

## RESEARCH ARTICLE

# Comparative Evaluation of Cleaning Capacity and Efficiency of Kedo-S Pediatric Rotary Files, Rotary ProTaper, and Hand K Files in Primary Molar Pulpectomy

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### ABSTRACT

**Aim and objective:** To assess and compare the cleaning efficacy and instrumentation time of K files, ProTaper, and Kedo-S rotary files in primary molars.

**Materials and methods:** India ink was injected into 120 root canals of selected primary molars. The root canals were randomly and equally divided into three groups based on instrumentation technique: group I—K files, group II—ProTaper, and group III—Kedo-S. After instrumentation with respective method, the canals were cleared and observed under a stereomicroscope, the instrumentation time for each root canal was also measured with a stopwatch. Statistical analysis was done with one-way analysis of variance (ANOVA) and *post hoc* Bonferroni.

**Result:** Kedo-S rotary files performed significantly better cleaning of the canals in the coronal and middle third than ProTaper and K files ( $p = 0.0001$ ). In the apical third, the difference between the two rotary systems was not significant. The time taken for instrumentation was lowest with Kedo-S followed by ProTaper and K files.

**Conclusion:** Kedo-S pediatric rotary system showed significantly better cleaning than ProTaper rotary system and K files in cleaning primary molar root canals.

**Clinical relevance:** The anatomy and morphology of primary teeth demand a specialized file system that will overcome the shortcomings of conventional biomechanical preparation. Kedo-S files, being exclusive pediatric rotary files, might prove to be a boon in primary canal preparation.

**Keywords:** Biomechanical preparation, Kedo-S rotary files, Pediatric rotary files, ProTaper rotary file, Pulpectomy.

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### INTRODUCTION

Pulpal involvement of primary teeth remains an everyday encounter for pediatric dentists despite numerous technical advances in the prevention of dental caries. Pulpectomy procedure is the preferred treatment for removal of infected radicular pulp in primary teeth that are in a restorable condition.<sup>1</sup> A successful pulpectomy depends on correct diagnosis, biomechanical preparation followed by obturation of the root canals.<sup>2</sup> The objective of biomechanical preparation in primary teeth is to remove the pulp tissue remnants, debris, and infected dentin from the canals and make a pathway for the irrigants to reach the apical third and to make optimal space for obturation.<sup>3</sup>

The conventional method used for biomechanical preparation in pulpectomy is hand instrumentation with stainless steel files and broaches.<sup>1</sup> In primary teeth, it has certain limitations such as increased canal preparation time, lack of flexibility leading to ledge formation and lateral perforation, a greater possibility of iatrogenic errors along inadequate cleaning of the canals.<sup>4-8</sup>

To overcome these shortcomings, the use of nickel-titanium instruments was advocated. Rotary instrumentation has been used successfully for three decades in permanent teeth. They have the advantage of speed, flexibility, and shape memory which shows better results in cleaning efficacy and time taken when compared with stainless steel files. In pediatric endodontics, the use of NiTi file system was introduced by Barr et al. in the year 2000.<sup>1</sup> Rotary file systems like Profile 0.04, ProTaper, Mtwo, Flexmaster, WaveOne, etc., are widely used for primary teeth pulpectomies and have shown to

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be faster along with resulting in consistently uniform, predictable fills.<sup>1,4,6,9-11</sup> Mhatre et al. reported a single visit pulpectomy in a 5-year-old female patient using rotary ProTaper in a crown down technique and concluded satisfactory treatment outcome with regard to the obturation quality.<sup>12</sup> Musale and Mujawar compared manual, hybrid, and rotary instrumentation techniques in primary molars, using cone-beam computed tomography (CBCT) and found that manual instrumentation with K files resulted in lower cleaning efficacy when compared with rotary and hybrid techniques.<sup>13</sup>

Nagaratna et al. stated that instrument failure is less with rotary files in primary teeth than in permanent teeth and hence

recommended using the rotary system for pulpectomy.<sup>14</sup> Though they are being widely advocated for application in primary teeth, yet the different anatomy and morphology of the primary root canals demands that a specialized file system should be adopted for their preparation.

One such exclusive pediatric rotary instrumentation system known as "Kedo-S" was introduced in 2016 by Dr Ganesh Jeevanandan. It consists of three NiTi files (D1, E1, U1) with a total length of 16 mm and an altered working length of 12 mm. These files have been stated to have a variably variable taper. D1 file has a tip diameter of 0.25 mm with a variable taper for use in primary molars with narrow canals (mesial canals in mandibular molars and distobuccal canals in maxillary molars). E1 has a tip diameter of 0.30 mm and is meant for wider molar canals (a distal canal in mandibular molars and a palatal canal in maxillary molars). U1 can be used in primary incisor teeth and has a tip diameter of 0.40<sup>15</sup> (Fig. 1).

