone beam computed tomography. SIMPLANT software was used to analyze the images of the distal roots to assess the incidence of canal transportation, centering ability, and detect the amount of removed dentin. **Results:** Kedo-S files group reflected less incidence of instrumentation errors (less transportation and better centering ability); however, Kedo-S files removed greater amount of dentin (0.4822±0.0234) than manual files (0.1814±0.0158) with significant difference between both groups (P-value<0.05). **Conclusions:** Kedo-S files achieved less transportation and better centering ability ratio than K-files, while they removed more radicular dentin that may weaken the teeth later.

Keywords: Kedo-S File, Hand K-File, Primary Teeth, Root Canal Treatment, Cone-Beam Computed Tomography.

1. INTRODUCTION

The main objective of performing root canal treatment in primary teeth is to retain them symptomless in the oral cavity, as it became clear that beside their function in mastication, esthetics, and speech, they also preserve the arch length to guide the underlying erupting permanent teeth.(1)

Conventional root canal preparation was done using hand instruments like files, reamers, drills etc. Unfortunately, the hand instrumentation techniques are more time consuming, that increase clinician's fatigue and patient uncooperativeness, also they can result in more iatrogenic errors.(2)

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In 2000, rotary systems were introduced to pulpectomy world by **Barr.**(3) Then through the last years, marked improvements in their design were noticed until the emergence of an exclusive pediatric Kedo-S rotary files. These files were designed by **JeevananDan** (4) in 2017, considering that the different morphology of primary teeth root canals increases the need to use particular files with altered length and taper.

The pediatric Kedo-S rotary files system consists of three files constructed to suit the different sizes of primary root canals and have working length of 12 mm to expedite its use only in primary teeth, also their taper is gradual to facilitate coronal enlargement and gaining straight-line access without over instrumentation of the inner wall of root surface.(5)

Canal transportation means a change in the physiological pathway of the root canal due to over reduction of radicular dentin in a single direction rather than in all directions equidistantly from the longitudinal axis of the tooth.(6) This asymmetrical dentin removal occurs mainly because all root canal instruments tend to straighten themselves inside the curved root canals.(7) The shaping or centering ability means the ability of an instrument to stay centered in the root canal during instrumentation, and to provide a correct enlargement without excessive weakening of root structure. It is one of the parameters more frequently used to know the performance of an endodontic rotary file.(8)

Bürklein and Schäfer(9) illustrated the various factors that increase the risk of canal transportation and loss of centering ability in the curved canals, these factors include inaccurate access cavity, inflexible instruments, instrument design, insufficient irrigation during mechanical canal preparation, instrumentation technique, degree of a canal curvature, unseen canal curvatures in two-dimensional radiographs, and finally the experience of the operator.

In the past, assessment of the thickness of remaining dentin, canal transportation, and centering ability was performed by traditional radiograph, sectioning technique, scanning electron microscope, or computer manipulation technique. These methods were difficult and invasive in nature, whereas the radiographic method provides two-dimensional images of three-dimensional objects. (10)

Cone-beam computed tomography (CBCT) is a new imaging modality that utilizes a cone-shaped X-ray beam and an area detector that captures a cylindrical volume of the data in one acquisition. (11) This non-destructive technology has been successfully used for accurate assessment of changes of root canal geometry before and after instrumentation, as it is capable of a qualitative and quantitative evaluation of the root canal system in the three dimensions. (12)

Numerous studies have been performed to compare the efficacy of rotary and hand files, but the vast majority of studies were directed toward permeant teeth while studies on the primary teeth using special pediatric files are still few, so this study aimed to evaluate the efficacy of pediatric Kedo-S rotary files versus conventional hand K-files in pulpectomy of primary molars.

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2. MATERIALS AND METHODS

2.1. Ethical standards and study setting

A comparative in-vitro study was carried out at the Pediatric Dentistry Department, Faculty of Dentistry, and the cone beam x-ray was done at the Oral Medicine and Periodontology, Oral Diagnosis & Oral Radiology Department, Faculty of Dentistry after obtaining the approval of the ethical committee (REC), Faculty of Dentistry, Tanta university, code (#R-PED-7-20-3). Informed written consent from parents was attained to use their children's extracted teeth in the research.

