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In vitro comparison of Hand K file, NT Pedo Gold and Kedo S-Square rotary file systems on dentin removal, taper of root canal and volumetric change in the root canal space in primary molars using cone beam computed Tomo graphy.

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Abstract

Introduction: Pulpectomy has been considered as the treatment of choice in severely inflammed primary teeth. Advancing technology in pediatric dentistry should be used for the better treatment protocol.

Aim: To evaluate and compare the effectiveness of three different file systems on dentin removal, taper of root canal and volumetric change in the root canal space.

Methodology: A total of 90 root canals of primary molars were randomly divided into three groups namely: Group I (n = 30) – Hand K file, Group II (N = 30) – NT Pedo Gold rotary file system and Group III (N = 30) – Kedo S-Square rotary file system. Dentin removal, taper and volumetric change in the root canal space were evaluated using CBCT. Data was subjected to statistical analysis.

Results: Kedo S-Square removed significantly less amount of dentin followed by NT Pedo Gold and Hand K file. Taper of root canal was more uniform and progressive by rotary files than the manual one. Volumetric change in the root canal space was highest in Hand K file out of all three file systems as it removed more dentin from the walls.

Conclusion: The use of Kedo S-Square resulted in better conservation of tooth followed by NT Pedo Gold and Hand File, making rotary files less aggressive hence, a safer method in Pediatric dentistry.

Keywords: Pulpectomy, rotary, dentin removal, taper, volume.

Introduction

Primary teeth serve as natural space maintainers and guide the eruption of permanent successors to their optimal position in the arch. Early loss of primary teeth is a major concern in the field of Pediatric dentistry causing a number of unpleasant consequences including loss of arch length, ectopic eruption and mesial tipping of the permanent molars.[1,2]

Pulpectomies should be considered over extraction as the treatment of choice of primary teeth with severe pulpal inflammation.[3]

The primary objective of instrumentation in primary molars is root canal debridement.[4] Barr (2000) introduced the rotary endodontics in Pediatric dentistry which brought a revolution in the root canal procedure in primary tooth.[5] The most significant advantage of the Pediatric rotary files is the reduced chair side time which makes it more comfortable for the patients and helps in maintaining patient cooperation.[6] The different anatomy and morphology of the primary root canals demands that a specialized file system should be adopted for their preparation.

One such Pediatric rotary instrumentation system is the "Kedo-S Square" rotary file which is the fourth generation of rotary Kedo-S files introduced in 2019. It has two files, one for anterior deciduous teeth (A1) and one for the posterior deciduous teeth (P1). It holds a uniqueness of having a variably variable taper design providing flexibility and efficiency to proper cleaning and shaping. NT Pedo Gold Kit (European precision technology) is designed with modified length and taper introduced for pulpectomy in primary teeth. This heat treated NiTi rotary instrument system is made of a controlled memory wire and has convex triangle cross-section design. This system contains three NiTi rotary files with a total length of 18mm.

Numerous methods like radiography, electron microscopy, stereomicroscopy, computed Tomography, cone beam computed tomography and micro computed tomography have been used.

A novel non-invasive 3D digital imaging approach, CBCT was used in this study to evade the inadequacy of two-dimensional techniques. The purpose of this research was to find an excellent canal instrumentation system for primary teeth. This CBCT study was conducted to compare dentin removal, taper and volumetric change in the root canal space using three different file systems.

Materials and method

The current in vitrostudy was an experimental, comparative study conducted in the Department of Pediatric and Preventive Dentistry, Rishiraj College of Dental Sciences and Research Centre, Bhopal, Madhya Pradesh.

The study was done on 90 root canals of primary molars extracted either due to orthodontic treatment or those that have been over retained beyond the usual age of exfoliation. The root canals were selected on the basis of

the criteria that was already determined which included primary molar roots with two-third of their remaining root length and excluding molars with more than one third of their root length resorbed and root canals with evidence of external/internal resorption and calcification. The teeth selected were stored in deionized water until the experimental time.

All the teeth were arranged on different blocks made of modelling wax to accommodate in the scanning tray of the CBCT machine (Carestream LLC, Onex Corporation, USA).

Pre – operative anatomic images was obtained by CBCT. Initial caries removal was done. Access cavity was prepared using round bur. After complete deroofing of the pulp chamber, 3% sodium hypochlorite was used to irrigate the chamber after which no. 10 K-file was introduced manually into the root canal until just visible at the apical foramen and 1 mm short of this initial length was recorded as working length for the root canal preparation and then the instrumentation was started. All the 90 canals were randomly divided into three groups:

Group I: a total of 30 canals were prepared by Hand K file with step back technique.

