

<https://doi.org/10.48047/AFJBS.6.6.2024.6657-6667>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

Comparison of Pediatric rotary files in primary teeth using CBCT and to assess apically extruded debris using different irrigating needles

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Volume 6, Issue 6, June 2024

Received: 02 May 2024

Accepted: 28 May 2024

Published: 15 June 2024

doi: [10.48047/AFJBS.6.6.2024.6657-6667](https://doi.org/10.48047/AFJBS.6.6.2024.6657-6667)

Abstract

Aim: Pulp therapy is considered successful when it effectively removes infectious microorganisms from the pulp space and does not result in post-endodontic complications. This study was done to assess the effectiveness of Kedo S Square and Pro AF Baby Gold at pulp therapy.

Materials and Methods: Four groups of 40 extracted primary maxillary anterior teeth were divided into four, and apical debris extrusion was assessed using the Myers and Montgomery method. The teeth were scanned using CBCT before and after instrumentation, and the time for instrumentation was measured.

Results: The study found no significant difference in debris removal between conventional and side vented needles using both Kedo S Square files. The apical third showed good taper, while Pro AF Baby Gold removed less dentin in the coronal third. No significant difference was observed at the middle third.

Conclusion: Regardless of needle design, all groups experience apical debris extrusion. However, side-vented needles cause less apical debris extrusion and are safer than conventional needles for pediatric endodontics. Kedo S Square provide a better taper than Pro AF Baby Gold. Both files effectively remove radicular dentin, but Kedo S Square files remove less dentin than Pro AF Baby Gold files.

Keywords: Apical Debris extrusion, Cone Beam Computed Tomography, Kedo S Square, Pro AF Baby Gold, Side Vented Needle

Introduction

Pulpectomy is the procedure that involves the complete removal of pulp from a root canal, by thorough cleaning, shaping, sterilization of root canals and filling them with resorbent materials.¹ Mechanical preparation of primary root canals had been traditionally carried out by hand instruments preferably K files. Despite certain advantages, the use of these files has been found to create canal irregularities, perforations, insufficient cleaning, zipping and undesired transportation of root canal. Additionally hand instruments tends to prolong the time of treatment that in turn effect the coordination of child in pediatric settings².

With the advancements in dental material technology and modernization of root canal instruments to overcome the limitation of hand instruments. Nickel-Titanium rotary instruments were marketed by various manufacturers. Barr et.al³ introduced these rotary file systems in primary teeth. Its usage in primary teeth offered several advantages that includes increased speed, cost effectiveness, and the achievement of consistent and predictable fillings. Recently, numerous pediatric rotary files were introduced to the market. The Kedo S Square is a specifically designed pediatric rotary system⁴. Additionally, there are other options like the Pro AF Baby Gold file by Dentobizz, which comprises five files made of NiTi CM wire with a flexible, constant taper⁵.

The efficacy of file system and its shaping ability can be evaluated by assessing residual dentin thickness and canal taper, as these factors are positively related to the instrument's aggressiveness and dentin removal. Maintaining adequate dentin thickness is crucial for providing opposition to side-way and chewing forces in teeth treated with root canal. To quantify canal taper and remaining dentin thickness, researchers employ a variety of technologies. Among them cone beam computed tomography is of great importance⁶.

However, the extent of extrusion can vary greatly among different file systems, depending on their specific design⁵. Minimizing instrumentation time is of paramount importance as it significantly proportional to the behavior and cooperation of children.

Therefore Kedo S Square and Pro AF Baby Gold rotary systems were used in this study to assess their preparation in root canals for primary anterior teeth.

Materials and Methods

IEC at Meghna Institute of Dental Sciences, has given an ethical clearance with reference number MIDS/MDS/PEDO/002. G-Power analysis was used to determine size of sample with a power of 95%. A total of 40 extracted primary maxillary anterior teeth with 2/3rd of

intact root length where pulpectomy was not carried out were included. Extracted teeth with calcified root canals and external or internal pathological root resorption were excluded. Teeth were cleaned using ultrasonic scaler and washed with distilled water and stored in 10% formalin until start of the experiment.

To ensure uniform lengths, all teeth were measured with digital vernier calipers, and the crowns were sectioned with a diamond disc until they reached a length of 10 mm. Only teeth where a 15K file(Mani,Japan) could barely be seen through the apex were selected. A K-file(# 15) was taken to determine WL till it was visible at apical foramen, and then reducing that measurement by 1 mm. The canal size was standardized to ensure that a 20K file could bind at the working length.