2.2. Sample size calculation and randomization

The sample size and power analysis were determined using the Epi-Info software statistical package, version 2002, developed by the World Health Organization and the Center for Disease Control and Prevention in Atlanta, Georgia, USA. Based on the previous study results conducted by **Waly** *et al.,* (13), 80% study power & an alpha (α) level of 0.05, the estimated minimum sample size (n) was a total of 20 molars, 10 molars for each group.

Twenty extracted mandibular primary molar teeth were collected from outpatients of Pediatric Dentistry Clinic, Faculty of Dentistry, Tanta University. Selected teeth were those that have been over retained past the age of exfoliation. The selected teeth had at least two-thirds of the distal roots were intact without any evidence of external or internal resorption, distal roots having only single main canal, distal roots were free from abnormalities as calcified canals, cracks, and root fractures. Also they had moderate root angulation (20-40°).

Simple randomization was computer generated by Research Randomizer software program (https://www.randomizer.org/).(14) To ensure covert distribution into the two groups, an independent person put randomization codes in sequentially numbered, secured, opaque wrappers.

2.3. Tooth Specimen Preparation

Teeth were cleaned from soft tissues and calculus using a hand scaler, washed under running water, then disinfected with 0.5% sodium hypochlorite, and stored in sterile normal saline solution at room temperature which has been changed every 24 hours until the teeth were used within three months after extraction. The cusps were flattened to create a stable reference point, then the coronal access opening was gained; roof of the pulp chamber was removed, and all overhanging edges were eliminated. The working length was established by inserting #10 k file until it was just visible at the apical foramen and then 1mm was subtracted. Each third of the root was represented by a fixed mid-point, these measuring points at each level were marked by application of small section of 0.5 mm ligation wire cemented by sticky radiolucent material to allow easy identification in radiograph. For the postoperative CBCT image, the same slice number (on axial or coronal sections) as preoperative one was selected for postoperative reading to ensure matching between both. The teeth were mounted on cylindrical wax molds, these molds

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were arranged in linear pattern in a custom-made block of cork constructed with dimensions less than the field of view (FOV) of the CBCT machine. This prepared block was placed in the tray of the CBCT machine and positioning laser light was adjusted accordingly (Figure-1). The FOV of the machine was set as 8 cm × 8 cm with voxel size of 0.12mm and 0.24 mm axial thickness. All the teeth in the preconstructed blocks were subjected to CBCT scanning by Vatech™ PaX-i3D Green imaging machine with the following exposure parameters: 90 kV, 12.6 mA, and 9 sec.

Twenty primary mandibular molars were divided randomly into 2 groups as follow:

- **Group I (positive control group)** (*n*=10):Distal canals were prepared using K-Hand files, in quarter pull turn motion up to file #30.
- **Group II (experimental group)** (*n*=10): Distal canals were prepared using Kedo-S rotary files in lateral brushing motion. The *D*1 file (red colour coded, tip diameter 0.25mm) followed by *E*1 file (blue colour coded, tip diameter 0.3mm) were used with endodontic motor at 300 rpm and 2.2 N/cm torque.

Teeth in both groups were irrigated with freshly prepared 1% sodium hypochlorite solution in 5 ml quantity during each file change followed by normal saline using a 23-gauge needle. 17% EDTA gel was used for lubrication of files during instrumentation. After instrumentation, the teeth were repositioned in the same preconstructed blocks in the same orientation used for the pre-instrumentation scan. The post instrumentation scan was taken with the same protocol and parameter settings. The pre and post instrumentation images for both manual and rotary groups were analyzed using the SIMPLANT Program 17.09 Software using the distance measuring tools . Dentin thickness was measured on the axial cuts from the periphery of the pulp space to the outer surface at three levels (cervical, middle, apical).

