



ORIGINAL RESEARCH

COMPARATIVE EVALUATION OF ANTI MICROBIAL EFFICACY USING MANUAL, SINGLE FILE AND MULTIPLE FILE SYSTEM DURING ROOT CANAL PREPARATION IN PRIMARY MOLARS - A RANDOMISED EX VIVO STUDY

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Abstract

Background: Pulpectomy is a key procedure in pediatric dentistry to remove infected pulp from primary teeth, aiming to prevent periapical infections. Success depends on thorough cleaning and disinfection of root canals. Rotary files, with their efficiency and reduced procedural time, are increasingly preferred over manual instruments. This study evaluates the antimicrobial efficacy of manual H-files, Kedo SG Blue, Kedo Nano Plus, and AF Baby rotary file systems during root canal preparation in primary molars.

Materials and Methods: A randomized ex vivo study was conducted with 45 children aged 4-9 years requiring pulpectomy in primary molars. Participants were randomly divided into four groups: Group I (Manual H-files), Group II (Kedo SG Blue), Group III (Kedo Nano Plus), and Group IV (AF Baby). Pre- and post-instrumentation microbial samples were collected and cultured (teasure c). Data were analyzed using the Wilcoxon test and one-way ANOVA.

Results: All groups showed a significant reduction in microbial load post-instrumentation ($P < 0.05$). Group II (Kedo SG Blue) had the highest microbial reduction (95%), followed by Group III (92%), Group IV (89%), and Group I (87%). However, the differences between groups were not statistically significant ($P > 0.05$).

Conclusion: Kedo-SG Blue demonstrated the greatest antimicrobial efficacy, suggesting that rotary file systems may be more efficient than manual methods for root canal disinfection in primary teeth.

Keywords: Primary teeth, Rotary files, Pulpectomy, Microbial load, Anti microbial efficacy

INTRODUCTION

In pediatric dentistry, pulpectomy is a common procedure performed on deciduous teeth to remove infected and necrotic pulp tissue^{1,2}. The procedure involves biomechanical preparation of the root canals before filling them with a biocompatible material³. Absence of clinical and radiographic symptoms, defines the success of pulpectomy which requires

meticulous biomechanical preparation and three-dimensional obturation⁴. Residual infection, often due to incomplete disinfection, is a significant cause of pulpectomy failure⁵.

Successful endodontic treatment hinges on the effective reduction of bacterial load, which prevents pulpal and periapical diseases⁶. The response of the inflammation

in the dental pulp to irritants, especially bacteria and their toxins, can lead to pulp tissue ischemia and necrosis^{7,8}. Therefore, thorough disinfection and meticulous biomechanical preparation of the root canals are crucial for the long-term success of endodontic therapy^{9,10}.

Hand filing has traditionally been used for preparing primary root canals but comes with significant drawbacks, such as longer preparation times, irregular canal shaping, and a higher risk of procedural errors¹¹. To overcome these limitations and enhance the accuracy of endodontic treatment in primary teeth, rotary instrumentation was introduced into pediatric dentistry¹². Nickel-titanium (Ni-Ti) rotary files offer several advantages over stainless steel hand files, including fewer procedural errors, reduced operator fatigue, and shorter preparation times, making them particularly suitable for use in pediatric dental practice^{13,14}.

In 2017, Ganesh Jeevanandan introduced a specialized pediatric rotary file that significantly reduced instrumentation time and provided an acceptable quality of obturation, making it well-suited for pediatric endodontics¹⁵. This innovation has evolved into the Kedo-SG blue rotary file system¹⁶. The Kedo-SG blue includes U1, D1 and E1 files that are coated with titanium, making them more flexible to clean and shape even complex canals. This leads to effective biomechanical preparation of the root canals^{16,17}. A newer version, the Kedo Nano Plus, features a coating with nanoparticles that improves flexibility and helps the file handle twisting forces in curved canals.

The Fanta AF™ Baby rotary system is another specialized rotary file for children, created with Nickel Titanium controlled memory Wire technology. This technology allows the files to be pre-curved before they are inserted into root canals, so they adapt to the shape of the canal and maintain their curvature during use¹⁸. The Fanta AF™ Baby file has a triangular cross-section and a 16 mm working length, which helps reduce stress by minimizing contact with the dentin¹⁹.

The literature has explored the effectiveness of rotary instruments concerning root obturation quality, biomechanical preparation time, and pain in post operative period after pulpectomy in deciduous teeth. However, few studies have evaluated the effectiveness of rotary files in eliminating pathogenic micro-organisms from deciduous root canals. Therefore, this study aims to compare the antimicrobial efficacy of root canal preparation using standard hand H files,

Kedo SG blue, Kedo Nano plus, and AF baby files in deciduous molars.

