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EVALUATION OF DEBRIS REMAINING ON THE CANAL WALL AFTER THE USE OF A NEW SINGLE PEDIATRIC ROTARY FILE SYSTEM IN PRIMARY ANTERIOR TEETH: AN IN-VITRO SCANNING ELECTRON MICROSCOPE STUDY

Dina Elsayed Tawfik*, Abeer Mostafa Abdellatif**, Mohamed Abdelrahman Mohamed*** *and* Ashraf Y. Alhosainy****

ABSTRACT

Aim: The goal of the current study is to compare the amount of remaining debris on the walls of the root canal of primary anterior teeth following instrumentation with a single NiTi rotary file system (Kedo-S-Square) and manual Stainless-steel files.

Methodology: This study was carried out as an in-vitro study, on twenty extracted primary anterior teeth. Teeth were divided into two groups randomly; Group I: Manual H-files, Group II: Kedo-S Square rotary files. After preparation of the root canal, longitudinal grooves were prepared on the roots and teeth were sectioned into two halves then processed to be evaluated at cervical, middle and apical thirds under SEM. Scores were given based on the amount of debris and data were collected and analyzed statistically.

Results: In terms of cleaning efficiency, the debris originating at the apical third using the rotary file system was slightly higher than manual technique; however, the result wasn't statistically significant (P> 0.05).

Conclusion: Single pediatric rotary file Kedo-S-square can be utilized as an efficient and faster replacement to manual H-Files in primary anterior teeth.

KEY WORDS: Debris removal, Rotary instrumentation, root canal treatment.

* Master Student, Department of Pediatric Dentistry and Dental Public Health, Faculty of Dentistry, Mansoura University, Mansoura, Egypt
** Professor, Department of Pediatric Dentistry and Dental Public Health, Faculty of Dentistry, Mansoura University, Mansoura, Egypt
*** Professor, Department of Oral Biology, Faculty of Dentistry, Mansoura University, Mansoura, Egypt
**** Lecturer, Department of Pediatric Dentistry and Dental Public Health, Faculty of Dentistry, Mansoura University, Mansoura, Egypt

INTRODUCTION

Primary anterior teeth are very important for maintaing ethetic, speech, and the integrity of dental arch and it is important to preserve these teeth till exfoliation time to avoid unfavorable consequences. That's why primary teeth with pulpal involvement should be treated to be maintained functional till their exfoliation. When it comes to deciduous teeth with irreversible pulpitis or pulp necrosis from trauma or caries, pulpectomy is the first line of treatment[1].

Removing irritants by thoroughly cleaning and shaping the root canals is essential to the effectiveness of pulpectomy. The primary goals of cleaning and shaping of the root canals are removing the hard and soft tissue harboring microorganisms, facilitating the access of irrigants to all parts of the canal and dentinal tubules, and creating adequate space to insert medication and obturating materials while maintaining integral root morphology[2].

In 2000 Barr et al were the first to study rotary files in deciduous teeth and found that using Ni-Ti rotary file system was faster and less time consuming than manual techniques. Since then, the utilization of rotary files has gained popularity in terms of preserving the original anatomy of the root canal owing to the rotary file system flexibility[3].

Although rotary Ni-Ti instruments were effective in preparation of the root canal. of deciduous teeth however, preparation was made with rotary files for permanent teeth where taper and length were considered limitations and thus the need for using special files designed for primary teeth was needed. kedo files are rotary endodontic files specially developed for deciduous teeth that were launched in 2016.The fourth generation of rotary Kedo-S files came into market in 2019 known as (Kedo-S-Square) as the initial exclusive single paediatric rotary file. It was found that Kedo-S-Square (A1) has the ability to provide good taper while preserving the tooth structure. However, there is still a great need to evaluate its cleaning ability[4-6].

Several methods of assessing canal debridement after preparation were used, each method show advantages and disadvantages. However, the use of Scanning Electron Microscope (SEM) has shown to be a beneficial way for evaluating the effectiveness of the endodontic procedures in eliminating root canal systems debris[7].