Kedo-S files were used for canal preparation in two separate cases in primary molars. In both cases, the instruments were found to be fast and effective in debidding the uneven canal walls of the primary teeth.<sup>16</sup> Panchal et al. compared instrumentation time and quality of obturation between Kedo-S files, K files, and H files. They concluded that Kedo-S files show better obturation quality with a higher number of optimal obturation when compared with the other systems.<sup>16</sup>

There have been no published studies to show the comparison between rotary file systems for permanent teeth and Kedo-S files in terms of significant differences in instrumentation time and cleaning efficacy. Hence, the present study aimed to compare the cleaning efficacy and instrumentation time of Kedo-S files with ProTaper files, when used in root canal preparation of primary molars.

## MATERIALS AND METHODS

The present study was conducted in the Department of Pedodontics and Preventive Dentistry, Institute of Dental Studies and Technologies, Kadrabad, Modinagar. Ethical clearance for conducting the study was obtained from the institutional ethical committee. This *in vitro* study was performed on primary molar teeth indicated for extraction having at least one root with 2/3rd of root length and without any prior endodontic treatment. Grossly decayed teeth with root resorption more than 2/3rd of root length,



Fig. 1: Kedo-S files (red: D1, blue: E1, black: U1) working length: 16 mm

teeth with internal and external root resorption, severe root angulation, and fractured roots were excluded from the study.

## Sample Size

A sample size of 120 was derived after considering the previously published literature. A total number of 47 molars were collected (19 maxillary and 28 mandibular) in which 46 root canals were in the maxillary teeth and 74 root canals were in the mandibular teeth which met the inclusion criteria. Thus, making a total of 120.

## Collection of Teeth and Their Storage

Freshly extracted teeth were washed under running water and all the soft tissue was removed from the root surface. The teeth were stored in 3% sodium hypochlorite for 24 hours for disinfection and afterward in saline, until the completion of the study.

## Method of Root Canal Preparation

A standard coronal access cavity was prepared in the tooth with a small round bur. The coronal pulp was removed with a sharp spoon excavator and the root canals were located. Radicular pulp was extirpated with a thin broach and working length was determined with a #10 file. The tip of the file was visualized using a magnifying glass and the final working length was then established 1 mm short of this recorded length. The pulp chamber and root canals were profusely irrigated with 2.5% sodium hypochlorite and saline to remove the organic debris. The canals were then injected with India ink dye with an insulin syringe from the coronal side until the ink leaked from the apical foramen. The ink was reapplied at least two to three times into the root canals to ensure complete staining of the canals after which the teeth were stored in saline at room temperature for 48 hours. The teeth were then mounted in dental plaster, to carry on with an unbiased procedure for biomechanical preparation of the root canals.

The teeth were randomly divided into 3 groups so that each group had 40 root canals. The groups were based on the file systems used for biomechanical preparation as follows:

Group I: The root canals were prepared manually with K files (length 21 mm) (Dentsply) by step-back technique.

Group II: The root canals were instrumented with a rotary ProTaper file system (Dentsply) in a modified technique: Sx up to 3 mm beyond the orifice and then the preparation was completed with S2.

Group III: Biomechanical preparation of the root canals was carried out with Kedo-S rotary files (Reeganz Dental Pvt Ltd) in crown down technique. The mesiobuccal, mesiolingual canals of mandibular molars and distal and mesial canals of maxillary molars were prepared with a D1 rotary file followed by E1 if necessary. The palatal and the distal canals were prepared with E1 files.

After each change of instruments, the root canals were irrigated with 1% sodium hypochlorite solution. Patency of root canals was checked with the #10 hand file.

The instrumentation time for each root canal was measured by a stopwatch from the beginning of insertion of the first file to the final preparation. The pulp chamber of all the instrumented teeth was then filled with temporary cement (cavity) and the teeth were demounted following which the apical ends were sealed with wax.

## Decalcification

The demounted teeth were decalcified in 7% hydrochloric acid in three separate glass beakers for each group and the acid solution was changed every alternate day to maintain the efficacy of

the solution. The completion of the decalcification process was determined using the probe method. The teeth were totally decalcified in an average period of 12 days.

