ORIGINAL RESEARCH

Comparative Evaluation of Apical Debris Extrusion in Primary Molars Using Three Different Pediatric Rotary Systems: An *In Vitro* Study

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Abstract

Aims and background: Failure of the endodontic treatment might be due to various reasons like zipping, apical blockade, ledging, debris extrusion, etc. Apical debris extrusion in primary teeth is of major concern as it does not have a proper well-developed apex, that is, mature apex. This study aims to compare and evaluate the apical debris extrusion in primary molars using three different pediatric rotary file system.

Materials and methods: Thirty freshly extracted teeth primary molars were divided into three experimental groups according to the used file systems as group I—NT Pedo Gold, group II—Pedo Flex, and group III—Kedo-S. Debris extruded during canal shaping were collected in preweighed vials. Each canal was irrigated with 6 mL of saline and 2 mL of sodium hypochlorite. The amount of debris extruded from each tooth was calculated by subtracting the preinstrumentation from the postinstrumentation measurement. Data were analyzed using analysis of variance (ANOVA) and *post hoc* Tukey tests with $\alpha = 0.05$.

Results: Kedo-S showed statistically significant lesser apical debris extrusion than Pedo Flex and NT Pedo Gold (p-value < 0.001) while comparing Pedo Flex and NT Pedo Gold insignificant difference.

Conclusion: All three pediatric rotary file systems extruded debris apically; while Kedo-S can be safely used as a rotary file in pediatric dentistry with minimal apical debris extrusion.

Clinical significance: An ideal rotary instrument should not extrude debris apically, the lesser the extrusion greater the endodontic treatment success. Kedo-S can be securely used as a rotary file with less apical debris extrusion than the other two rotary systems.

Keywords: Apical debris extrusion, Kedo-S, NT Pedo Gold, Pedo Flex, Primary molars, Rotary pedodontics.

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Introduction

First and foremost, things to be considered for maintaining the primary teeth are to preserve both the normal jawbone and optimal muscle development, proper pronunciation, and to reserve space for corresponding permanent teeth until they erupt in inappropriate position. Failure to maintain the primary teeth has several consequences like altered function and improper phonetics, the presence of gap due to early loss of teeth results in deleterious oral habits, and it may also cause space loss which might either disturb eruption sequence or ectopic eruption.[1–3]

Irreversible pulpitis, pulpal necrosis, and nonvital teeth are the major signs and symptoms in primary teeth indicating the endodontic procedure.[4] Maintaining the space, esthetics, and function are the factors to be considered for the preservation of the primary tooth by pediatric endodontic procedures. The complex morphology and delicate walls of the root canal are the hurdles faced by pedodontists during the procedure.[5]

Initially, biomechanical preparation of the primary teeth was done only by hand files and the idea of using the rotary endodontic file in primary teeth was introduced by Barr et al. in 1999.[6] It was a successful trial as it decreased the working time with predictable obturation.[6,7] Later, with modifications in the protocol of endodontic files like ProTaper, K3, and Hero Shaper, these files were used effectively in primary teeth.[8–10]

The inconvenience for the oral cavities in children arose as these endodontic rotary files were with a constant taper and were longer than the primary teeth.[5] Jeevanandan in 2017 introduced "Kedo-S" the first pediatric rotary file in India.[11] Later, many pediatric rotary files like Prime Pedo, Pro AF Baby Gold, DXL-Pro Pedo, Pedo Flex, Denco Kids, Sani Kid rotary files, etc., evolved.[5]

Among different reasons for endodontic treatment like zipping, apical blockade, ledging, etc., commonly observed in manual preparation,[12] apical debris extrusion in primary teeth is of major concern as it does not have a proper well-developed apex, that is, mature apex.

This study aims to compare the amount of debris extruded by each rotary system and to find out a better system with minimally extruding debris apically among the three pediatric rotary systems—NT Pedo Gold (Nineten dental product, Europe),

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Pedo Flex (Orikam Healthcare, India), and Kedo-S (Reeganz dental care, India).

Materials and Methods

The study proposal was approved by the Institutional Ethics Committee under the registration number VDCW/IEC/298/2022,37 and freshly extracted teeth were exposed to cone beam computed tomography (CBCT). Among 37 primary molars (Fig. 1), 30 primary molars with only 3 canals and at least 2/3rd of the root length and without internal or external resorption, severe root angulation, and root fracture were included in the study using CBCT.[13] Specimen included in the study were randomly allocated into three groups (n = 10), according to the file systems used as group I—NT Pedo Gold (Nineten dental product, Europe), group II—Pedo Flex (Orikam Healthcare, India), and group III—Kedo-S (Reeganz dental care, India). Eppendorf tubes were preweighed using the electronic weighing balance (Precisa, Dietikon, Switzerland). Three measurements were taken for each tube consecutively and the mean values were recorded as preop weight of the tubes. Access cavity was prepared using no. 4-round bur (BR 31, Mani, Japan). The access cavity's roof was removed using safe-end diamond-tapered fissure (EX 24, Mani, Japan) bur with an outward brushing motion. Working length and canal patency were determined using 10 size K-file (Mani, Japan) by introducing the 10k size file manually into the canal until just visible at the apical foramen and 1 mm short of this length was recorded as working length. After the working length determination of each canal, all the canals were prepared into 15-size K-file (Mani, Japan) manually. The prepared sample teeth were then inserted into the hole created in the container lid separately till the cemento-enamel junction (CEJ), while the roots were placed inside the Eppendorf tubes. The scintillation vial (air-tight container) was closed using the lid along with the tooth such that the Eppendorf tube was present inside the containers (Fig. 2) and containers were covered with aluminum foil to eliminate the operator bias. The tooth crown was sealed to the container lid using the self-cure resin and the apparatus was made airtight. A 24 gauge syringe needle was inserted into the lid to equalize the pressure, (Fig. 2) (Myer and Montgomery apparatus).[14]

