Original Article

Comparative Evaluation of Extrusion of Apical Debris in Primary Anterior Teeth using Two Different Rotary Systems and Hand Files: An *In Vitro* Study

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Abstract

Background: The success of endodontic treatment depends on the chemomechanical preparation of the tooth. However, the debris produced during canal preparation may extrude through the apical foramen causing postoperative complications. **Aim:** The aim of this study is to compare the apical debris extrusion during root canal preparation in primary anterior teeth using hand files, rotary ProTaper files, and rotary Kedo-S files. **Materials and Methods:** Forty-five freshly extracted primary canine with mature apices and a single canal were randomly divided into three groups for instrumentation as follows (n = 15): Group 1: hand files; Group 2: rotary ProTaper files; and Group 3: rotary Kedo-S files. Myers and Montgomery experimental model was used for this study. Apically extruded debris collected in a preweighed Eppendorf tubes was placed in the incubator at 70°C for 5 days. The weight of the debris collected was determined by subtracting the pre- and post-instrumentation weight of the Eppendorf tubes. The data collected were analyzed using the analysis of variance and Tukey's *post-hoc* tests. **Results:** Hand files produced more apical debris extrusion than ProTaper and Kedo-S files ($P < 0.05$) while Kedo-S produced the least ($P < 0.05$). **Conclusion:** All instrumentation systems cause apical debris extrusion. Kedo-S produced less apical debris extrusion when compared to the hand files and ProTaper files.

Keywords: *Apical extrusion, K-files, Kedo-S, ProTaper*

Introduction

Endodontic treatment and preservation of the primary teeth are important not only for the normal development of the jawbone and musculature but also for the eruption of succeeding permanent teeth into the ideal position and for functional reasons. Early loss of primary teeth can result in altered phonation, development of aberrant habits, and alteration in the eruption pathway of permanent teeth.[1-3] Periapical infection of the primary teeth is one of the major contributing factors for early loss of deciduous teeth.[4] Hence, endodontic treatment is the treatment of choice for treating the teeth with chronic pulpitis and nonvital teeth.[5] For the ultimate success of the endodontic treatment, all the procedures should be carried out with the aim of maintaining or healing of the periradicular tissues, thus saving the primary tooth till the eruption of the permanent successor.[6] The steps in pulpectomy comprise the administration of local anesthesia, rubber dam isolation, access cavity preparation, working length determination, biomechanical preparation of the root canals, obturation with a suitable material, and a coronal seal followed by the placement of stainless steel crown.

Chemomechanical preparation of the root canal is the most essential factor that ultimately determines the success of the endodontic treatment in primary teeth.[7,8] Conventionally, mechanical preparation of the root canals in primary teeth was carried out using hand files. With continuous evolution and advancements in the endodontic field of pediatric dentistry, the primary root canals are now being instrumented with rotary files.[9-14] The ProTaper rotary files are the most commonly used rotary file system for the canal instrumentation in primary teeth.[15]

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It has the shaping files (S) and finishing files (F). Shaping files have an increasing taper in the coronal direction and finishing files (F) have a decreasing taper. Studies have shown that instrumentation with ProTaper files produce a more regular canal diameter and is less time-consuming than that manual files.[16,17] Kedo-S file is an exclusive pediatric rotary file introduced for canal preparation of the primary teeth. It has three sets of files, namely D1, E1, and U1 having a rip diameter of 0.25 mm, 0.30 mm, and 0.40 mm, respectively. D1 is used to prepare narrow root canals, E1 for the preparation of wider canals, and U1 is used to prepare root canals of upper anterior teeth. Kedo-S files have variably variable taper facilitating efficient canal preparation and avoid over instrumentation of the root canals.[18] There are no studies in the literature evaluating the efficiency of Kedo-S file system. However, irrespective of the file system used, apical extrusion of debris during root canal instrumentation is inevitable.[19-22] The extruded debris may contain pulp remnants, dentinal chips, necrotic debris, microorganisms, and irrigation solution that can result in inflammation, postoperative pain, flare-ups, delayed healing, and even possible damage to the permanent tooth germ.[22-25] The amount of apical debris extrusion depends on the type of instrumentation system used.[26]

Studies have shown that the amount of apically extruded debris was more with push–pull instrumentation technique than the rotational motion technique.[27] There are no studies in the literature evaluating the apical extrusion of debris using Kedo-S rotary files. The aim of the present study was to compare the amount of apically extruded debris and irritant using conventional hand files, rotary ProTaper files, and Kedo-S files.

