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COMPARATIVE EVALUATION OF THE SHAPING ABILITY OF THREE ROTARY SYSTEMS IN PRIMARY MOLARS: IN VITRO STUDY

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ABSTRACT

Aim: This in-vitro study aimed to evaluate the shaping ability of hand K files, Kedo S, Hyflex, and the Race evo rotary files when used in the biomechanical preparation of primary molars by using CBCT.

Materials and methods: One hundred forty extracted human primary mandibular second molars were randomly allocated into 4 groups of 35 each. Group A: Prepared with stainless steel hand files (MANI, Inc.; Tochigi, Japan), group B: Prepared with Kedo S plus pediatric rotary files (Chennai, Tamil Nadu, India), group C: Prepared with Hyflex cm (Colten- Whaledent) rotary files and group D: Prepared with Race Evo (FKG Dentaire SA, La Chaux de Fonds, Switzerland) rotary files. Before starting any procedure, all the samples were scanned using cone-beam CT (Gendex -GXDP-800, Kavo, Dental Charlotte United States). Pre- operative measurements were performed at 3 points at the middle one third of the distal root canals of the primary molars. Postoperative scans were obtained similar to a preoperative manner. The root canal thickness measurements were made at the same level of the preoperative readings.

Results: Comparisons were made between the study groups' means. Data were compared using One Way ANOVA test followed by Tukey's Post Hoc test. The findings revealed no significant difference between any of the groups.

Conclusion: No differences were noted concerning the shaping ability of the rotary systems used. Thus, all these systems could be used in instrumentation of primary molars.

KEYWORDS Kedo S, primary teeth, CBCT, Pediatric rotary files

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INTRODUCTION

Elimination of bacteria from an infected root canal is a primary cause for root canal treatment.[1,2] Which maintains the integrity of oral tissues, preserving the deciduous teeth until their physiological exfoliation.[2,3] Mechanical preparation and disinfection of root canals are considered crucial steps for achieving a successful treatment outcome for both permanent teeth and primary teeth.[4,5]But performing root canal therapy is challenging for both permanent and primary teeth due to the presence of complex root canal anatomy, proximity to vital structures or permanent tooth buds, tortuous root canals, and perceived behavioural management difficulties. [4,5] The biomechanical preparation can be performed via manual or rotary files. However, the time taken for instrumentation is reduced while using the rotary files, plus the cleanliness and shaping of the canals are more efficacious.[2,6,7,8]

During the biomechanical preparation, a lot of procedural errors can arise such as transportation of canals, ledges, perforations, and cracks formation along the length of the root.[9]

In general, it is advised to instrument root canals in a way that effectively enlarges while maintaining the original anatomy and preserves the maximal dentin thickness. [10] The root canal procedure in the primary tooth was revolutionised when Barr et al. introduced nickel-titanium rotary files to paediatric endodontics. [11] Subsequently, a number of research on the use of rotary endodontic files for primary tooth root canal preparation were published in the literature.[12]

Although there were no rotary files specifically for primary teeth until 2016, primary teeth root canals were still prepared with the same rotary files designed for permanent teeth. In the field of paediatric dentistry, and more specifically paediatric endodontics, a fresh venture was made with the creation of Kedo S files, a unique rotary endodontic file for primary teeth. Three distinct Ni-Ti rotary files with differing diameters make up the Kedo S file system. Each file has a total length of 16 mm and a working length of 12 mm with a different taper. There aren't many research comparing the effectiveness of the hand file system and the Kedo S file in primary teeth.[5,13]

By evaluating the ability of the endodontic instruments to shape using a variety of techniques, including radiography, histological sections, electron microscopy, computed tomography (CT), cone-beam CT (CBCT), micro-CT, and stereomicroscope. Currently, CBCT is frequently utilised for endodontic instruments' non-invasive examination of prepared root canals.[5,14]

The present study is designed to comparatively evaluate the shaping ability of the hand K files, kedo S rotary files, Hyflex rotary files, and the Race evo rotary files when used in the biomechanical preparation of primary molars by using CBCT.

MATERIALS AND METHODS

Teeth selection and storage

Faculty of Dentistry Beni-Suef University assessed and approved the research protocol of the current study by its Ethics research committee (approval no. #REC-FDBSU/0112022-04SS).