- Group I: A total of 10 primary molars were prepared using NT Pedo Gold. Instrumentation was done at 300 rpm and 2.0 Ncm torque. Canal preparation was done till 25/04 and 20/04 for wide and narrow canals, respectively. Each rotary file was used in the particular canal two times, only in the "in and out" action without applying excess pressure on the files.
- Group II: A total of 10 primary molars were prepared using Pedo Flex file. Instrumentation was done at 300 rpm and 2.0 Ncm torque. Canal preparation was done till 25/04 and 20/04 for wide and narrow canals, respectively. Each rotary file was used in the particular canal two times, only in the "in and out" action without applying excess pressure on the files.

Fig. 2: Myers and Montgomery apparatus

Fig. 1: Tooth collected for the study

- Group III: A total of 10 primary molars was prepared using Kedo-S file. Instrumentation was done at 300 rpm and 2.0 Ncm torque. Canal preparation was done with D1 file followed by E1 file for wider canals and D1 for narrower canals. Each rotary file was used in the particular canal two times, only in the "in and out" action without applying excess pressure on the files.

Root canals were irrigated using 1 mL of 3% sodium hypochlorite followed by 3 mL normal saline during instrumentation and the whole of 6 mL of saline and 2 mL of sodium hypochlorite was used for each tooth. 17% ethylenediaminetetraacetic acid (EDTA) was used for lubricating the file.[15] The tooth was then removed and Eppendorf tubes were collected and incubated at 70°C for 5 days till the moisture content was evaporated and weighed (postop). Debris was then calculated by measuring the difference in the weight of the Eppendorf tube (postop–preop). Mean values were statistically analyzed and results were obtained.[14,15]

Results

Table 1 shows the mean average of apical debris extrusion of three pediatric rotary instruments. On comparing the values between and within the group, the between-groups comparison was statistically significant, while the comparison within the group was insignificant. Hence, in Table 2, *post hoc* test comparison between three groups where statistically significant lesser debris extrusion was observed in group III and insignificant difference between group I and group II. Figure 3 depicts the comparison between mean values of apically extruded debris for all three groups which stated that group II has the highest extrusion followed by group I and group III.

Discussion

Previous studies in the literature state that any endodontic instrument has the property of extruding the debris apically. Since every endodontic instrument has this property, the amount of debris extruded into the apex is of major concern especially in primary teeth for two reasons. One, it might jeopardize the health of permanent tooth buds.[16,17] Two, the roots of the primary tooth are already in a resorbing state and do not have a proper apex like permanent teeth which indirectly increases the apical debris extrusion than permanent teeth.[18,19]

Rotary pedodontics is an emerging trend in the field of pediatric dentistry with many beneficial effects like good cleaning efficacy, limited instrumentation time, etc.[20–22] The hazardous effects like reduced dentin thickness, apical debris extrusion should be taken into account before choosing a rotary file. Therefore, an ideal endodontic instrument should have better cleaning efficiency with limited debris extrusion periapically.[15] The present study evaluated the apical debris extrusion using commercially available three pediatric rotary file systems.

Pediatric rotary file systems with different cross-sections, taper and metallurgy were selected for the study. Regarding the files used in this study, Kedo-S is a triangular cross-section, negative rake angle, noncutting tip-variably varying taper ranging between 4 and 8% taper. Jeevanandan[11] and Asif et al.[14] stated that Kedo-S showed lesser debris extrusion when compared with rotary ProTaper and Hand files. Hence, Kedo-S files were selected for the study. Pedo Flex is one of the pediatric rotary files with 4% taper, triangular with sharp edges cross-section, and heat-treated NiTi metallurgy with very minimal data in the literature selected for the study. NT Pedo Gold is a pediatric rotary file system with 4% taper, convex triangular cross-section with passive safety tip, and heat-treated NiTi metallurgy. To the best of our knowledge, there are no studies in the literature regarding NT Pedo Gold file.