Group II: a total of 30 canals were prepared by NT Pedo Gold rotary file system till the working length using the Dentsply X smart end motor with 1.4 N cm torque and 250 rpm speed.

Group III: a total of 30 canals were prepared by Kedo S Square rotary file system using the Dentsply X smart Endo motor with 2-2.2 N cm torque and 250 rpm speed till the working length.

Regular irrigation of root canals was done with 3% NaOCl followed by normal saline in between. The post instrumentation CBCT images were taken.

Dentin removal

To determine dentin removal, measurements were taken in both mesial and distal root surfaces. Initially the length of the root was determined. This total length was divided into three halves i.e coronal, middle and apical third where dentin removal was calculated. Dentin removal on mesial side of the root surface was assessed by the formula: M1 – M2. M1 is the distance between the mesial periphery of root and mesial periphery of canal before instrumentation. M2 is the distance between the mesial periphery of root and mesial periphery of canal after instrumentation.

Similarly, the formula D1 – D2 was used for assessing dentin removal on distal side. D1 is the distance between the distal periphery of root and distal periphery of canal before instrumentation. D2 - is the distance between the distal periphery of root and distal periphery of canal after instrumentation.

Taper of root canals

At the centre of the three halves of the root length, coronal, middle and apical third, the maximum mesiodistal diameter was measured. If the reduction of this diameter from coronal, middle and apical third was progressive, then it was considered as good taper. If the reading remained the same or increased instead of getting reduced then it was recorded as a poor taper.

Volume

The volumetric change in the root canal space was done by CBCT unit and the pre-operative and post operative scans were kept as DICOM files. Pre instrumentation CBCT scan was done followed by instrumentation of all the samples using their allotted file system after which post instrumentation scan was done. The volume of all the samples was calculated from the canal orifice to 1 mm short of apical foramen. The specimens were viewed from the orifice to apex both in cross-section and

longitudinal section with a thickness of 0.125 mm/slice and a 360° rotation under high resolution. The total volume was obtained by using ITK-SNAP Software (version 3.8.0).

Pre-instrumentation and post-instrumentation values of canal volume were recorded and their difference was calculated.

Statistical analysis

The data was subjected to statistical analysis using Statistical Package for the Social Sciences (SPSS Version 23; Chicago Inc., IL, USA). Kolmogorov–Smirnov and Shapiro Wilk tests were performed to determine the normality of the data. The mean for different readings between the various files for dentin removal in the mesial and distal side was compared using the ANOVA test.

Tukey's post hoc analysis was conducted to find significant differences between the files system. Chi square statistic was applied to find variability between the tapering amongst the three-file system. Paired t test was run to determine any difference between pre and post intervention for volumetric analysis. For all analysis, p value lesser than 0.05 was considered to be statistically significant.

Results

The statistical analysis showed that on the mesial side of the root, there was significant difference in dentin removal at all levels i.e coronal, middle thirds and apical thirds by all the file systems. Hand K file removed significantly more dentin than the other two file systems, the least being shown by Kedo-S Square rotary file systems. Inter-group comparison showed significant difference between all three file systems at coronal and middle third except at the apical third where no significant difference was seen between Kedo-S Square and NT Pedo Gold file system. On the distal side of the root, similar result was observed. Dentin removal at all thirds was maximum by Hand K file, followed by NT Pedo Gold and Kedo-S Square rotary file system. Inter-group comparison showed significant difference except between Kedo-S Square and NT Pedo Gold rotary file systems at coronal and apical thirds.

There was significant difference in the taper of the root canal preparations between the three groups. It was observed that 88% of Kedo-S Square canal preparation, 77% of NT Pedo Gold file preparation and 50% of Hand K file preparation was considered as good tapered preparations. A statistically significant difference was observed between all three groups regarding volumetric change in the root canal space.

As mentioned earlier, Kedo S-Square rotary file system removed the least amount of dentin followed by NT Pedo Gold and Hand K file, so the change in the volume of the root canal space also consequently gave the same outcome with Kedo S-Square showing the least volumetric change in the root canal space and Hand K file the highest.