Therefore, the goal of our study is to assess the debris remnant amount on canal walls following the use of manual instrumentation compared with Kedo-S-Square using a scanning electron microscope. The null hypothesis was that there is no difference between manual and rotary file in terms of cleaning efficiency.

METHODOLOGY

Study design:

This study was designed as an in-vitro study to assess the cleaning efficacy of a new single paediatric rotary file system (Kedo-S-Square) in primary anterior teeth under scanning electron microscope This in-vitro study was carried out at the Department of Pediatric dentistry and dental public health, faculty of Dentistry, Mansoura university. The approval of the study was taken from Ethical Committee of scientific research of Faculty of Dentistry, Mansoura University with the code number: M12080622.

Sample size calculation:

Sample size was calculated by G*Power software (version 3.1.9.7).

The estimated sample size of the study was10 specimens in each group at 5% level of significance and 80% power of the study, using G*Power calculator.

Sample size was calculated based on Mean scores for smear layer among the studied group 2.60 and 3.60 (Subramaniam et al., 2016). The sample

size was estimated at 20 total and the allocation ratio between group 1 and 2 was 1:1 so 10 specimens required in each group.

Specimens' selection:

Twenty freshly extracted primary maxillary incisors were collected for the study from dental clinics in Mansoura city and Faculty of Dentistry Clinic, Mansoura University. The collected teeth were non restorable or retained beyond exfoliation time. The included teeth had the following criteria: no pathologic root resorption, either external or internal, is present, no or minimal physiologic root resorption and root caries free. The teeth were cleaned, disinfected and preserved in 10% formalin solution until they were used in the study[8].

Sample preparation and grouping:

Caries was removed by using No.4 carbide bur then access opening was done by using bur No.330 pear shape. Measuring the working length was done using k file inserted into the canal till it was visible then subtracting 1 mm. Decoronation of the samples was done using low speed diamond disk with water coolant to establish a standardized working length of 10 mm.

Teeth were divided into two groups randomly, each containing 10 teeth.

Group 1: where instrumentation was done by using manual stainless-steel H files (Dentsply Maillefer, Ballaigues, Switzerland)

Group 2: where Kedo-S-Square A1 (Reeganz dental care Pvt. Ltd. India) rotary file was used for instrumentation.

Instrumentation:

Group (1):

Manual H-files system, ranging from size #15 till master apical file #40 (Mani, Japan) was utilized for instrumentation using retraction motion (push and pull) technique. Each hand file was applied to a maximum of three teeth to ensure cutting efficiency and maintain uniformity during preparation.

Group (2):

Rotary Kedo-S Square A1 file system which is a single file system for primary anterior teeth (Reeganz Dental Care Pvt. Ltd. India) was used for preparation, a lateral brushing motion 2-3 times per tooth was used to reach the working length by using E Connect pro endodontic motor in a clockwise rotation motion (Changzhou Eighteeth Medical Technology Co., Ltd.) at 300 rpm and 2.2 N cm torque according to the recommendations given by the manufacturer[6].

Standard irrigation for both groups was 10 mm of 1% sodium hypochlorite during the entire cleaning procedure and lubrication was done using EDTA gel then final flush was done with 5 ml saline to counteract the irrigant action. Preparation of all canals was done by single operator[6, 9].

Evaluation by scanning Electron Microscope:

After instrumentation, a low-speed water-cooled handpiece with attached diamond disk was used to create two grooves longitudinally on the palatal and labial surfaces of each root. However, the grooves weren't deep enough to avoid contamination of the canal space. Chisel and mallet were used to separate the 2 halves. By flipping a coin, one half was randomly selected from each separated root. All samples were dehydrated and dried in a desiccator for 24 hours, root sections were placed on aluminium stub, sputter-coated with a thin layer of gold (10-30 nm) using SPI-Sputter Coater (SPI Module- Sputter Carbon/Gold coater 110v 50/60 Hz, USA) then examined using SEM (JEOL JSM-6510LV; JEOL, Tokyo, Japan) [9].