In the current research 140 primary extracted mandibular second molars were used. Teeth were removed due to bad prognosis and over-retention over the age of exfoliation. [15] The inclusion criteria included extracted molars in children aged 5 to 11 years, primary mandibular second molars with an intact furcation (clinically and radiographically), teeth with a minimum root length of 8 mm, no root fractures as seen clinically or radiographically, no calcifications, and no developmental anomalies. The exclusion criteria were molars with clinically or radiographically visible involvement of the furcation, severe external or internal root resorption, teeth with a root length of less than 8 mm, the presence of any root fracture, calcifications, and any developmental aberration.[16,17]

Teeth were cleaned with running water and kept in saline solution at 4˚C for not more than one month.[18]

Sample preparation

Primary molars were mounted in cylindrical self-cure acrylic resin using molds (2cmx3cm) large round bur (Meisinger, Hager & Meisinger GmbH, D-41468 NEUSS, Germany) were used to open the access cavity followed by profuse irrigation using 1% sodium hypochlorite (NaOCl) to remove debris.[19] Distal root canals were selected in the study for standardization of the samples. Patency was determined using stainless steel K-file (MANI, Inc.; Tochigi, Japan) size 10.[20] The radiographic method was used to determine the working length, which was kept 1 mm short of the radiographic apex.[21]

Scanning of Samples before Root Canal Preparation

Cone-beam CT (Gendex -GXDP-800, Kavo, Dental Charlotte United States) was used to scan all teeth before any procedure at the department of Oral Radiology Faculty of Dentistry Ain-Shams University. The cone-beam CT scans were performed at 90 KV and 6.3 mA, with an 80 microns voxel size and a 5X5 cm display field of view. Fixing of the acrylic blocks were done using beam incidence at the central portion of the device. It took 30 seconds to conduct each scan. Pre- operative measurements were performed at 3 points at the middle one third of the distal root canals of the primary molars.

Grouping and Instrumentation

One hundred forty primary mandibular second molars were numbered from 1 to 140 and randomly allocated (using randomization tables) into four groups of 35 each.

- Group A: Prepared with stainless steel hand files (MANI, Inc.; Tochigi, Japan).
- Group B: Prepared with Kedo S plus pediatric rotary files (Chennai, Tamil Nadu, India)
- Group C: Prepared with Hyflex cm (Colten-Whaledent) rotary files.
- Group D: Prepared with Race Evo (FKG Dentaire SA, La Chaux de Fonds, Switzerland) rotary files.

Group A

K-files made of stainless Steel (Mani Inc, Japan) from size 15 to 30, 21 mm in length were used for the instrumentation of the distal canal of primary molar using the conventional technique with the quarter turn-pull movement. Instrumentation was performed to the working length, followed by recapitulation and 1% NaOCl was used to irrigate the canals after the use of each file.[19]

Group B

The distal root canals of the lower primary second molars in this group were instrumented with the Rotary E Kido-S plus file system (Reeganz Dental Care Pvt. Ltd. India) the preparation done using lateral brushing motion 1 to 2 times in a clockwise rotation motion till full working length using X-Smart endodontic motor (Dentsply, Wave one, Germany) at 300 rpm speed and 2.2 N cm torque.

The E file has a blue band on its handle that denotes a tip diameter of 0.30 mm.[10] 1% NaOCl was used for irrigation and EDTA gel (Glyde File Prep, Dentsply Maillefer) for root canal lubrication.[19] Only three canals were instrumented with a single file before it was discarded, or sooner if it displayed any evident distortion.[4]

Group C

The distal root canals of the lower primary second molars in this group were instrumented with Hyflex CM rotary files, the preparation done in a clockwise rotation motion using X-Smart endodontic motor (Dentsply, Wave one, Germany) at 500 rpm speed and 2.5 N cm torque[22]. First file size 25 taper 8% was used as an orifice opener, followed by

size 20 taper 4%, size 25 taper 4%, size 30 taper 4% were used in a sequential manner till the working length. 1% NaOCl was used during instrumentation and EDTA (Glyde File Prep, Dentsply Maillefer) was used for root canal lubrication. [19] Only three canals were instrumented with a single file before it was discarded, or sooner if it displayed any evident distortion.

Group D

The Race Evo were used to instrument the distal root canal of lower primary second molars in a clockwise rotation motion using X-Smart endodontic motor (Dentsply, Wave one, Germany) at 800 rpm speed and 1.5 Ncm torque.

Files used were RE1 15/0.4 one red band, followed by RE2 25/0.4 two red bands then finally RE3 30/0.4 (one red and one blue band). All files used 2 to 3 strokes in a very light pressure till the full working length ("RACE EVO | FKG Dentaire," brochure). 1% NaOCl was used during instrumentation and EDTA (Glyde File Prep, Dentsply Maillefer) was used for root canal lubrication. Only three canals were instrumented with a single file before it was discarded, or sooner if it displayed any evident distortion.

Post-preparation Scanning: After root canal preparation, samples from the postoperative images were placed similar to the first scans. The measurements of the root canal thickness were taken at the same level as the preoperative readings as shown in figure (1).