MATERIALS AND METHODS

Sample Size and Participant Selection

G-power was used to calculate a sample size of 60 with a 95% confidence level using data from a prior study²⁰. The inclusion criteria were: 1) Cooperative children aged 4 to 9 years requiring pulpectomy for primary molars with irreversible pulpitis; 2) healthy children with no significant medical conditions; 3) No systemic antibiotic use for the past two weeks; 4) deciduous teeth with adequate tooth structure and at least two-thirds of the root structure remaining and 5) No sinus tract and pathological root resorption.

From March 2024 to May 2024, 60 children who required pulpectomy in single visit for primary molars were selected from the Outpatients Department of Pediatric and preventive dentistry. After comprehensive clinical examination and radiographic evaluations, participants were selected and randomly allotted to one of four groups.

Clinical Procedure

Local anesthesia was administered using 2% lignocaine with 1:200,000 adrenaline (LOX*2% ADRENALINE, Neon Laboratories Limited, India). Rubber dam (GDC Marketing, India) isolation was done, and both the dam and tooth were disinfected with a 5% iodine solution to minimize microbial contamination. Using a sterile no. 6 round bur (Mani, Inc., Japan) access was obtained and by non-end cutting bur roof of the pulp chamber was removed. Pulp was extirpated performed with the help of the barbed broach, and canal working lengths were obtained with a no. 15 K-file (Mani, Inc., Tochigi, Japan) according to Ingle's method.

PRE OP SAMPLE COLLECTION

Sampling was done from the the palatal canal of maxillary primary molars and distal canal of mandibular primary molars. To prevent contamination, other canal orifices were sealed with Cavit (3M ESPE) before sampling. After identifying the canals, they were irrigated with a saline solution. To obtain the microbiological samples from inside the canal, Sterile Dentsply paper points were used. These samples were then carefully transferred to ultra-snap tubes containing a D-luciferin solution and ATP bioenzyme.

The snap valve of each tube was moved back and forth to ensure contact between the paper point and the liquid. After submerging the sample tip and gently shaking for 5-10 seconds, the ultra-snap tube was placed into a luminometer to read the results.

Instrumentation was carried out based on the assigned groups:

Group I (15 teeth): Instrumentation was performed with Manual H-files (Mani, Tochigi, Japan) using conventional retraction motion (Step-back technique) up to size 35.

Group II (15 teeth): Instrumentation was performed with Kedo-SG blue rotary files (KEDO Dental, India) after measuring working length with hand K-files. The D1 rotary file (red color-coded, with a tip diameter of 0.25 and a variable taper) was used to prepare the narrow mesiobuccal and mesiolingual canals. The E1 rotary file (blue color-coded, with a tip diameter of 0.30 and a variable taper) was used to prepare the wider distal canals, reaching the full working length with an X-Smart endodontic motor (Dentsply Maillefer, OK, USA) at 300 rpm and torque of 2.2 N cm.

Group III (15 teeth): Instrumentation was performed with Kedo Nano Plus rotary files (KEDO Dental, India) after measuring working length with 15 size K-files. The Kedo Nano Plus rotary files are used in a brushing motion (Crown-down technique) with an X-Smart endodontic motor (Dentsply Maillefer, OK, USA) at 300 rpm and torque of 2.2 N cm.

Group IV (15 teeth): Instrumentation was carried out using CM NiTi Pro-AF Baby Gold files at 300 rpm and 2 N/cm torque. This system includes five files with a continuous taper of 4–6%, featuring a unique orifice opener labeled B0. The files were used sequentially as follows: B0 (#20/04) for initial preparation, B1 (#25/04) for further shaping, and B2 (#25/06) for deeper cleaning. For wider canals, the B3 file (#30/04) was utilized.

POST OP SAMPLE COLLECTION

Endo prep RC (Anabond Stedman, Pharma Research Ltd., India) was used as a lubricant for both manual and rotary instrumentation. After instrumentation, canals were irrigated with 10 mL of sterile saline (Fresenius Kabi India, Pvt. Ltd). The bio-mechanical preparation was completed in one session. Following this, microbiological samples were obtained post operatively from the same canal using paper points, that are placed into ultra-snap tubes for analysis, with results being subsequently obtained. With appropriately sized paper points, canal were dried and obturated with Metapex (Meta Biomed Co. Ltd., Korea). After obturation, restoration was done with type II glass ionomer cement (GC, India) and covered with a stainless steel crown (3M ESPE, USA).

Statistical Analysis

The results were analyzed using SPSS software version 23.0 (SPSS Inc., USA) by a statistician who was blinded to the study details. The Wilcoxon test was used to compare mean values between pre- and post-instrumentation samples. One-way ANOVA was conducted to determine statistical differences among the four groups. A significance level of $P < 0.05$ was considered.

RESULTS

After instrumentation, all groups demonstrated a significant reduction in microbial load within the canals ($P < 0.05$). Specifically, microbial counts decreased by 87% in Group I, 95% in Group II, 92% in Group III, and 89% in Group IV. Group II achieved the greatest reduction, followed by Group III, Group IV, and Group I. However, the differences between the groups were not statistically significant ($P > 0.05$) (Table 1).