Images were captured at cervical, middle, and apical thirds of root canals under magnification of

1000X for detection of debris, the root canal lumen center was evaluated regarding cleanliness using a system of scores introduced by Hülsmann et al [10].

The scoring was performed by two well trained, calibrated operators who were blind to the groups. To remove any bias, individual scoring for each group was recorded then repeated again. The kappa value for inter-examiner reproducibility was k=0.94. Root canal center was quantitatively assesed for the debris amount [9]. Scores from (1-5) were given as following:

TABLE (1) The debris scale

Score	Description
Score 1	Clean wall and contains minor debris only.
Score 2	Few masses of debris.
Score 3	Lesser than 50% of the wall is covered by several debris clusters.
Score 4	Above 50% of the wall is covered by debris.
Score 5	Whole or almost whole layer of debris covering the wall.

Statistical analysis

All data were collected, placed in tables, and statistically analyzed using SPSS 26 for windows (SPSS Inc., Chicago, IL, USA)

Qualitative data were displayed as frequencies and relative percentages. Chi square test ($\chi 2$) and Fisher exact were utilized to calculate difference between qualitative variables as specified.

All statistical comparisons were two tailed with significance level of P-value ≤ 0.05 indicates significant, p <0.001 indicates highly significant difference while, P> 0.05 indicates non-significant difference.

RESULTS

By comparing between group I (manual group) and group II (rotary group) regarding frequency of debris score at cervical, middle and apical third, the results were statistically non-significant (p value >0.05).

It was found that 50% of manual group had clean wall with only minor debris (score 1) at cervical and middle third compared to 40% in group II while 10% in manual group had less than 50% of the wall covered by multiple clusters of debris (score 3) at cervical third compared to 0% in rotary group, the reverse is true at middle third as 0% in manual group had score 3 while 10% in rotary group had score 3.

Regarding debris score at apical third, 60% of manual group had clean wall and contained minor debris only (score 1) compared to 40% in group II while score 4 (more than 50% of the wall is coated with debris) was higher in rotary group (30%) than in manual group (0%), however the difference wasn't statistically significant.

TABLE (2) Frequency of debris scores obtained Between manual group and rotary group

	Score	Group I (n=10)	Group II (n=10)	$X^{2(F.Ex)}$	P value
Cervical	1	5(50%)	4(40%)	1.5	0.65
	2	4(40%)	6(60%)		
	3	1(10%)	0(0%)		
Middle	1	5(50%)	4(40%)	2.2	0.99
	2	4(40%)	5(50%)		
	3	1(10%)	0(0%)		
	4	0(0%)	1(10%)		
Apical	1	6(60%)	4(40%)	4.4	0.31
	2	3(30%)	3(30%)		
	3	1(10%)	0(0%)		
	4	0(0%)	3(30%)		

Regarding the comparison between cervical, middle and apical third relation to the frequency

