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A Comparative In Vitro Study of Rotary Versus Manual Instruments for Canal Preparation of Primary Molars

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ABSTRACT

Purpose: This study aimed to compare the pediatric nickel-titanium (Ni-Ti) rotary system and manual instrumentation for root canal preparation for primary molar teeth to assess their efficiency in preparation time and cleaning capacity. **Material and methods:** Sixty-four primary molar canals were categorized into two groups randomly—Group I, 27 canals manually instrumented with K-files; and group II, 31 canals instrumented with Ni-Ti rotary files (Kedo-SG). India ink was injected into the root canals in both groups with insulin syringes. The instrumentation times were recorded; thereafter, the teeth were cleared using various solutions, following which, two observers evaluated and observed the root canals under a stereomicroscope. **Results:** The preparation time in group I using K-files was significantly longer than that in group II, which used exclusive pediatric primary tooth rotary files (group I vs. group II, 01:30 vs. 00:58, respectively; $P=.0202$; t-test, $P<.001$). Moreover, the rotary files demonstrated significant canal cleaning capacity than the K-files for complete cleaning of the root canals (approximately 38% vs. 8%, respectively; $P=.013$). **Conclusion:** The use of rotary files for preparation of primary molar teeth has several advantages over the manual K-files, including faster working time. Therefore, the use of rotary files will improve compliance with children, and additionally, provide acceptable cleaning capacity.

KEYWORDS

Rotary files, primary molars,
exclusive primary tooth

- Paper extracted from PhD thesis, titled “Comparative Study of Rotary versus Manual Instrumentation in Canal preparation of Primary Molars”
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INTRODUCTION

Surgical removal of the infected or affected pulp constitutes the conservative treatment method for in situ preservation of primary teeth until natural exfoliation. This process is immensely crucial for optimum occlusion and interrogation of the arch perimeter. Moreover, preserving the primary molar teeth until normal shedding is considered as a natural space maintainer, and it also helps in natural mastication ⁽¹⁻³⁾.

Although its importance, preparation of root canals during pulpectomy remains challenging because of the morphological diversity of root canals in the primary molars ⁽⁴⁾. The choice of instrumentation for preparing difficult canals in primary roots, which undergoing normal resorptions, is the main hurdle for pulpectomy of primary molars ⁽⁵⁾.

An additional challenge is performing pulpectomy in children, which is a lengthy procedure. A previous report indicated that the cooperation and attentive of children become lesser for dental procedures with long procedure time; hence, the duration of primary molar pulpectomy is an important consideration ⁽⁶⁾.

Root canal preparation is performed using manual or rotary instruments. Recently, use of rotary instruments for root canal preparation technique has received considerable attention, possibly because of the limitations of manual instruments that can induce iatrogenic errors such as ledging, zipping canal transportation, and/or apical blockage ⁽⁷⁾.

Dentistry has witnessed great developments in the recent years. In the field of pulp therapy, in addition to the dental materials, the instrumentation, techniques, etc. has improved considerably to yield a superior procedural outcomes ⁽⁸⁾.

The technological advancements in rotary files for primary molar pulpectomies stated during the 1980s was a crucial period in medical technology, two case reports, described the pulpectomy technique using rotary files for primary teeth ^(9,10).

Although the morphology of root canals in primary teeth renders endodontic treatment difficult, several rotary instruments have been devised to treat the roots of primary teeth ⁽¹¹⁻¹³⁾. The mechanical instruments in primary molars canal preparation; shows that the rotary instruments conferred superior results than manual instruments, possibly because rotary systems render more centered preparations and less iatrogenic errors, resulting in a more homogeneous preparation of the primary molar root canals ⁽¹¹⁾.

Since the cleaning capacity of the primary canals with exclusive rotary system (Kedo-SG), it is not yet investigated before, based on previous knowledge, this study was conducted to compare the exclusive pediatric nickel-titanium (Ni-Ti) rotary files and manual instruments for preparation of the root canals for primary molar teeth. Their efficiency with regard to preparation time and cleaning capacity of the primary canals were investigated, by using a rotary file with short length, taper, non-cutting tip and controlled memory.