2.4. Assessment of removed dentin amount:

Root canal volume for each tooth was calculated before and after instrumentation. The volume of removed dentin was determined for each tooth by subtracting the un-instrumented canal volume (V1) from the instrumented canal volume (V2) (Volume of removed dentin = V2-V1).[(15)]

2.5. Canal transportation and centering ability

The amount of canal transportation was estimated according to the formula proposed by Gambill et al. (15) as follows:

Canal transportation = (M1 − M2) − (D1 − D2). Where M1 = Shortest distance between mesial periphery of root & mesial periphery of uninstrumented canal, M2 = Shortest distance between mesial periphery of root & mesial periphery of instrumented canal, D1 = Shortest distance between distal periphery of root & distal periphery of uninstrumented canal and D2 = Shortest distance between distal periphery of root & distal periphery of instrumented canal.

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Regarding transportation direction: No transportation occurred if the results equal zero, while the positive values mean that transportation occurred toward mesial direction, and the negative values mean that transportation occurred toward distal direction.

Centering ability ratio was derived from the values of (M1, M2, D1, D2) calculated for canal transportation using the formula (15): Centering ability ratio = (M1 − M2)/ (D1 − D2) or (D1 − D2)/ (M1 − M2). If differences are unequal, smaller value is considered as numerator .When the result equals 1, this represents the perfect centering ability. On the other hand, results near to zero reflect the lower capacity of the instrument to maintain centering ability in central axis of canal.

2.6. Statistical analysis

Descriptive and analytical statistics were done using SPSS (Statistical Package for the Social Sciences) software version 26 package system, 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. P value was set at <0.05.

3. RESULTS

3.1. Evaluation of transportation:

Although both groups caused transportation, the mean transportation values occurred in rotary group were minimum and significantly lower than manual group at all three levels (P-value<0.05).(Table-1, Figure-2)

Table (1): Comparison of transportation means in distal canals between both groups

Transportation	Manual	Rotary	P-value
	Mean ± SD	Mean ± SD	
Cervical third	0.3310±0.1810	0.1270±0.0334	0.0025*
Middle third	0.1450±0.1136	0.04200±0.0220	0.0114*
Apical third	0.0820±0.0419	0.0390±0.0145	0.0066*

*Significant at 0.05 level.

3.2. Evaluation of Centering ability ratio:

The mean of centering ability ratio was greater in rotary group than manual group at all three levels(Table-2, Figure-2). After comparison between the two groups using independent sample t-test, the difference was found to be statistically significant only at the cervical level (P-value <0.05). However, at middle and apical levels, the differences were non-significant .

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Table (2): Comparison of centering ability ratio means in distal canals between both groups.

Centering ability	Manual files	Rotary files	P-value
	Mean ± SD	Mean ± SD	
Cervical third	0.3208 ±0.1005	0.4596 ±0.0917	0.0047*
Middle third	0.4570 ±0.2738	0.5024 ±0.2261	0.6907
Apical third	0.4492 ±0.1975	0.5332 ±0.1872	0.3419

*Significant at 0.05 level.

3.3. Evaluation of volume of removed dentin:

After statistical analysis and comparing means using independent sample t-test, it was noted that rotary files removed greater amount of dentin than manual files with significant difference between both groups (P-value<0.05)(Table-3, Figure-3)

Table (3): Comparison of volume of removed dentin means between both groups.

	Manual	Rotary	P-value
	Mean±SD	Mean±SD	
Removed dentin volume	0.1814±0.0158	0.4822±0.0234	<0.0001*

*Significant at 0.05 level.

4. DISCUSSION

Root canal treatment of primary teeth is a challenge due to the complex anatomy of primary teeth pulp and the unexpected behavior of the young children. (16) Cone-beam computed tomography imaging technique was adopted in this study, as it provides a definite, reproducible, and three-dimensional imaging that helps in estimation of dentine thickness and root canal volume changes before and after instrumentation without damaging the specimens. (17) Extracted lower molars were used for CBCT evaluation in order to avoid unnecessary radiation exposure for children.