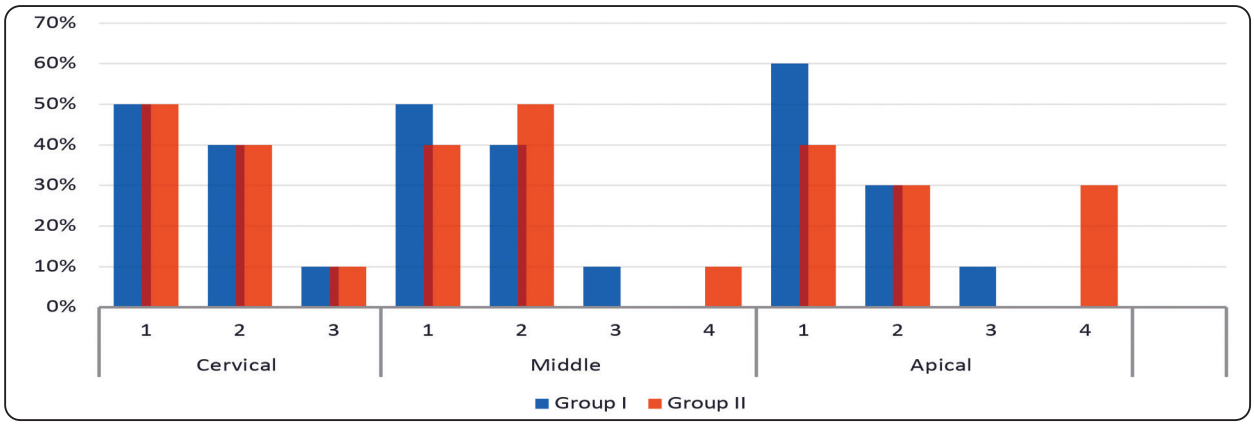

Fig. (1) Bar chart represent Frequency of debris scores obtained Between manual group and rotary group

TABLE (3) Frequency of debris scores obtained Between cervical, middle and apical third in each group separately

	Score	Cervical	Middle	Apical	$X^{2(F.Ex)}$	P value
Group I	**1**	5(50%)	5(50%)	6(60%)	0.30	0.98
	2	4(40%)	4(40%)	3(30%)		
	3	1(10%)	1(10%)	1(10%)		
Group II	**1**	4(40%)	4(40%)	4(40%)	4.5	0.40
	2	6(60%)	5(50%)	3(30%)		
	3	0(0%)	0(0%)	0(0%)		
	4	0(0%)	1(10%)	3(30%)		

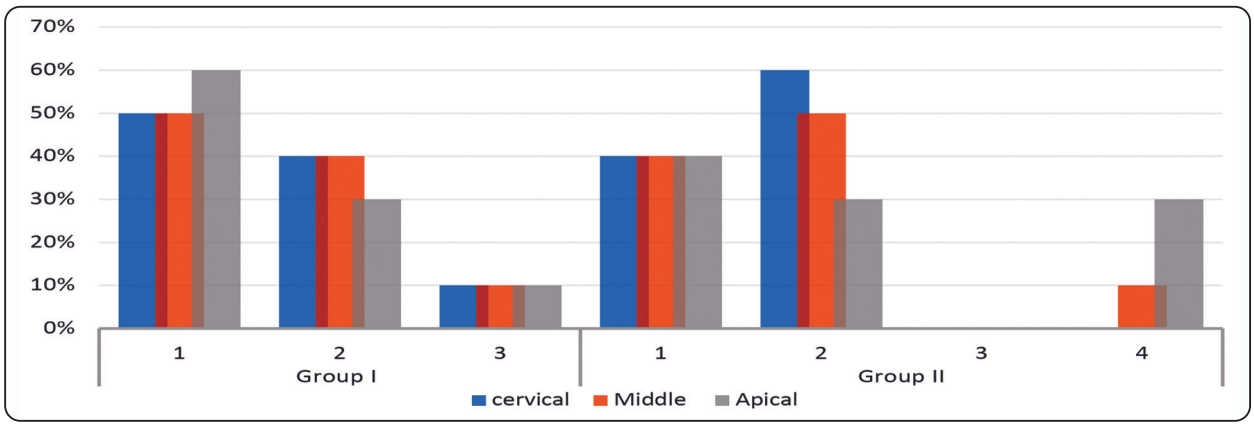

Fig. (2) Bar chart represent frequency of debris scores obtained between cervical, middle and apical third in each group separately.

of debris score in manual group, the results was statistically non-significant (p value >0.05) as 50% of cervical and middle third had clean wall with minor debris only (score 1) compared to 60% in apical third.

Also 10% of cervical, middle and apical third exhibited less than 50% of the wall covered by multiple clusters of debris (score 3).

Regarding the comparison between cervical, middle and apical third, in rotary group, the results was statistically non-significant (p value >0.05) as 40% of cervical, middle and apical third had clean walls and contained minor debris only (score 1). Also score 3 wasn't found in cervical, middle or apical third.

Regarding score 4, it was found that 0% of cervical third, 10% of middle third and 30% of apical third had more than 50% of the wall coated with multiple clusters of debris (score 4); however, results weren't statistically significant.