Materials and Methods

The present study was conducted in the department of pediatric and preventive dentistry after getting approval from the Institutional Review Board. A total of 45 extracted deciduous canines [Figure 1] as a part of preventive orthodontic treatment with closed apex and without resorption in children between 5 and 8 years of age were included in the study. Digital radiographs were taken to ensure that all the teeth had a single canal. Teeth with external or internal resorption, teeth with cracks or fractures, and teeth with more than one canal were excluded from the study. The sample size was calculated from a previous study with 95% power using G power analysis.[28] The teeth were cleaned, by removing the external debris and soft-tissue remnants, using an ultrasonic scaler and stored in distilled water at room temperature until the start of the experiment.

Access preparation was done using no. 6 round diamond points (Mani Inc., Japan) with a high-speed handpiece under copious irrigation. Canal patency and the working length of each tooth were determined by inserting size 15 K-file (DENTSPLY Maillefer, Ballaigues, Switzerland) until the tip of the file was just visible at the apical foremen, and then, 1 mm was reduced from that.

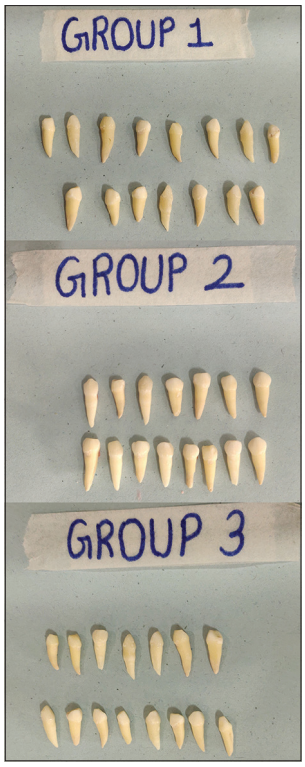

Figure 1: Forty-five primary canines that were used in the current study

In the current study, Myers and Montgomery experimental model was used [Figure 2].[27] The stoppers were separated from the Eppendorf tubes, and preweighing of the empty Eppendorf tubes was done using 10^{-5} precision electronic weighing balance (Sartorius AG, Gottingen, Germany [Figure 3]). Three consecutive measurements were taken for each tube, and the mean values were recorded. Holes were created in these stoppers, and each tooth was inserted into each of these holes up to the cemento-enamel junction. A 27-G needle was placed alongside the stopper as a drainage cannula to equalize the pressure inside and outside the tube. The Eppendorf tubes with the tooth and needle were fitted into the vials, which were covered by aluminum foil to eliminate operator bias during the instrumentation of the canals. During the study, the Eppendorf tubes were not touched, and the entire apparatus was handled only by the vial.

The teeth were coded and randomly divided into the following three groups:

- Group 1: Hand files (DENTSPLY Maillefer, Ballaigues, Switzerland) (n = 15) Hand instrumentation was performed using a quarter pull method with stainless steel K-files in the following sequence: size 25/0.02 taper, size 30/0.02 taper, size 35/0.02 taper, and size 40/0.02 taper
- Group 2: ProTaper files (DENTSPLY Maillefer,

Figure 2: Myers and Montgomery experimental model

Figure 3: Microbalance (Sartorius AG, Gottingen, Germany)

Ballaigues, Switzerland) (n = 15)
The root canals were prepared with ProTaper Universal instruments at 300 rpm and 2 Ncm torque (X-Smart, DENTSPLY India Pvt. Ltd., Delhi, India) in the following order S1, S2, F1, and F2 according to the manufacturer's instruction

- Group 3: Kedo-S files (Reeganz Dental Care Pvt. Ltd., India) (n = 15)
  The root canals were prepared with U1 Kedo-S file used at 300 rpm and 2 Ncm torque (X-Smart, DENTSPLY India Pvt. Ltd., Delhi, India).

To avoid variation in the technique and to eliminate bias, a single operator did the procedures of cleaning and shaping and irrigation for all the samples. The root canal of every sample was irrigated with a constant of 10 ml distilled water during instrumentation. After the completion of instrumentation, the debris adherent to the external surface of the root was collected by rinsing the tip of the root tip with 1 ml of distilled water into the Eppendorf tube. The tubes were then placed in the incubator at 70°C for 5 days[29] to allow the evaporation of the distilled water collected during the rinsing of the root surface so that only the dry debris remains for the analysis. The net weight of the dry debris was obtained by subtracting the initial weight of the empty Eppendorf tubes from the new value.

Statistical analysis was performed using the SPSS version 22.0 (SPSS Inc., Chicago. IL,USA). Data collected were analyzed statistically using the one-way analysis of variance and Tukey's *post hoc* analysis. Level of statistical significance was set at $P < 0.05$.