### Dehydration

After decalcification, the teeth specimens were kept in running tap water for 24 hours to neutralize the acid. Dehydration was done by keeping the teeth in a series of freshly prepared solutions of 70% ethyl alcohol for 16 hours, 80% alcohol for 8 hours, 95% alcohol for 8 hours, 100% alcohol for 8 hours. After completion of the dehydration procedure, the teeth were cleared in xylene for 6 hours.

### Analysis of the Canals

The cleared teeth were examined under a stereomicroscope at 10 $\times$  magnification. The teeth were scored according to the amount of India ink remaining in the coronal, middle, and apical thirds of the canals on a scale of 0 to 3. The scoring criteria were as follows:

- 0 = total ink removal.
- 1 = >50% ink removal.
- 2 = <50% ink removal (Fig. 2).
- 3 = no ink removal (Fig. 3).

These scores were then tabulated for the three groups and each root canal at the coronal, middle, and apical third. The composite scores for all teeth were also recorded.

### Statistical Analysis

The statistical tests used were one-way analysis of variance (ANOVA) test and *post hoc* tests (or *post hoc* comparison tests)-Bonferroni test. The *p* value was taken significantly when <0.05 at a confidence interval of 95%.

## RESULTS

### Cleaning Efficacy

Group III (Kedo-S) rotary files performed significantly better than group II (ProTaper) and group I (K files) with regards to the cleaning efficacy in the coronal, middle, and apical third of the root canals, with a *p* value of 0.0001 which is highly significant. In all the groups, maximum cleaning was seen in the middle one-third of the root canals and minimum cleaning was in the apical one-third (Table 1).

The intergroup comparison with *post hoc* Bonferroni revealed significantly better cleaning efficiency of Kedo-S when compared with ProTaper in the coronal and middle third but in the apical third

the difference was not statistically significant. Also, Kedo-S and ProTaper performed better than K files in the coronal, middle, and apical thirds with a statistically significant difference. The composite scores of the overall cleaning efficacy of files systems showed significantly better performance by group III (Kedo-S) than group II (ProTaper) and group I (K files) with the *p* value of 0.0001 (Table 2).

### Instrumentation Time

Group III (Kedo-S) rotary files took a mean of 2.53 minutes (SD = 0.636) and group II (ProTaper) took 2.58 minutes (S.D = 0.707) whereas group I (K files) took 4.22 minutes (S.D = 1.14). The difference among the three groups was significant with *p* = 0.0001 (Table 3).

## DISCUSSION

In primary teeth, the biomechanical preparation with rotary files was introduced by Barr et al. in 2000. They used ProFile 0.04 taper for root canal preparation since they can be used efficiently without undue aggressiveness.<sup>1</sup> Kuo et al. first reported the use of ProTaper NiTi rotary system for pulpectomy in primary molars. They modified the conventional protocol so that a no. 10 K file was used to explore the canals and then the Sx file was inserted into the canal to about 3 mm beyond the root canal orifice in a brushing motion. The S2 file was inserted into the canal while rotating and taken to working length. This method showed a 95% success rate at the 12-month follow-up with regards to canal filling quality.<sup>4</sup> This protocol was used in the present study where ProTaper rotary files performed comparatively better in the middle third than the coronal and apical third. The least cleaning was seen in the apical third. The ProTaper files are active cutting instruments where the shaper files (Sx, S1, S2) have an increasing taper from tip to toe. Because of this, these files are mainly cut in the middle third of the root canal whereas their tips follow the glide path to create access for the finishing files. This justifies the better cleaning efficiency of ProTaper in the middle third of the root canals.<sup>17</sup>

In the present study, a stereomicroscopic evaluation showed less efficient canal cleaning by group I (K files) which was significantly poor than both the rotary systems. The difference in the cleaning capacity can be due to several factors one of which is the operator technique. K files are dependent on the skill and experience of the clinician and motion of the hand during root canal preparation whereas rotary instrumentation does not depend on



Fig. 2: Stereomicroscopic picture shows <50% ink removal



Fig. 3: Stereomicroscopic picture shows no ink removal



**Table 1:** Mean score of cleaning efficacy of K files, ProTaper, and Kedo-S at the coronal, middle, and apical third and the intergroup differences

Coronal		Middle		Apical	
Groups	Mean	Groups	Mean	Groups	Mean
I	1.98 ± 0.733	I	1.75 ± 0.670	I	2.10 ± 0.709
II	1.50 ± 0.716	II	1.15 ± 0.736	II	1.53 ± 0.751
III	0.85 ± 0.662	III	0.63 ± 0.628	III	1.15 ± 0.736
	$p = 0.0001$		$p = 0.0001$		$p = 0.0001$
I vs II	0.475	I vs II	0.600	I vs II	0.575
I vs III	1.125	I vs III	1.125	I vs III	0.950
II vs III	0.650	II vs III	0.525	II vs III	0.375