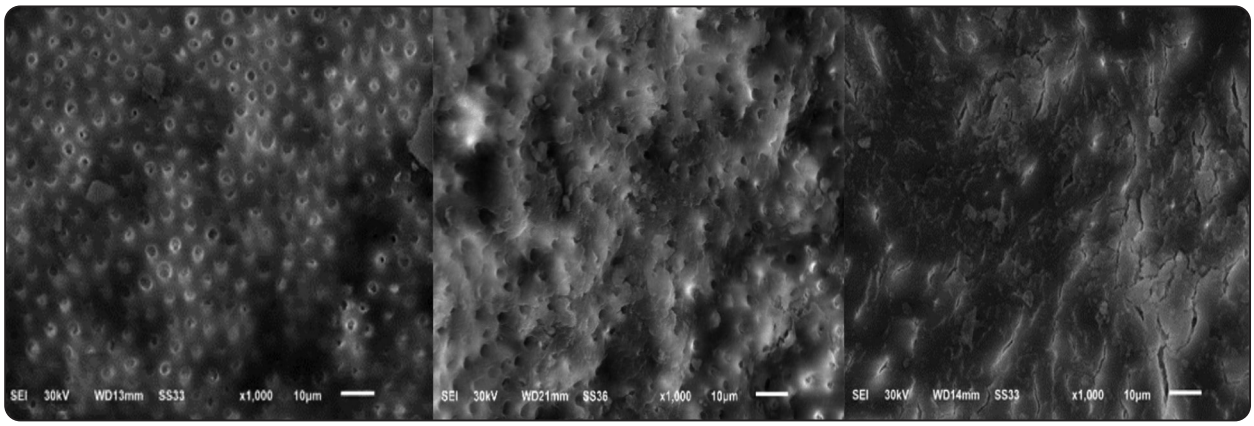

Fig. (3) Scanning electron microscope images of dentin surface of the root canal instrumented with manual files (group I) showing different debris score at coronal, middle, apical respectively from left to right. Coronal (score 1), middle (score 2), apical (score 3).

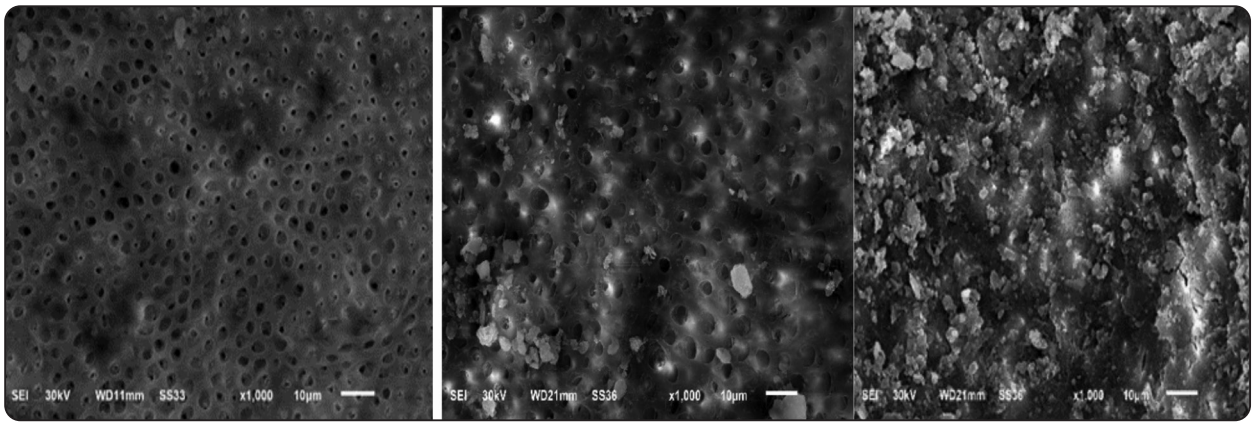

Fig. (4) Scanning electron microscope images of dentin surface of the root canal instrumented with rotary files A1 Kedo-S-Square (group II). showing different debris score at coronal, middle, apical respectively from left to right. Coronal (score 1), middle (score2), apical (score 4).