Statistical analysis

Microsoft Excel 2016 was used to perform the statistical analysis together with SPSS 20®, Graph Pad Prism®. The information provided as standard deviations and means. Shapiro-Wilk and Kolmogorov-Smirnov tests were used to examine the quantitative data for normality, and the results showed that the significant level (P-value) was unimportant since P-value > 0.05 indicated that the data had a normal distribution (parametric data). As a result, the One Way ANOVA test was used to compare the characteristics of the various groups, followed by the Tukey's Post Hoc test for multiple comparisons.

RESULTS

During this study, mean ± standard deviation of amount of dentine removal in group A was (0.137±0.07) which ranged from (0.07) minimally to (0.25) maximally. In group B, mean ± standard deviation of amount of dentine removal were (0.14±0.056) which ranged from (0.05) minimally to (0.24) maximally. In group C, mean ± standard deviation of amount of dentine removal were (0.126±0.054) which ranged from (0.06) minimal-

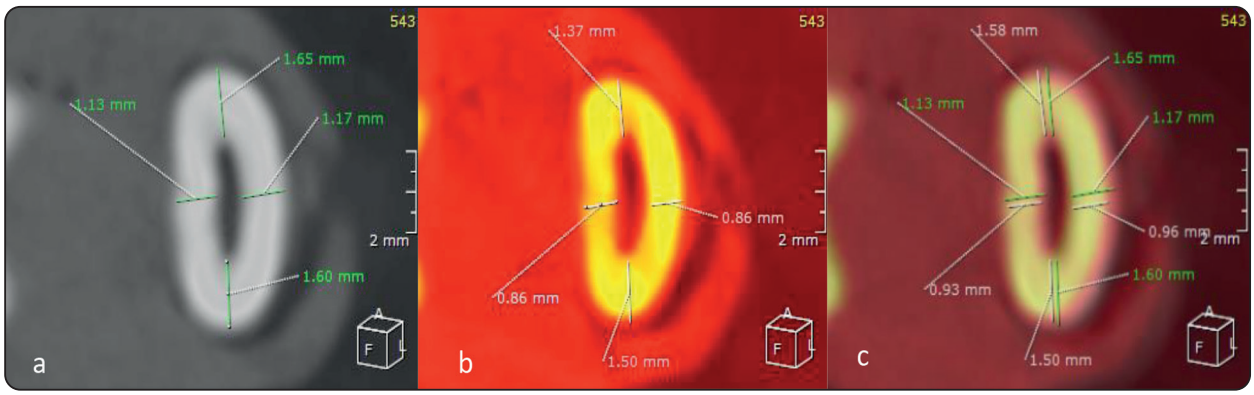

Fig. (1): a- Preoperative scan, b- Postoperative scan, and c- Superimposition of both scans after the use of Kedo S plus files.

ly to (0.22) maximally in group D, mean ± standard deviation of amount of dentine removal were (0.115±0.043) which ranged from (0.053) minimally to (0.16) maximally, this data is presented in as table (1) and shown in figure (2).

One Way Analysis of Variance (One Way ANOVA) and Tukey's Post Hoc test for multiple comparisons were used, and the results are shown in table (2). They showed that there was no statistically significant difference between any of the groups, with a P-value of greater than 0.05.

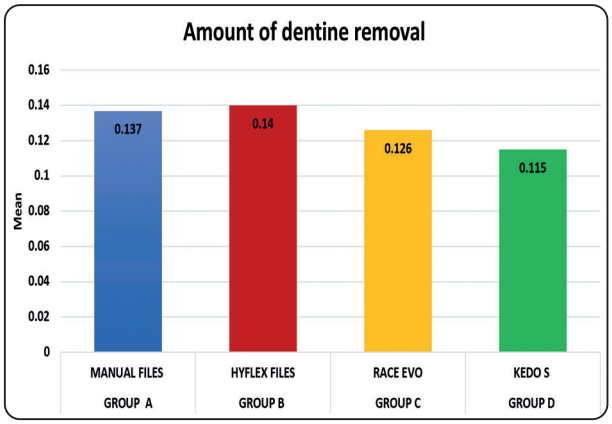

Fig. (2) Bar chart showing Descriptive Analysis of amount of dentine removal of Different Groups.