In the present study, Kedo-S files group achieved minimal transportation that was significantly lower than K-files group at all three levels of root. This lower tendency toward transportation in Kedo-S files is most probably due to flexibility of Ni-Ti files and their non-cutting tips. (18) This result is in line with Del Fabbro *et al*., (19) who confirmed that usage of NiTi rotary files in primary teeth helps to maintain the original shape of root canal. In addition, Waly *et al*., (13) reported less transportation in Kedo-S files group than K-files group with no significant difference between them. The conflict with Waly *et al*., regarding the significant difference may be attributed to different mathematical calculation of transportation mean values, as this study took in consideration only the exact amounts of transportation ignoring their direction represented in positive or negative values. While in Waly et al study, the positive and negative values made the mean value near zero which gave false indication about the exact amount of transportation. On the other side, Abd El Fatah *et al.,* (20) reveled significant higher transportation of pediatric rotary files than K-files only at the apical third of root, while Prabhakar *et al*., (21) have shown a significant

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lower transportation of rotary files at middle third only. These contrasts with the present study may be due to different prepared canals and different rotary files used. Regarding the centering ability ratio, Kedo-S files group had performed better centralization than manual K-files group at all root canal levels with significant difference at the cervical third only, this agreed with Waly *et al*., (13) who documented the same finding. This result disagreed with Prabhakar *et al*., (21) who documented that the rotary files significantly surpassed K-hand files in centering ability ratio at only the middle third of root canal, otherwise in Selivany and Ahmed (17) study, the significant better centralization was recorded by rotary files in the apical root canal third. This may be attributed to different rotary files systems used in each study and different operators.

In this study, rotary files removed greater amount of dentin than manual files with significant difference between them, this may be caused by increased taper of Kedo-S files at cervical region. This result disagreed with Nabeeh *et al*., (22) Seema *et al*., (23) who documented that Kedo-S files removed less amount of dentin when compared to K-files, also Mohamed *et al*., (24) showed minimum amount of removed dentine using Kedo-S square files. This argument could be caused by the clinician's tendency towards more vigorous instrumentation, or due to usage of greater numbers of rigid K-hand files. Limitations of this study include that; only the distal roots of mandibular molars containing a single main canal were considered for CBCT evaluation although they possess variabilities in the number of root canals. Also, the canal transportation and centering ability were measured according to Gambill formula which evaluates the iatrogenic errors only in mesiodistal direction ignoring that they can also occur in buccolingual direction.

5. CONCLUSION

Rotary instrumentation with pediatric Kedo-S files can maintain original root canal morphology with minimal alterations. While they removed more radicular dentin that may weaken the teeth than K-files.

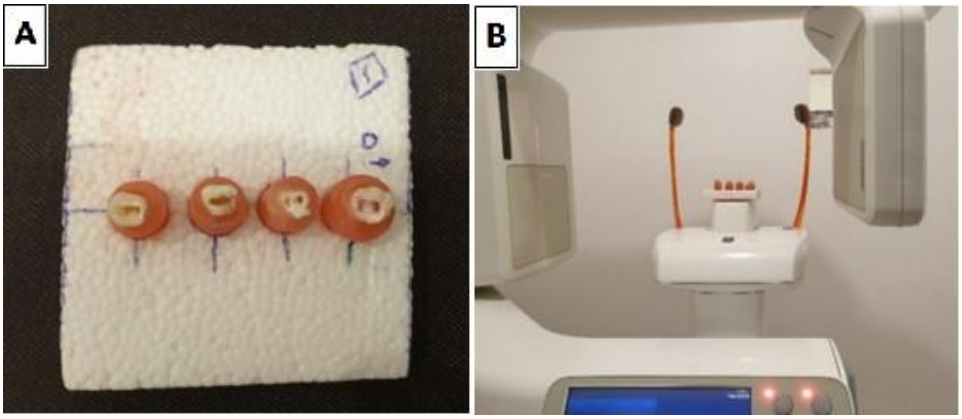

Figure (1): photographs showing methods of standardization of the specimens a) teeth arranged in a custom-made block. b) Samples block arranged on CBCT bite plate.