Primary teeth with only three canals with at least 2/3rd of the remaining tooth were selected for the study using preop CBCT exposure. The aim of the present study was to evaluate the apical debris caused due to the blades of the files, hence, the rotations per minute and torque have been standardized to 300 rpm and 2.0 Ncm, respectively for all the groups. Irrigation of the canals was standardized by using 6 mL of 0.9% normal saline for each and 17% EDTA was used to lubricate the files in the study as these are the commonly used irrigants.[13]

Table 1: Mean and standard deviation

Group	*Number*	*Mean ± SD (of weight)*
I	10	1.6588 ± 0.22190
II	10	1.7150 ± 0.09181
III	10	0.8538 ± 0.16784

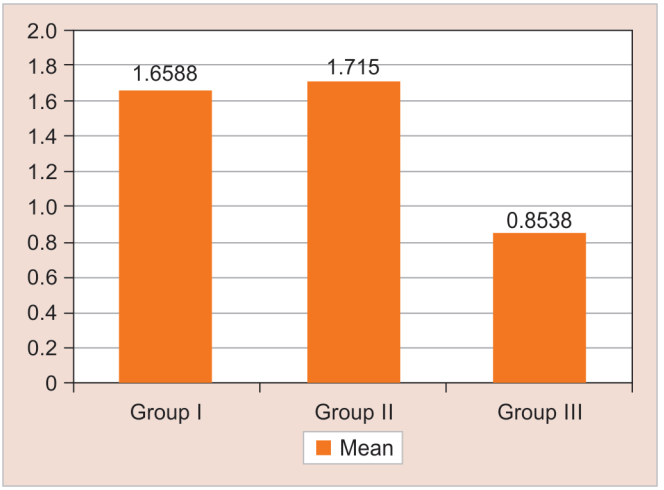

Fig. 3: Mean values of apically extruded debris for groups I, II, and III

Table 2: *Post hoc* test comparison between three groups

Group	*Group*	*Mean differencebetween the groups*	*Standard error*	*p-value*
I	II	–0.05625	0.08458	0.786
	III	0.80500*	0.08458	0.000*
II	I	0.05625	0.08458	0.786
	III	0.86125*	0.08458	0.000*
III	I	–0.80500*	0.08458	0.000*
	II	–0.86125*	0.08458	0.000*

**p*-value statistically significant (<0.05)

Various methodologies to quantify the apical debris extrusion were proposed by authors like Tanalp and Güngör[23] and Myers and Montgomery,[24] among which Myers and Montgomery's method is the most used one. Hence, the latter method is selected for the present study. Few previous studies simulated the periapical tissues using floral foam.[25] But simulation of periapical tissues was not attempted in this study as materials used for the latter might block the apical foramen or may absorb the irrigants extruded which in either way might hamper the results.[14,21] Aluminum foil was used to cover the Myer and Montgomery apparatus to eliminate the observer bias and only 5 canals were prepared using each file after which a new file was replaced.

The results of the present study showed insignificant difference on comparing the apically extruded debris using NT Pedo Gold and Pedo Flex which might be due to their similar metallurgy and taper. In spite of the statistically insignificant difference upon evaluating Pedo Flex and NT Pedo Gold, the latter showed less debris which might be due to the passive safety tip of NT Pedo Gold.

When Pedo Flex was compared to Kedo-S in the present study, there was significantly lesser debris extrusion which might be due to two reasons—one is the noncutting end of the file, hence, only lesser dentin was removed and lesser debris extrusion, on the other hand, taper of Kedo-S ranges from 4 to 8% from apical to coronal region, respectively, since there is increased taper up to 8% in the coronal region there might be increased flushing of the debris along with irrigating solution coronally.

Studies conducted by Preethy et al. in 2019[26] and Asif et al. in 2019[14] stated that Kedo-S showed lesser debris extrusion which is similar to the present study. On the contrary, few studies conducted by Rathi et al. in 2021[15] and Pawar et al.[27] in 2021 showed different results stating that Kedo-S extruded more debris. The differences in the data might be due to various reasons like, Kedo-S could have been compared with different files, protocol for filing could be different, or a different irrigating solution could have been used to lubricate and irrigate the canal. As there are no articles that evaluated the apical debris extrusion of Pedo Flex and NT Pedo group, data obtained from the present study cannot be compared with other studies.

The limitations of the study include the absence of periapical simulation as the presence of periapical tissues normally will have the pressure, thereby not allowing the contents to extrude apically. A tooth with fully formed roots with no signs of resorption should be evaluated in future studies.

Conclusion

Within the limitations of the study, irrespective of the files used in the study all the files extruded debris. On comparing Kedo-S with two other commercial pediatric rotary files—NT Pedo Gold and Pedo Flex, Kedo-S produced significantly lesser debris extrusion than the other groups proving it to be a better file with a wide safety margin.

Clinical Significance

Rotary pedodontics is an emerging trend in the field of pediatric dentistry, choosing a rotary file with the least apical extrusion is of prime concern as it might jeopardize the periapical healing and reinfection. Among the three pediatric files evaluated in the study, Kedo-S extruded minimal debris authenticating it to be a safer file and can be used in pediatric patients.

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