DISCUSSION

Deciduous teeth are thought to present a challenge for biomechanical preparation as they often feature auxiliary canals and torturous root canal anatomy together with the importance to maintain good child behavior. Thus, the need to use rotary instrumentation in deciduous teeth has increased to save time which leads to decreased child and operator's fatigue.

The primary goal of any root canal preparation is to eliminate vital and/or necrotic pulpal remains, dentin that is infected, and dentin debris to eradicate any harmful microorganisms[9]. Dentin chips, and vital or necrotic pulpal remains which are not well attached to the canal walls were classified as debris. To avoid its potential deleterious effect it is desirable to remove this layer as microorganisms remain inside this layer[11].

Till now, as far as we know, this research is the first to assess and to put the cleaning ability of Kedo-S Square and Manual H-files in primary anterior teeth into comparison using SEM. This file was chosen as it is considered the initial exclusive single paediatric rotary file and this is in agreement with Mohammed et al[6] who put the Kedo-S Square, K- & H- hand files in comparison to assess their shaping ability in primary anterior teeth.

Anterior primary teeth were chosen rather than primary molars as the study is directed toward cleaning efficacy instead of cyclic fatigue and torsional resistance[7]. SEM seems to be a suitable method for studying the effect of endodontic instruments on the root canal's inner wall, it was also used to assess the efficiency of cleaning as it is more precise for debris assessment under high magnification by using numerical scoring system proposed by Hülsmann et al [10]. Unlike some other previous studies which assessed the cleaning efficiency of endodontic files using cheap methods like india ink [12, 13].

Null hypothesis was confirmed as the study revealed that difference in the efficiency of cleaning was statistically non-significant. In this study, the highest debris accumulation was at the apical third of the group prepared with rotary files. The explanation could be due to the typical structure of the root canal where the narrowest area lies at the apical region as more contact with the instrument occurs leading to more debris aggregation and effective irrigation becomes challenging. Also, the design of the Kedo-S-Square at the apical third is convex triangular cross section with 6% taper at the apical 5 mm this will lead to less apical preparation with conservation of the tooth structure at the apical third while its action at this region is more by scrapping rather than cutting together with the motion of rotary system might be the cause.

The result of the present study is in accordance with Silva et al[14] where no statistically significant difference was found in the 3 root thirds when compared manual K-files with rotary Profile .04 regarding cleaning capacity by using india ink; however, they found that rotary files resulted in the reduction of instrumentation time and considered that as relevant clinical factor for endodontic treatment.

These conclusions have been verified by Mehlawat et al[15] and Ramezanali et al[16] however, in spite of the similarity of the studies we stress the variations in methodologies between our current study and previous ones, encompassing differences in evaluating canal cleaning techniques, the specific rotary systems utilized, as well as the sequence and quantity of instruments employed during preparation.

However, our findings contradicted those of Habib et al[17] who reported that pediatric rotary files produced, in comparison to manual preparation, cleaner root canal walls in the apical and middle thirds when compared Kidzo Rotary file with manual NiTi files using SEM.

In contrast to our study, Kalita et al[12] found, after using india ink on 120 root canals of selected

primary molars for evaluation of the efficacy of cleaning, that Kedo-S rotary files significantly outperformed ProTaper and K files in cleaning the canals at the cervical and middle thirds. However, no statistically significant difference was found at the apical third. Also, Musale et al[18] found after comparing three different rotary systems ProFile, ProTaper file and Hero Shaper file with manual k-files that cleaning efficacy of rotary files significantly outperformed manual files by using india ink and stereomicroscope for their study.

CONCLUSION

Given the constraints of the present study, it can be inferred that:

a) No significant difference was found between manual H-files and Kedo-S-Square rotary files regarding the effectiveness of cleaning in terms of the amount of inorganic debris remnants on the canal walls of primary anterior teeth after instrumentation where none of the preparation methods used, left the walls of the canals completely devoid of any surface debris..

b) In the light of the outcomes attained, the Kedo-S-Square rotary system can be considered as a viable substitute to manual H-Files in primary anterior teeth as rotary instrumentation might be faster in preparation thus decreasing the child and operator fatigue.

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