TABLE (1) Descriptive Analysis of amount of dentine removal of Different Groups:

Group		N	Minimum	Maximum	Median	Mean	Standard Deviation
GROUP A	MANUAL FILES	10	0.070	0.253	0.112	0.137	0.070
GROUP B	HYFLEX FILES	10	0.050	0.247	0.127	0.140	0.056
GROUP C	RACE EVO	10	0.060	0.220	0.108	0.126	0.054
GROUP D	KEDO S	10	0.053	0.160	0.122	0.115	0.043

TABLE (2) Multiple Comparison Analysis of amount of dentine removal of Different Groups:

Tukey's multiple comparisons test	Mean 1	Mean 2	Mean Diff.	SE of diff.	Mean Diff.	95.00% CI of diff.	P Value
GROUP A vs. GROUP B	0.137	0.140	-0.003	0.025	-0.003	-0.07 to 0.06	0.999 ns
GROUP A vs. GROUP B	0.137	0.126	0.011	0.025	0.011	-0.05 to 0.07	0.975 ns
GROUP A vs. GROUP D	0.137	0.115	0.021	0.025	0.021	-0.04 to 0.08	0.835 ns
GROUP B vs. GROUP C	0.140	0.126	0.014	0.025	0.014	-0.05 to 0.08	0.948 ns
GROUP B vs. GROUP D	0.140	0.115	0.024	0.025	0.024	-0.04 to 0.09	0.771 ns
GROUP C vs. GROUP D	0.126	0.115	0.011	0.025	0.011	-0.05 to 0.07	0.974 ns

DISCUSSION

In the last decades, a transformation has occurred in the management of infected primary teeth from extractions to pulpectomy which has become an essential procedure in pediatric patients in order to prevent space loss that may occur after extraction and also to guide the permanent successor to erupt in its proper place.[23] For pediatric dentists the main objective of pulpectomy is the complete removal of the infected or hyperemic tissues and seal the canals using a biocompatible material. Another important objective of root canal treatment (pulpectomy) is to perform the procedure in a shorter time and at the same time provide a good quality treatment.[24]

A recent development has occurred in the field of pediatric endodontics which is the use of Ni–Ti rotary instruments for canal preparation of the primary teeth. The strength of Ni-Ti rotary systems is to uniformly prepare the canals and maintain the shape with less instrumentation time and less dentine removal.[11] Studies in literature showed many Ni-Ti rotary systems designed for permanent teeth that can be used in instrumenting primary teeth. [24,25]

Hyflex CM, Race-evo and Kedo S were used in the present study. The manufacturing company claims that Hyflex CM and Race-evo underwent heat treatment that triggers a martensite-austenite transition below body temperature 32˚C, which renders the files flexibility and better ability to negotiate severely curved root canals of the deciduous teeth.[26]

Kedo S file system is specifically designed for deciduous molars with a total length of the files is 16 mm and a working length of 12 mm which is suitable for the short roots of the deciduous molars and children's small mouth opening.[13] Also Kedo S files have a variable taper corresponding to the use in primary teeth root canals.[13]

In the present study single distal root canals of the primary mandibular second molars were used. CBCT has been used as it offers accurate and more precise three-dimensional imaging. CBCT has been used to assess the shaping ability by measuring the amount of dentine removed in the middle third at 3 different points. This reflects instruments aggressiveness, specifically in primary teeth that has the highest curvatures in the middle one-third, [26] where the more amount of dentin removed during instrumentation will accelerates tooth exfoliation. [17]

The results of the current study showed non-significant difference in dentine removal between the 4 groups this result was similar to Tofangchiha et al, as they compared groups prepared by different instruments such as hand files, RaCe (reamer with alternating cutting edges) and Kedo S pediatric rotary file system. They evaluated cleaning efficacy of the samples using stereomicroscope in apical, middle and coronal thirds. They found that Kedo S showed more cleaning effect in coronal third than the rest of the groups and no significant difference between the middle and apical thirds was observed. [27]

Also, Prabhakar et al, Seema et al, and Abdelfatah et al, results were consistent with the results of the present study.[28,5,17]

The current study's findings are different from Kalital S. et al. who evaluated and compared the effect of cleaning and instrumentation time of K files, ProTaper, and Kedo S files in primary molars using India ink. After instrumentation canals were cleared and observed under stereomicroscope. The Kedo S paediatric rotary system demonstrated noticeably better cleaning than the ProTaper rotary system and K files, especially in the middle one third, after instrumentation with the appropriate technique.[29] Additionally, Kummer et al., Selvakumar et al., and Musale et al. discovered that rotary systems had greater overall cleanliness than manual systems.[30,31,32]. This variation may be brought on by variations in the evaluation method, degree of root canal curvature, and file types.

CONCLUSION

Within the limitations of this study, no differences were noted concerning the shaping ability of the rotary systems used. Thus, all these systems could be used in instrumentation of primary molars. However, Kedo S files has the benefits of a short shank that can adapt to limited mouth opening of pediatric patients.

RECOMMENDATIONS

Additional research is required to investigate the effectiveness of Kedo S files in various canal types with a larger sample size.

Clinical Significance

The Kedo S files can be considered as a significant development in the field of pediatric endodontics.

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