The specimens were categorized into four groups:

Group a : Kedo-S Square with 27G conventional needle

Group b : Pro AF Baby Gold with 27G conventional needle

Group c : Kedo-S Square with 27G Side vented needle

Group d : Pro AF Baby Gold with 27G Side vented needle

Eppendorf tubes(Clear &Sure,Recombigen Laboratories,India) are preweighed with a precision balance (Azcet, India) with three measurements taken for accuracy. Each sample was adjusted till CEJ by making holes in the stoppers. A 27 guage needle was used for pressure equalization. Tubes and needles were kept in aluminum-foil-covered vials to prevent bias, with only the vials being handled during the study.

Group A & Group C(Kedo-S Square file and 27G Conventional needle,27G Side vented needle):Initial patency will be checked with #15 K-File using a watch-winding motion. Instrumentation will follow the Kedo-S Square(Reeganz Dental Care Pvt. Ltd. India) NiTi rotary file protocol. Each canal will be irrigated with 1 mL of distilled water using either a 27G conventional or side-vented needle(Romsons,India) depending on the group. Files will be inspected for clogging and cleaned with tissue paper if needed. The primary investigator will handle up to five teeth at a time to reduce fatigue and errors

Group B & Group D(Pro AF Baby Gold files and 27G Conventional needle, 27G Side vented needle):Initial patency will be checked with #15 No. K-File will using a watch-winding motion.Instrumentation will follow Pro AF Baby Gold file protocol.Irrigation will be done with 27G Conventional needle and 27G Side vented needle(Romsons,India) in each group respectively

After instrumentation, debris was gathered by rinsing tip of the root with 1 mL of distilled water into an Eppendorf tube.For five days, the tubes were incubated at 70°C in an incubator

(Serwell,India) to drive out the water and leave behind just dry debris.To calculate the net weight of the debris, the weight of the empty tube was subtracted from the overall weight.

CBCT Evaluation:Pre-operatively, samples were mounted and scanned utilizing a 5 x 5 field of view on a Rainbow CT (South Korea). Dentium 3D software (Seoul, Korea) was used for the scanning, and the exposure parameters were 19 seconds, 94 kV, and 8 mA.Measurements were taken from apex as apical 1/3rd at 3 mm , middle 1/3rd at 6 mm, and coronal 1/3rd at 9 mm. There were post-instrumentation scans. Measuring the remaining thickness of dentin from axial cuts at the three levels allowed for the evaluation of the files shaping capacity. At these levels, canal taper was measured using sagittal CBCT cuts in the mesio-distal direction

The removed dentin percentage% was calculated, per Gambill JM et al⁶.

$$\frac{(X1 - X2) \text{ or } (Y1 - Y2)}{(X1 \text{ or } Y1)} \times 100$$

The location depends on which side (X or Y),where

X1 = Shortest measurement from the root exterior to uninstrumented canal.

X2 = Equivalent measurement in the corresponding instrumented canal.

Y1 = Shortest measurement from the root interior to uninstrumented canal.

Y2 = Equivalent measurement in the corresponding instrumented canal.

Instrumentation time in minutes and seconds was recorded using digital stopwatch , starting from the first file insertion and ending with the last irrigation.

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Statistical Analysis:SPSS version 25.0 was used to analyze data. Intergroup comparisons used the Independent Unpaired T-test, with significance set at $p \leq 0.05$.

Results:

Table 1 : Standard deviations and Mean of debris (gm) were significantly lower for Kedo S Square compared to Pro AF Baby Gold.(Figure 1)

Table 1:Intergroup comparison of apical debris extrusion after instrumentation and irrigation

Group vs Group (n=10) (n=10)	Test Used	Mean	Std. Deviation	P value
Group A vs Group B	Unpaired T Test	7.48	2.19	0.01*S
Group A vs Group C		10.47	2.83	
Group B vs Group D		7.48	2.19	0.63*NS
Group B vs Group D		6.96	2.70	
Group C vs Group D		10.47	2.83	0.12*NS
Group C vs Group D		8.15	3.59	
Group B vs Group C		6.96	2.70	0.41*NS
Group B vs Group C		8.15	3.59	
Group B vs Group C		10.47	2.83	0.01*S
Group B vs Group C		6.96	2.70	