MATERIALS AND METHODS

This study was approved by research Ethics Committee of the Faculty of Medicine, Al-Azhar University for Girls.

Sample grouping:

Sixty-four canals were chosen from primary molars; they were allotted randomly between the test and control groups by an examiner blinded to the cases. Six canals were excluded from the study due to lateral perforations and canal transportation (control group, 5 canals; test group, 1 canal).

The teeth were divided into two groups (by an examiner blinded to the study):

Group 1: Control group (N=27)—The root canals were prepared manually using K-files.

Group 2: Test group (N=31)—The root canals were prepared with Kedo-SG exclusive pediatric Ni-Ti rotary files.

Sample preparation:

After assessing the cavity preparation and recording the procedure duration, we injected 10 units of India ink with an 30-gauge insulin syringe into the root canals.

Manual instrumentation with K-files was performed with the step-back technique. The preparations were completed using files of sizes #15–#30 with recapitulation. Rotary canal preparation using Kedo-SG rotary files (Reeganz Dental Care Pvt. Ltd. India) was performed with 16-mm Ni-Ti files driven by a hand piece (X-Smart endodontic motor Dentsply) at 300 rpm as per manufacturer's recommendation. A total of two instruments (D1 and E1; as recommended by the manufacturer) were used to prepare canals up to the determined working length, but not <12 mm (working length of the files).

Measurements:

The instrumentation time for each canal was measured by an observer using a chronometer; the time taken for instrument exchange was not considered. To evaluate the cleaning capacity, all teeth underwent the following three procedures:

1. Decalcification: immersion of the teeth into 7% hydrochloric acid solution
2. Dehydration: immersion of the teeth in a series of diluted ethyl alcohol gradients for dehydration (70% for 16 hours [changed every 8 hours]; 80% alcohol for 8 hours; 95% alcohol for 8 hours; and 100% alcohol for 8 hours).
3. Clearing of the dehydrated teeth: immersion of the dehydrated teeth into methyl salicylate solution for 6 hours

Then, the canals were analyzed under a stereo-microscope at 10X magnification (MEIJI Company) to assess for traces of India ink in the coronal, middle, and apical third of the canals. The following scoring criteria were used:

Score 0: total clearing (canal is completely clean)

Score 1: almost complete ink removal (traces of ink in some areas)

Score 2: partial ink removal (remnants of ink on the canal walls in some areas)

Score 3: no ink removal (appreciable amount of ink is present)^(14,15).

Statistical analysis:

The data collected were manually entered into an MS excel spreadsheet and tabulated. The statistical analysis was performed using SPSS ver 23. (IBM Corp., USA) by an independent biostatistician. A significance value (α) $P < 0.05$ was considered statistically significant, and the confidence interval was set at 95%, with 80% power of test (β). Frequencies and percentages were used to present categorical variables in descriptive analysis. Continuous variables are presented as mean with standard deviation. Pearson's Chi-square test was used for testing any statistically significant association among the categorical variables.

The sample size calculation for this study was based on the results of previously reported studies that assessed cleaning capacity as the primary outcome^(14,15). The effect size for the difference between two groups was calculated to be 0.86 using an alpha (α) level of 5% and beta (β) level of 20%, i.e., power = 80%; the minimum estimated sample size was 24 samples per group for a total of 48 samples. Sample size calculation was performed using IBM® SPSS® SamplePower® Release 3.0.1.

RESULTS

The mean values of cleaning time in the control and test groups are shown in Table 1 and (Fig. 1a, 1b). The cleaning time was statistically significant between the two groups.

Table (1) Comparison of cleaning time between the test and control groups

	Type	N	Mean	Standard deviation	Standard error of mean
Time	Control	27	01:31.415	00:40.139	00:07.725
	Test	31	00:58.330	00:28.590	00:05.135

Student t-test was used for finding difference in cleaning time between two groups.