Table 1. Comparison of Pre- and Post-Instrumentation Microbial Load Reduction Across Different File Systems

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Groups	Sample	Mean	Standard deviation	Mean difference (CFU/mL)	Microbial reduction	P value
H files	Pre-instrumentation	1.560	0.674	1.362	87	0.001

	Post-instrumentation	0.197	0.411			
Kedo SG blue	Pre-instrumentation	0.921	0.566	0.854	95	0.001
	Post-instrumentation	0.067	0.025			
Kedo nano plus	Pre-instrumentation	1.270	0.642	1.164	92	0.001
	Post-instrumentation	0.106	0.080			
AF baby file	Pre-instrumentation	0.513	0.167	0.460	89	0.001
	Post-instrumentation	0.053	0.020			

DISCUSSION

The primary objective of pulpectomy in primary teeth is to eliminate microbial infection and prevent its recurrence, facilitating peri-radicular healing and reducing the child's discomfort. Biomechanical preparation of the root canals, either by manual or rotary instrumentation, plays a crucial role in achieving the primary goal²¹. Effective eradication of bacteria from the root canals is essential for a successful outcome, but this is considered challenging because of the complex anatomy of primary root canals^{22,23}. The findings from this study provide insights into the comparative effectiveness of different file systems in reducing the microbial load during pulpectomy in pediatric patients.

In this study, four different file systems were evaluated: Kedo SG Blue, Kedo S Plus, AF Baby, and manual K-files (H files). Among the rotary systems, Kedo SG Blue and Kedo S Plus exhibited superior flexibility and a

progressive taper, making them well-suited for biomechanical preparation of the narrow, tortuous canals of primary teeth²⁴. The single-file design of these systems helps to minimize excessive dentin removal and reduces the formation of a smear layer, which can harbor residual bacteria^{24,25}. The AF Baby file system, although not a single-file system, demonstrated effectiveness in reducing microbial load as well. The rotary file systems collectively performed better than the traditional H-files²⁶.

The results showed significant reductions in microbial load across all four groups post-instrumentation. Group II, which utilized the Kedo SG Blue system, achieved the highest reduction (95%), followed closely by Group III (Kedo S Plus) with a 92% reduction, Group IV (AF Baby) with 89%, and Group I (manual K-files) with an 87% reduction. Although the rotary

systems demonstrated greater efficacy than the manual files, the differences between the groups were not statistically significant ($P > 0.05$). This suggests that while rotary systems may offer clinical advantages in terms of speed and efficiency, all systems were effective in significantly reducing bacterial counts.

The use of rotary files in primary teeth is advantageous because of their enhanced flexibility, that allows them to better navigate the tortuous and narrow canals that are typical of deciduous molars²⁷. The Kedo SG Blue and Kedo NanoPlus systems, in particular, showed excellent performance in reaching difficult areas and ensuring a thorough cleaning. The study's results corroborate findings from previous research, such as that by Lakshamanan et al., which also highlighted the superiority of rotary systems over manual files in reducing microbial load²¹. The clockwise rotation and brushing motion of rotary files, combined with their smaller diameters, reduce the risk of canal transportation and dentin over-removal, which can lead to primary root resorption²⁸.

However, despite the overall efficacy in reducing microbial counts, none of the file systems completely eradicated microorganisms from the root canals. This outcome aligns with previous studies that emphasize the limitations of current endodontic procedures in achieving complete sterilization²⁹. The complex anatomy of primary teeth, which includes accessory canals, lateral canals, and isthmuses, presents a significant challenge in ensuring thorough debridement and disinfection³⁰. Consequently, the primary aim of pulpectomy remains the reduction of bacterial load to a level that the host's immune system

can manage, rather than complete bacterial elimination³¹.

To avoid introducing bias from antimicrobial irrigants, the study employed saline as the sole irrigant during the procedures. Although saline lacks the antibacterial properties of more commonly used irrigants such as sodium hypochlorite, it is effective in mechanically flushing out debris and microorganisms^{32,33}. Byström and Sundqvist previously demonstrated that saline can significantly reduce bacterial counts, though it does not actively kill bacteria³⁴. This choice allowed the study to isolate the effects of the instrumentation methods on microbial reduction without the confounding influence of additional chemical agents.

The limitation of the study is that it only measured microbial reductions immediately after instrumentation, without long-term follow-up. Further research is needed to assess whether these reductions translate into improved clinical outcomes, such as long-term tooth survival and the prevention of reinfection.

CONCLUSION

In this randomised clinical trial, both rotary files and manual files proved highly effective at removing microbes from root canals. The Kedo-SG Blue pediatric rotary file demonstrated superior performance in reducing microbial load compared to manual techniques. Achieving efficient root canal cleaning in a shorter time frame is especially beneficial for pediatric patients.

DECLARATIONS

Ethics approval and consent to participate

Not applicable

Conflicts Of Interests

None

Author Contribution

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None

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