*NS: Not significant *S:Significant

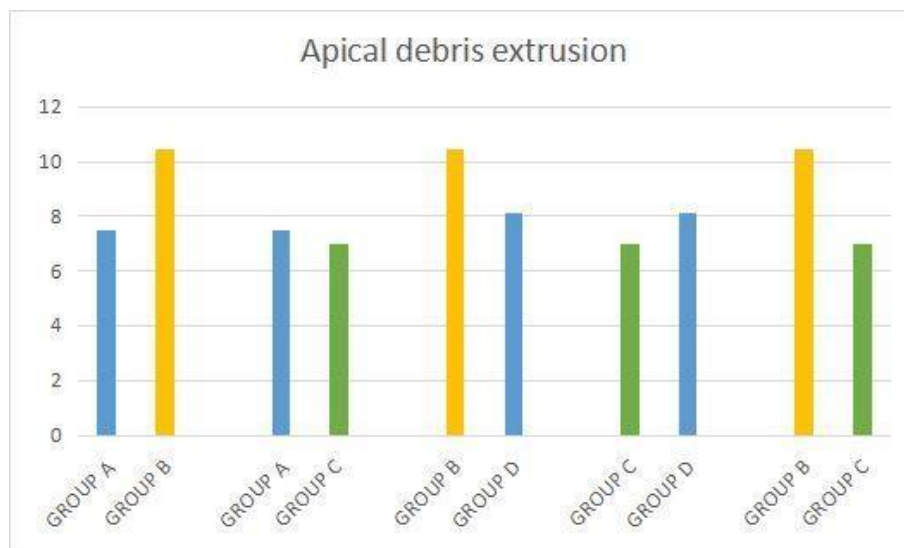


Figure 1 : Apical debris extrusion after instrumentation and irrigation

Table 2 :Intergroup comparison of root canal taper after instrumentation showed no significant difference between Kedo S Square and Pro AF Baby Gold files for coronal & middle thirds.However, on comparing two file systems a highly significant difference was noted in apical taper.(Figure 2)

Table 2 :Intergroup comparison of root canal taper after instrumentation with Kedo S square and Pro AF Baby Gold files using CBCT

Taper(mm)	Group	N	Mean	Std. Deviation	P value
Coronal	Kedo- S square	20	0.1790	0.20154	0.80 *NS
	Pro AF Baby gold	20	0.1930	0.14008	
Middle	Kedo- S square	20	0.1090	0.11016	0.07 *NS
	Pro AF Baby gold	20	0.1910	0.16559	
Apical	Kedo- S square	20	0.1330	0.08862	0.009 *HS
	Pro AF Baby gold	20	0.0650	0.06557	

*NS-Not significant *HS – Highly significant at $p < 0.01$

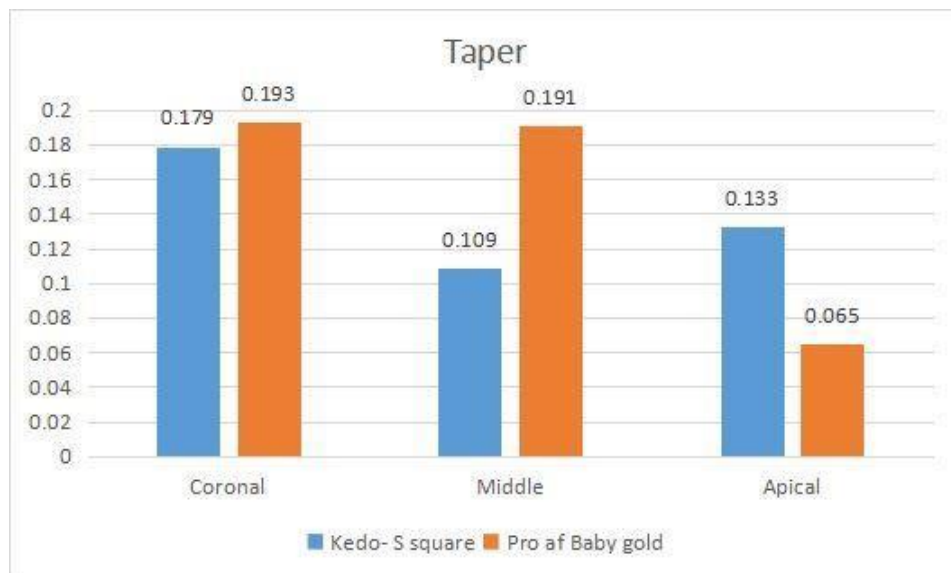


Figure 2: Taper after instrumentation with Kedo S Square And Pro AF Baby Gold files using CBCT