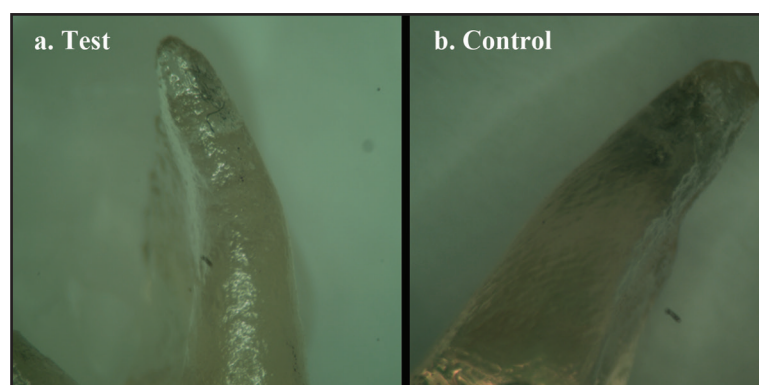


Figure (1): Representative stereomicroscopic at $\times 10$ magnification, images. (a) Test group, (b) Control group.

The results show that the percentage of canals with a clearing score of zero in the test group is higher than that in the control group, and the difference was statistically significant Table 2.

Table (2) Cleaning scores between the test and control groups

Type			Test	Control	Total
Cleaning score	Score 0	N	12	2	14
		%	85.7	14.3	100.0
	Score 1	N	14	13	27
		%	51.9	48.1	100.0
	Score 2	N	4	9	13
		%	30.8	69.2	100.0
	Score 3	N	1	3	4
		%	25.0	75.0	100.0
	Total	N	31	27	58
		%	53.4	46.6	100.0

Chi-square test was used to estimate the relationship between the cleaning scores in the test and control groups ($P = 020$)

DISCUSSION

Exclusive primary tooth rotary systems with Ni-Ti files were recently introduced for root canals preparation, and limited studies are presently reported on this system⁽⁸⁾. The present in vitro study compared the pediatric Ni-Ti rotary system and manual instrumentation for canal preparation of primary molar and investigated their efficiency with regard to the preparation time and cleaning capacity of the primary canals.

Choosing the appropriate equipment for endodontic treatment can be challenging. The ideal instrument should facilitate adequate disinfection before sealing all root canals to ensure better prognosis⁽¹²⁾.

The results of this study highlights the complexity of the root canal system and canal morphology in primary molars^(16,17); the length of the root canals in the primary molars in this study varied from 13–22 mm, although majority of the canals were 15 mm long.

In the present study, the preparation time with manual K-files was significantly longer than that with exclusive primary tooth rotary system, and this result in congruent with those reported by several studies for permanent as well as primary molars^(6,9,12).

The major advantage of the exclusive primary rotary files is their length, which is approximately 16 mm, sufficient for cleaning most of the primary molar length⁽¹³⁾. Moreover, the rotary instruments are easy to start and use, with minimal adjustments.

Penetration of the ink into the root canals was helpful to study the clearing technique and to demonstrate the cleaning capacity of both the manual and rotary filling systems⁽¹⁸⁾. Several studies have shown that rotary mechanical systems are superior to manual instruments in both primary and permanent dentitions. Although some studies have reported no difference in the cleaning capacity^(9,13,15), this could be due to the differences in the type of the canals

and teeth, types of techniques and instruments used, as well as the operator competency^(8,18,19).

In this study, the rotary files showed significant high canal cleaning capacity as compared with the K-files. We used two files for canal preparation, starting with D1 file then progressing to E1 file⁽²⁰⁾. In contrast, with the manual files, we used four different files (#15, #20, #25, and #30) for primary molars.

CONCLUSION

Preparation of the root canals of primary molars with a rotary file was found to be less time consuming than that with a manual file. Additionally, the rotary system had superior cleaning capacity than manual files. Future studies should assess the efficiency of files with approximately 12-mm active part, and moreover, investigate the rigidity of those files.

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