Results

A statistically significant difference was noted in the extrusion of the apical debris among the three groups ($P < 0.05$) [Table 1]. It was also noted that instrumentation with Kedo-S rotary files produced statistically lesser extrusion of the apical debris compared to instrumentation with ProTaper and hand files ($P < 0.05$) [Table 2].

Table 1: Mean and standard deviation of weight of apically extruded debris in grams using one-way analysis of variance

Group	*n*	Mean±SD	*P*
Hand File	15	0.0018893±0.00068844	
ProTaper	15	0.0014467±0.00033245	0.001
Kedo-S	15	0.0007267±0.00024159	

P<0.005. SD: Standard deviation

Table 2: Tukey's *post-hoc* analysis

Group (I)	Group (J)	Significance
Hand Files	ProTaper	0.032
Hand Files	Kedo-S	0.000
ProTaper	Hand Files	0.032
ProTaper	Kedo-S	0.000
Kedo-S	Hand Files	0.000
Kedo-S	ProTaper	0.000

Discussion

Apical debris and irrigant extrusion can be one of the postoperative complications of the root canal treatment. Extrusion of apical debris is not commonly investigated on primary teeth. The possible reason could be due to the physiologic resorption of the primary tooth root that is seen soon after the completion of its formation. The apical debris extrusion is usually more in the primary teeth because of the presence of wide apical diameter when compared to the permanent teeth.[30]

For successful endodontic treatment, it is important to minimize the extrusion of apical debris during the canal instrumentation. The apical extrusion depends on the root canal morphology, instrument type and size, working length, type and amount of irrigant used, and type and technique of instrumentation.[6,31-34] There are only a few studies available in the literature evaluating the amount of apical debris extruded in primary teeth following canal preparation.

Although there are different techniques for the measurement of the collected apical debris in the

present study, the generally accepted method of Myers and Montgomery was used.[27] The drawback of this experimental setup is the absence of physical backpressure provided by the periapical tissues, which resist extrusion of debris and irrigant from the periapical area. Altundasar *et al*.[35] used floral foam to simulate the periapical tissues, but this setup had the disadvantage of absorption of irrigant and debris by the floral foam. Therefore, in the present study, no attempt was made to simulate the periapical tissue resistance.

Radiographs were taken to ensure that the sample teeth contained straight and single canals and only those teeth were included in the study to maintain the uniformity between the three groups. Working length was determined 1-mm short of the apex since there are studies in the literature, which states that the extrusion of apical debris is more when the instrumentation was performed until the root apex than when performed 1-mm short of the apex.[36] Distilled water was used as an irrigant to avoid the crystallization of sodium hypochlorite solution, which can lead to misleading weight measurements, and the amount of irrigant used was kept constant for all the groups. All possible measures were taken to prevent the bias as much as possible to our knowledge.

In primary teeth, the most commonly used rotary system is ProTaper file.[15] Hence, the ProTaper rotary files, Kedo-S files, and conventional hand files were selected for the evaluation in the present study. The results of the present study revealed that the extrusion of debris apically is more with hand files compared to the rotary files ($P < 0.05$). Huang *et al*. evaluated the amount of apical debris during endodontic retreatment in permanent teeth with hand files and ProTaper system and determined that hand files produced significantly more amount of apical debris extrusion.[37] De-Deus *et al*. evaluated the amount of apically extruded debris during canal preparation with hand files, ProTaper, WaveOne, and Reciproc systems and found that hand files extruded significantly more debris than all other groups.[38] Apical extrusion studies done in primary teeth also show that hand files produced significantly more apical debris followed by ProTaper files.[29,30] The results of the present study are consistent with that of the above-mentioned studies.

The present study revealed that all the three instrumentation systems cause apical extrusion of the debris with Kedo-S files producing the least extrusion. One possible reason could be due to the single file system concept in Kedo-S rotary files, whereas the other files compared were used in a sequence of more than two files for the canal preparation. Other contributing factors for Kedo-S showing the least extrusion are the length and the taper of the file design.

Furthermore, hand files produce more apical debris extrusion than the rotary files as the K-files are instrumented in filing motion which pushes the debris apically and also it has a taper of 0.02 which creates less space for the debris to get flushed coronally.[29]

Conclusion

Kedo-S rotary file produces lesser extrusion of debris apically when compared to the other files making it a more suitable rotary instrument for use in primary teeth with minimal postoperative complications.

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Conflicts of interest

There are no conflicts of interest.

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