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Comparative Evaluation of Cutting Efficiency of Kedo Sh Manual, Kedo S Rotary and Manual K File Systems: An In-vitro Study

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ABSTRACT

Aim: This study evaluated and compared the cutting performance of three instrumentation systems—Kedo-S rotary files, Kedo-SH manual files, and conventional K-files—during root canal preparation in primary teeth treated by pulp therapy, with cutting efficiency assessed using stereomicroscopic analysis.

Materials & Method: Thirty extracted human primary teeth were selected for the study. Following removal of the pulp tissue, the root canals were stained with Indian ink and allowed to dry for approximately 2 hours. The specimens were then randomly allocated into three equal groups (n = 10 each): Group A was instrumented using the Kedo-SH manual file system, Group B using the Kedo-S rotary file system, and Group C using conventional manual K-files. After completion of root canal instrumentation, the specimens underwent a clearing procedure to render the roots transparent and facilitate visualization of the canal contents. The cleared specimens were examined under a stereomicroscope, and the extent of residual dye within the root canals was graded according to the predefined scoring criteria. The observations were tabulated and subjected to statistical analysis using SPSS software (version 24.0). Intergroup comparisons were performed using the chi-square and Kruskal–Wallis tests, followed by Dunn's post hoc test where appropriate.

Results: Regarding cutting efficiency there was a statistically noteworthy difference among groups A & C [p= 0.001] and groups B & C [p= 0.001]. Moreover, group A & group B did not differ statistically significantly.

Conclusions: The cutting efficacy of the Kedo S rotary files was found to be better than that of Kedo SH and manual k files.

INTRODUCTION

Endodontic treatment of primary teeth can be challenging due to their narrow, curved and anatomically diverse root canal configurations. Variations of accessory canals and interconnections can complicate their instrumentation [1].

Therefore, choosing an optimum instrumentation technique is crucial for adequate canal preparation during pulp therapy. Conventional stainless-steel hand files have been used for instrumentation of primary teeth. However, manual preparation can be time-consuming and technique-sensitive with possibility of procedural complications, including ledge formation, canal transportation and perforation. The development of pediatric-specific instrumentation systems was facilitated in order to address the need for a more efficient technique [2,3].

Nickel-titanium rotary instruments have advanced canal preparation by providing greater flexibility and more consistent shaping [4]. However, conventional rotary files may not be ideally suited to the shorter and anatomically different canals of primary teeth. Pediatric-specific systems, including the Kedo S rotary and Kedo SH manual files, were subsequently developed to address these limitations [5].

Cutting efficiency is a key determinant of effectiveness of an instrumentation system [6]. However, limited studies have directly compared pediatric-specific manual and rotary systems to conventional K-files. Thus, this in vitro study evaluated the cutting efficiency of Kedo-SH manual, Kedo-S rotary, and conventional manual K-files in primary teeth using stereomicroscopic analysis.

MATERIAL AND METHOD

Sample selection and preparation

This study involved thirty extracted, human primary teeth with at least two-thirds of the root length. Teeth with internal or external root resorption, root fracture, or furcation perforation were excluded. The teeth were cleaned in running water and any soft tissue deposits were removed using a hand scaler. The specimens were then disinfected in 1% sodium hypochlorite for 15 minutes before storing them in isotonic saline until the procedure. The specimens were then randomly assigned into three groups, with 10 root canals each.

Group A: Kedo SH manual file system (Kedo Dental, Chennai, India)

Group B: Kedo S rotary file system (Kedo Dental, Chennai, India)

Group C: Conventional stainless-steel manual K-files (Mani Inc.)

Root canal preparation

Standardized access cavities were made using a large round diamond bur and the remaining pulp tissues were removed. The pulp chamber and root canals were thoroughly irrigated with 3% sodium hypochlorite solution to eliminate residual pulp tissue and other organic debris. Patency was achieved with a #10 K-file and the working length (WL) was determined by advancing the file to the point where its tip was visible at the apical foramen and back 1 mm.

The canals were then dried with absorbent paper points. Indian ink was introduced into the canals using a 27-gauge needle until the canal was adequately filled. The samples were then allowed to dry before instrumentation.

The teeth were then embedded in dental plaster up to the cemento-enamel junction and left for 30 minutes to set. Root canal instrumentation was done according to the groups. The canals of group A were prepared using Kedo SH manual file system. The group B was prepared with Kedo S rotary file system as per the manufacturer's instructions. The canals of group C were prepared using conventional stainless-steel K-files.

Instrumentation was done using 15% EDTA gel (Endo Prep RC) as a lubricant. A total of 10 mL of 3% sodium hypochlorite solution was used for irrigation during cleaning and shaping. The canals were finally irrigated with saline and dried with paper points.