Table 3:Intergroup comparison of mean percentage reduction in dentin thickness after instrumentation showed a highly significant difference at the coronal third ($p = 0.002$).Middle third showed no significant difference ($p = 0.29$). However, a highly significant disparity was noted in apical third ($p = 0.001$). (Figure 3)

Table 3: Intergroup Comparison Of Mean Percent Reduction In Dentin Thickness At Different Levels After Instrumentation

Level (Percent reduction)	Group	N	Mean	Std. Deviation	P value
Coronal	Kedo- S square	20	23.3022	15.41487	0.002 *HS
	Pro AF Baby gold	20	16.2189	12.76325	
Middle	Kedo- S square	20	19.8546	14.72952	0.29 *NS
	Pro AF Baby gold	20	22.0814	11.95809	
Apical	Kedo- S square	20	13.7598	15.41190	0.000 *HS
	Pro AF Baby gold	20	27.1644	13.15685	

*NS-Not significant *HS – Highly significant

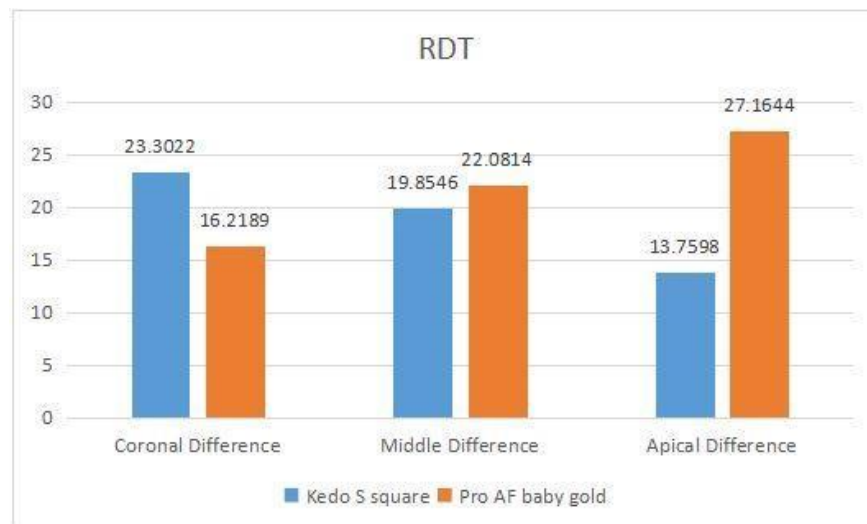


Figure 3 :Mean Percent Reduction In Dentin Thickness At Different Levels After Instrumentation

Table 4:On intergroup comparison of instrumentation time between two files revealed a significant difference.

Table 4: Intergroup comparison of instrumentation time between Kedo S Square and Pro AF Baby Gold files

Instrumentation Time(min)	N	Mean	Std.Deviation	P-value
Kedo S Square	20	2.30	0.535	0.000 *HS
Pro AF Baby Gold	20	5.10	0.737	

*HS = Highly significant

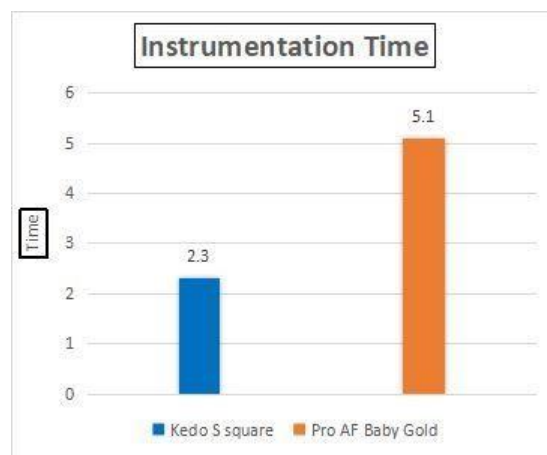


Figure 4: Intergroup Comparison Of Instrumentation Time With Kedo S Square And Pro AF Baby Gold