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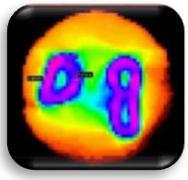
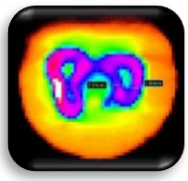
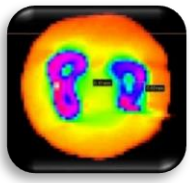
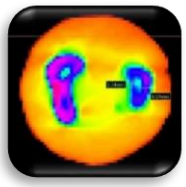
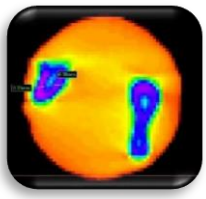
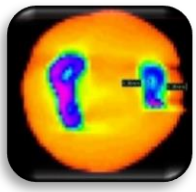
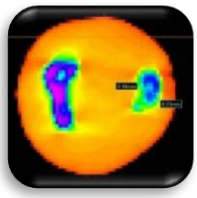
Pre-instrumentation.	Post-instrumentation.		Pre-instrumentation.	Post-instrumentation.
		Cervical third		
		Middle third		
		Apical third		
Rotary group			Manual group	

Figure (2): Axial dentin thickness in both group and measurements of M1&D1 and M2&D2

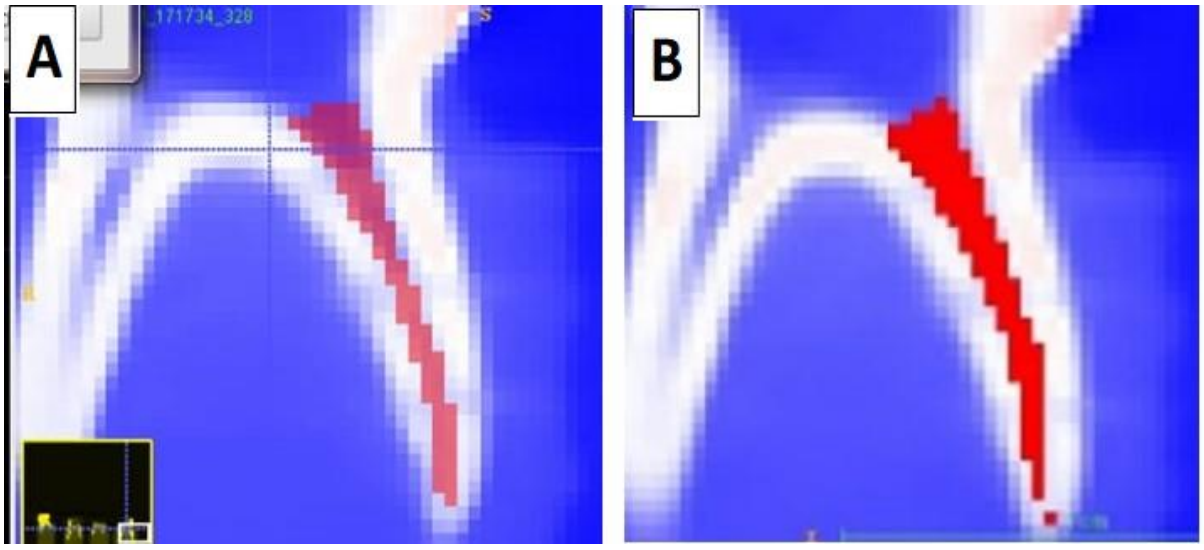


Figure (3): Evaluation of pulp volume in manual group.

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DECLARATIONS

Ethical approval and consent to participate.

Ethical Approval for the present study was obtained from the ethical committee (REC), Faculty of Dentistry, Tanta University, code (#R-PED-7-20-3) in accordance with the ethical guidelines outlined in the 1964 Helsinki Declaration and its subsequent revisions. The study purpose was explained to the Patients' parents and informed written consent was acquired from parents at the extraction time.

Consent for publication: Not applicable

Availability of Data and Materials

On reasonable request, the datasets utilized and/or analyzed during the present study are accessible from the corresponding author.

Competing interests

The authors declared no conflict of interest relevant to this article.

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There was no funding provided to the authors by any organizations.

Authors' contributions

(A.M.M). Contributed to the study design, data collection, and writing the manuscript. (A.M.E). Contributed to the study design, data gathering, and drafting of the manuscript. (H.I.S). Contributed to the study's design, data collection, and manuscript revision. (W.H.A). Helped design the study and explained the data. The final article had been reviewed and accepted by all authors.

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