**Table 2:** Mean composite scores of cleaning efficacy of the three groups

Composite score	Mean	SD	Mean difference	p value	
Group I	2.00	0.453	Group I vs Group II	-0.525	0.0001
Group II	1.48	0.594	Group I vs Group III	-0.950	0.0001
Group III	1.05	0.504	Group II vs Group III	-0.425	0.001
<i>p</i>	0.0001				

**Table 3:** Mean instrumentation time taken by the three groups

Instrument time	Mean (minutes)	SD	Mean difference	p value	
Group I	4.22	1.14	Group I vs Group II	-1.637	0.001
Group II	2.58	0.707	Group I vs Group III	-1.695	0.001
Group III	2.53	0.636	Group II vs Group III	0.058	1.00
<i>p</i>	0.0001				

the operator. A study carried out by Musale and Mujawar found that manual instrumentation with K files resulted in lower cleaning efficacy when compared with rotary and hybrid techniques.<sup>14</sup> Stavileci et al. compared and evaluated the root canal cleaning efficacy of the ProTaper rotary system with stainless steel K files using micro-computed tomography which showed that ProTaper rotary files left fewer untouched root canal surfaces compared with manual preparation in coronal, middle, and apical section.<sup>18</sup>

In the present study, Kedo-S rotary system showed significantly better cleaning efficiency than ProTaper rotary system and K files. The good cleaning of group III (Kedo-S) at the coronal third in the present study can be attributed to its variably variable taper (4-8%) which aids in better coronal enlargement and straight-line access. A 0.25 tip 4% taper file is required for adequate canal preparation in apical and middle thirds whereas in coronal one-third 6% taper file aids in better canal preparation.<sup>19</sup> Jeevanandan and Govindaraju compared Kedo-S files and manual instrumentation techniques for instrumentation time and quality of obturation. The pre- and postoperative radiographs showed that 77% optimally filled teeth were found with Kedo-S group. Whereas only 40% optimal filled teeth were found with manual technique.<sup>20</sup> Panchal et al. compared the obturation quality in primary root canals after instrumentation with K files, H files, and Kedo-S rotary files. The results showed a higher number of optimally filled canals with Kedo-S compared with K file and H files.<sup>16</sup> The Kedo-S pediatric rotary files have a gradual taper aiding in easy coronal enlargement and straight-line access. This gradual taper also helps in efficient canal preparation and avoids the instrumentation of the inner wall of the root surface.

In the present study, although the cleaning capacity of Kedo-S in the apical third was better than K files, yet it was not significant when compared with ProTaper. One drawback of Kedo-S files

could be their length which is 16 mm, and the working length is 12 mm. As the mean length of the primary maxillary and mandibular molars is 16.7 and 16.22 mm, respectively, and the mean root length (when unresorbed) is 11.32 and 10.32 mm, respectively.<sup>21</sup> Therefore, in certain cases, when the length of the root is >12 mm, Kedo-S system might be insufficient for complete cleaning of the apical end. Thus giving rise to a reduced mean cleaning efficiency score in the apical third.

In the present study, both the rotary systems took less instrumentation time than manual techniques. Jeevanandan et al. and Panchal et al. in their study concluded that Kedo-S rotary instrumentation was less time taking than K files and H files in primary molars. Crespo et al. in their study concluded that instrumentation time was significantly reduced with the rotary system when compared with the manual system. The authors believe that the reduction in preparation time is due to the less number of files used with the rotary system.<sup>5</sup> Also, the rotary system is engine driven which makes it faster than manual instrumentation. This can induce a positive attitude in the patient and helps in attaining patient cooperation.<sup>5</sup> According to the literature, decreased working time is one of the major advantages of rotary instrumentation in primary teeth. The results of the present study confirm the fact that rotary instrumentation is less time taking than manual instrumentation.

## CONCLUSION

Within the limits imposed by the techniques and conditions used in the present study, it can be concluded that Kedo-S pediatric rotary system proved to be significantly better than ProTaper rotary system and K files in cleaning primary molar root canals.

The rotary instrumentation technique takes significantly less time than the manual instrumentation technique. The present study results and observations were limited to *in vitro* primary molar preparation. *In vivo* studies should be extended to evaluate the most effective instrumentation technique for root canal cleaning in primary molars.

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