Table 1: Mean comparisons of dentin removal between group I, group II, and group III at coronal third, middle third, and apical third on the mesial side

Groups	Hand k file Mean ±SD	NT pedo gold Mean ±SD	Kedo s-square Mean ±SD	p value
Coronal	.2733 ± .03710	.2483 ± .00786	.1833 ± .01572	.000*
Middle	.3017 ± .03569	.2000 ± .00840	.1739 ± .00778	.000*
Apical	.1911 ± .04255	.1528 ± .00669	.1450 ± .00857	0.000*

Table 2: Mean comparisons of dentin removal between group I, group II, and group III at coronal third, middle third, and apical third on the distal side

Groups	Hand k file Mean ±SD	NT pedo gold Mean ±SD	Kedo s-square Mean ±SD	p value
Coronal	.3033 ±.01455	2217 ± .01383	.2206 ± .14489	.006*
Middle	.2383 ± .02749	.1967 ± .00970	.1689 ± .00900	0.000*
Apical	.1800 ± .02142	.1561 ± .01335	.1494 ± .01056	0.000*

Table 3: Comparison of tapering between file system

File system	PoorN (%)	GoodN (%)	Chi square statistic	P Value
Hand	15 (50)	15 (50)	9.8413	0.007*
NT Pedo Gold	8 (26.7)	22 (73.3)		
Kedo S Square	4 (13.4)	26 (86.6)		

Table 4: Comparison of volumetric analysis between pre and post operative phase between file system

File system	Pre	Post	Paired 't' statistic	P value
Hand	27.0539 ± 0.6855	32.371 ± 1.7213	-12.723	0.000*
NT Pedo Gold	24.8189 ± 1.1010	28.4172 ± 1.11793	-13.666	0.000*
Kedo S Square	25.6756 ± 1.3572	27.1789 ± 1.4028	-3.667	0.002*

Figure 1 a): Dentin removal on mesial side.

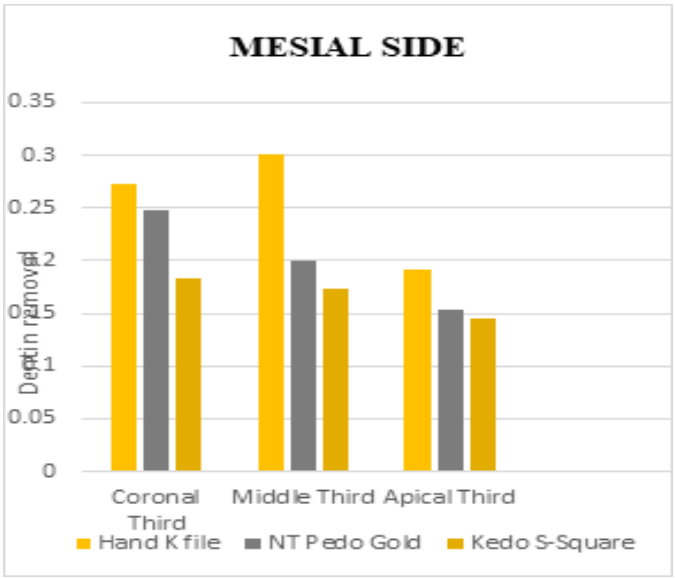


Figure 1 b): Dentin removal on distal side.