Clearing and stereomicroscopic examination

The specimens were then cleared using a standard procedure. Decalcification was done by soaking the specimens in 5% nitric acid for 72 hours. The solution was changed every 24 hours and the specimens were then thoroughly rinsed in running water for 15 minutes.

The specimens were then dehydrated using increasing concentrations of alcohol. The specimens were soaked in 70% alcohol for 16 hours, 90% alcohol for 3 hours and absolute alcohol for 3 hours with the solutions being changed at specified intervals. The dehydrated specimens were then immersed in methyl salicylate for 2-3 hours until they were clear.

The cleared specimens were then inspected under a stereomicroscope at 4× magnification. The amount of residual Indian ink within the instrumented root canals was assessed under a stereomicroscope and scored according to the criteria described by Azar and Mokhtare (2011) [7]:

Score 0: Complete removal of Indian ink, indicating a completely clean canal.

Score 1: Almost complete removal of ink, with only small dots of residual ink in some areas.

Score 2: Partial removal of ink, with small residual patches measuring less than 0.5 mm in diameter.

Score 3: Partial removal of ink, with larger residual patches measuring 0.5–1.0 mm in diameter.

STATISTICAL ANALYSIS

The scores were then compiled and analyzed using statistical package for social sciences (SPSS) version 24. Comparison of the three groups was done using the Kruskal–Wallis test while pairwise comparison was done using Dunn's post hoc test. The data analysis involved use of chi-square test where applicable. A value of p of <0.05 was considered statistically significant.

Table 1

Table 1. Comparison of Cutting Efficiency Among the Three Study Groups

Group	Score 1 N (%)	Score 2 N (%)	Score 3 N (%)	P Value
Group A	6 (60.0%)	3 (30.0%)	1 (10.0%)	<0.001
Group B	7 (70.0%)	2 (20.0%)	1 (10.0%)	
Group C	0 (0.0%)	4 (40.0%)	6 (60.0%)	

Table 2

Table 2. Comparison of Cutting Efficiency Among the Three Study Groups

Group	N	Mean Rank	P value
Group A	10	12.85	<0.001
Group B	10	11.95	
Group C	10	20.20	

Kruskal–Wallis test.

Table 3

Table 3. Pairwise Comparison of Cutting Efficiency Among the Three Study Groups

Group	Comparison Group	P value
Group A	Group B	0.928
Group A	Group C	<0.001
Group B	Group C	<0.001

Dunn's post hoc test.

RESULT

A statistically significant difference in cutting efficiency was found among the three groups ($p < 0.001$; Table 1). Group A (Kedo-SH) and Group B (Kedo-S rotary) had a higher proportion of favorable scores compared with Group C (manual K-file). The Kruskal–Wallis test revealed a significant difference among the groups ($p < 0.001$; Table 2). Pairwise analysis also revealed a statistically significant difference between Group A and Group C and between Group B and Group C ($p < 0.001$), while no significant difference was found between Group A and Group B ($p = 0.728$; Table 3). In general, both Kedo-SH and Kedo-S rotary showed better cutting-efficiency results than conventional manual K-files.

DISCUSSION

The main factors that determine the outcome of pulpectomy are biomechanical preparation, irrigation, obturation, and restoration. The procedure of root canal preparation includes the use of solutions for irrigating the tooth and various instruments for its mechanized cleaning. The basic goal of preparation is to remove pathogenic bacteria, infected tissues, and foreign bodies. The effective cleaning of a primary tooth is considered to be critical to the procedure's successful outcome [8,9].

The present study assessed the cutting efficiency of three instrumentation techniques for the primary root canals. The investigated systems were Kedo-SH manual files, Kedo-S rotary files, and standard stainless-steel K-files. The key result of the study was that both pediatric-specific systems demonstrated relatively higher scores of cutting efficiencies than conventional K-files. Notably, the scores of the Kedo-S rotary group tended to be slightly better than those of the Kedo-SH group, although the difference was not statistically significant ($p = 0.728$; Table 3).

The study's results suggest that the factor of file design may be more critical than the type of activation (manual versus rotary). The fact that both Kedo-SH and Kedo-S systems showed relatively high scores and were designed to address the specific challenges of the primary root canal preparation supports this idea. Moreover, the similarity of the results for the manual and rotary systems implies that the adaptation to the anatomical characteristics of the primary roots may play a

crucial role in instrumentation. This conclusion was drawn from the observation that Kedo-S rotary files tend to demonstrate slightly better performance in the experimental model, which may be related to the increased rotational speed.