Discussion

It is essential to reduce apical debris extrusion during canal instrumentation for endodontic therapy to be successful. Root canal anatomy, tool size and type, working length, irrigant type and quantity, and instrumentation method are some of the parameters that affect apical extrusion. While various methods exist to quantify apical debris, this in vitro study employed the widely accepted Myers and Montgomery model⁷. Atlundasar et al.,⁹ found that irrigation needles and rotary instruments affect the amount of extruded irrigant. Their study showed that open-ended needles led to more debris and irrigant extrusion compared to side-vented needles. This current study showed the amount of debris extrusion were significantly less for Kedo S Square than Pro AF Baby Gold. The current study's findings could be attributed to variations in the cross-section, the methodology, or the number of instruments employed. According to Albrecht et al.,¹⁰ reduced number of files can assist in minimizing canal aberrations and apical extrusion.

The present study found no statistically significant difference in root canal taper at coronal and middle thirds between the two file systems. However, a significant difference in apical taper was observed between Kedo S Square & Pro AF Baby Gold. Kedo S Square achieved a notably better taper in the apical one third. It is because, in contrast to fixed narrow taper hand files, their double cross-section and varying taper better correspond to the structure of primary teeth. Specifically, Kedo S Square have a taper of 6 to 8%, with the first 5 mm at 6% taper, increasing to 7% and 8% further up. This design promotes greater cervical enlargement while restricting apical preparation, thus reducing the risk of extruding obturating material. Pro AF Baby Gold⁵ are made from CM wire heat treated technology with a constant 4% taper, are 17 mm long. The CM wire helps reduce deformities and the risk of file separation, and the files feature greater cutting efficacy and non-cutting tip. Srinivas et al.,¹¹ found that Kedo S produced better taper than manual K-files. Nahid Razani et al.,¹² observed M-Two system had superior taper compared to hand K-files in CBCT scans. Seema et al.,¹³ found no significance in taper between K-files, Protaper and Kedo S using CBCT.

Maintaining adequate residual dentin is crucial for a tooth's resistance to forces. The cutting efficacy of the instrument is correlated with removal of dentin. The Kedo S Square showed more precise, minimally invasive preparation, which helps save the dimensions of thin-walled primary root canals, balancing effective cleaning with tooth structure

preservation. In the present study the comparison of mean reduction in dentin thickness after instrumentation when compared at coronal third exhibited a highly significant difference. In contrast no significance was seen at the middle 1/3rd. In the apical third, a notable difference was observed in two groups. Pro AF Baby Gold demonstrated a greater dentin removal. The difference is attributed to the Kedo-S Square files non-cutting safety tip and variable taper, which conserves apical dentin and improves irrigation and cleaning for better obturation. The varying taper engages less of the canal wall with each file. Seema et al.,¹³ observed that while hand K-files removed more dentin at the coronal third, hand K-files and Kedo-S rotary files did not significantly vary in dentin removal at the middle or apical thirds.

Reducing instrumentation time is key to minimizing operator and child fatigue, which improves cooperation. This study found Kedo S Square significantly reduced time of instrumentation to 2.30 minutes, compared to 5.10 minutes with Pro AF Baby Gold. Kedo S Square took the least amount of time between K-files and H-files, according to Lakshmanan et al.,¹⁴. Kedo S system reduced time and improved obturation quality, enhancing children's cooperation during procedure according to Panchal et al.,¹⁵ this difference may be due to variations in operator skill and experience, emphasizing the need to consider operator expertise when evaluating instrumentation techniques.

This study uses primary anterior teeth with no apical resorption and having straight roots. Future research should examine how apical resorption affects debris extrusion. Results may differ in clinical settings. Nonetheless, pediatric rotary files are recommended over hand files for more effective and efficient pulpectomy. They offer a simpler, quicker approach to root canal debridement in primary teeth. Findings should be applied cautiously, considering patient variations and case specifics. This study assessed Kedo S Square and Pro AF Baby Gold to explore their potential as alternatives to manual files, focusing on their variable taper and shorter length. Further research is needed to evaluate patient acceptance and long-term clinical and radiographic success to confirm their efficacy and durability in practice.

Conclusion

Irrespective of needle design, apical debris extrusion is seen in all groups, however groups with side vented needles exhibited lesser apical debris extrusion making them more safer than conventional needles while pediatric endodontic therapy. Kedo S Square files achieved better taper than Pro AF Baby Gold files. However Kedo S Square showed comparatively less dentin removal than Pro AF Baby Gold.

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