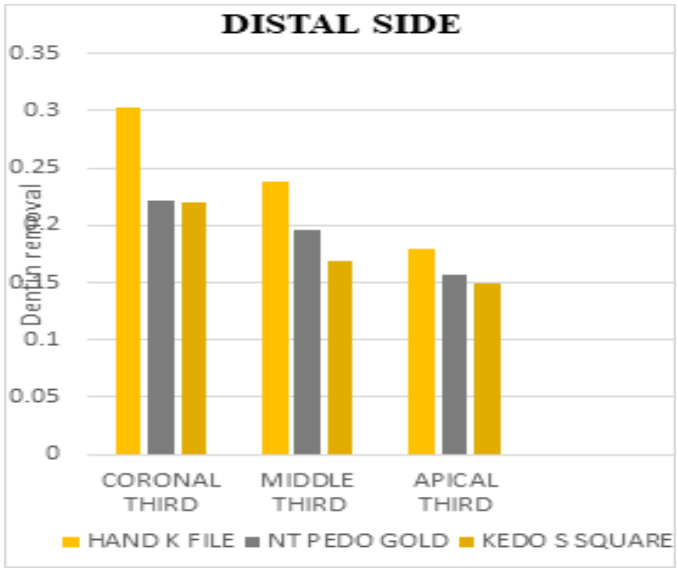


Figure 2: Tapering

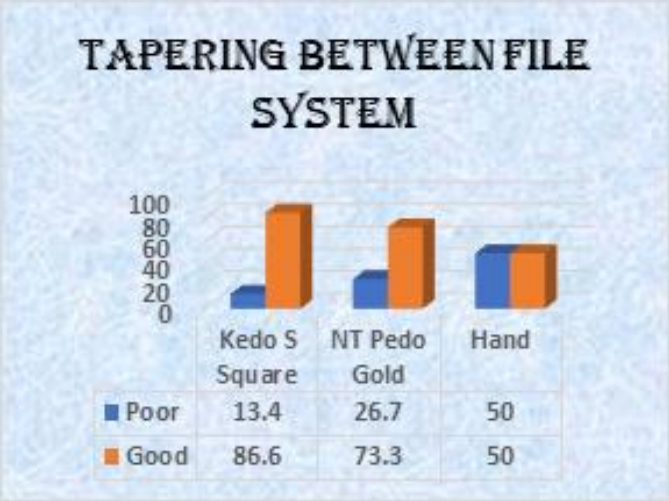
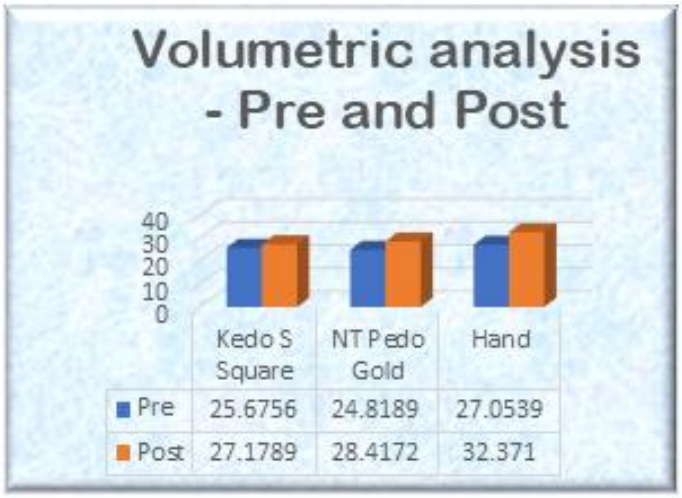


Figure 3: Volumetric analysis.



Discussion

An appropriate chemo mechanical preparation of the root canals is essential for an effective endodontic procedure.[7,8]Present study evaluated and compared dentin removal, taper of root canal and volumetric change in the root canal space by using Hand K file, NT Pedo Gold and Kedo S-Square rotary file systems. Regardless of the technique, manual or rotary, shaping the root canals results in substantial removal of dentine from the root walls.[9] A positive correlation is present between the aggressiveness of the root canal instrument and amount of dentin removal.[10] Our result showed more aggressive dentin removal by hand file than rotary file systems. This is in accordance with study done by Mohamed et al (2022)[11] who evaluated dentin removal using Kedo-S, Hand K file and H file and observed that Kedo-S Square removed slightly less amount of dentin in apical and coronal thirds. Shahriari S et al (2009)[12] evaluated the removed dentin thickness by SS hand instruments or rotary Profile instruments where the latter prepares root canals with a greater conservation of tooth structure.

According to Schilders, the mechanical aim of the root canal preparation is to form a continuously tapering cone, essential for the applaudable placement of the obturating material.[13] Our study showed that 88% of Kedo-S Square canal preparation, 77% of NT Pedo Gold file preparation and 50% of Hand K file preparation was considered as good tapered preparations. Srinivas et al. (2019)[14] concluded that Kedo-S rotary files creates conical and superiorly tapered canal preparation as compared to hand K-files. Musale PK et al (2013)[15] observed that on using rotary Profile, Protaper, Hero Shaper and K-files, canal taper was significantly more conical for rotary files as compared to K-files. No significant difference was found in taper in an invitro study done by Seema et al.[16] on comparison of hand K files, rotary Protaper files, and rotary Kedo-S files.

Conservation of the dentinal structure is crucial in preventing the fracture of endodontically treated teeth. Checking the volume of the root canal space is vital to understand the amount of tooth material removed by endodontic treatment as the amount of dentin removal indicates the aggressiveness of the instrument. In our study, the change in the volume of the root canal space the least by Kedo S-Square and Hand K file was the highest. Resemblance was seen in a study by Nabeeh PK et al (2021)[17] in which he compared volumetric changes in primary molar root canals by four different file systems using CBCT and concluded that One Shape

rotary files and Kedo-S rotary files can be efficient and safer instruments in primary molar canals. Jeeva Nandan and Thomas (2018)[18] in his study did a volumetric analysis of hand, reciprocating and rotary instrumentation techniques in primary molars using spiral CT in which rotary instrumentation technique was found to be effective for preparing root canal in primary teeth compared to manual and reciprocating techniques.

Success of the root canal treatment is influenced by the technique and the quality of instrumentation, irrigation, disinfection and obturation of the root canal. The studies available regarding the superiority of any given type of file in cleaning root canals in primary teeth are selectively few; hence further research are being carried out to evaluate the effectiveness of different kinds of file systems in primary teeth.

Conclusion

The following pinnacle were found

- Dentin removal was the highest in case of Hand K-file followed by NT Pedo Gold and Kedo S-Square rotary file systems.
- Taper of root canal was more uniform and progressive by rotary files than the manual one.

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