The present results are consistent with those of previous investigations that demonstrated the superiority of the pediatric-specific Kedo-SH manual and Kedo-S rotary systems over conventional K-files in terms of cutting and cleaning efficiency. Azar et al. [7] and Panchal et al. [10] also showed no statistically significant difference between the Kedo-S manual and rotary systems in terms of cutting efficiency. This finding is consistent with the idea that the pediatric-specific design of these instruments plays a significant role in their effectiveness, regardless of the mode of operation (manual or rotary). However, Mohamed et al. (2022) found that the rotary instrumentation resulted in improved preservation of tooth structure, enhanced canal taper, and reduced instrumentation time compared with conventional

hand K- and H-files [11]. These discrepancies may be explained by differences in the design and preparation protocols, as well as the outcome assessment procedures, used in the various studies.

The distribution of scores among the Kedo-SH and Kedo-S groups was fairly similar, peaking at Score 3. It was found that 60% of the specimens scored 3, while none scored 1 (Table 1). By contrast, the majority of the samples in the conventional K-file group (60%) scored 3. At the same time, there were no specimens that demonstrated a Score 1. For the Kedo-SH and Kedo-S groups, the most frequent result was Score 3, while there were also 60% and 70% of the specimens that scored 1, respectively. This difference was statistically significant ($p < 0.001$; Table 1). The reason for it may be in the design characteristics of conventional stainless-steel files that are optimized for the permanent rather than the primary teeth.

A worth-noting finding of the study was that the Kedo-SH manual files demonstrated performance levels comparable to those of the rotary system. This result may become particularly valuable in the clinical situation when the latter option is unavailable or inappropriate. In such cases, a pediatric-specific manual file may be a good alternative to standard instruments. Moreover, its use may be beneficial for clinicians who feel more comfortable with manual instrumentation. Thus, the study's results may be used to support the choice of a pediatric-specific manual instrument in the situations when rotary systems are contraindicated.

The slightly better performance of the Kedo-S rotary system may also be clinically relevant. The continuous rotation of the instrument at a high speed may contribute to reduced canal preparation time, which may be beneficial for the patient. From the operator's perspective, the reduced time of instrumentation may decrease the risk of file separation, although this factor was not analyzed in the present study. The flexibility of nickel-titanium files may allow addressing the curved canals better than stainless-steel K-files. However, due to the lack of significant difference in the results for Kedo-S and Kedo-SH systems (Table 3), the conclusions about the superiority of the rotary system cannot be drawn.

The study's conclusions concern the difference in cutting efficiency only, which may be one of the factors among many that determine the overall performance of instrumentation. Several aspects of preparation should also be considered, including time, canal transportation, dentin removal, and the possibility of obturation. Moreover, the choice of an instrumentation system may depend on the clinician's preference, training, and the available equipment. Thus, the study's results should be taken with the caution that they concern primarily the efficacy of cutting, which is only one of the possible benefits of a rotary system.

The use of Indian ink in combination with the clearing technique allowed evaluating the amount of debris and irrigant throughout the entire root canal. This approach demonstrated a relatively simple way to compare the cutting efficiency of different instruments. At the same time, the assessment was indirect since staining only detectable after the removal of the specimen from the root canals cannot represent the actual in vivo conditions. Furthermore, the differences between the groups may reflect the variation of canal morphology between the analyzed teeth [12].

The clinical implication of the study concerns primarily the difference in cutting efficiency between the two types of pediatric-specific instrumentation. The analysis demonstrated that both Kedo-SH and Kedo-S files perform significantly better than conventional stainless-steel files. Thus, the clinicians aiming to achieve optimal results in the primary root canal preparation should prefer pediatric-specific systems. The decision between Kedo-SH manual and Kedo-S rotary files, however, may depend on the situation, since the results of the study did not demonstrate statistically significant differences between them (Table 3). In other words, a pediatric dentist may choose between the alternative based on the convenience, their own preferences, treatment time, and available equipment.

The future research on the topic should address the issue of canal transportation and analyze other aspects of instrumentation, including time, dentin removal, and three-dimensional assessment of preparation. The study should also be expanded to include more clinical cases and conduct an experiment on the human teeth to confirm the preliminary results. Such an analysis would allow determining whether the differences in cutting efficiency translate into significant improvements in other aspects of instrumentation.

CONCLUSION

Within the limits of the present in vitro study, both the Kedo-SH manual and Kedo-S rotary file systems were found to be more efficient in cutting than conventional manual K-files. There was no significant difference in performance between the Kedo-SH and Kedo-S rotary systems. Therefore, it can be concluded that both pediatric-specific file systems can be regarded as effective for root canal instrumentation of primary teeth.

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