

To Compare and Evaluate Rotary and Manual Techniques in Biomechanical Preparation of Primary Molars to Know Their Effects in Terms of Cleaning and Shaping Efficacy

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ABSTRACT

Background: The introduction of the rotary file system for children was a revolution in the field of pediatric endodontics. These files are cost-effective and help in consistent obturations with shorter instrumentation time.

Aim: The present randomized controlled trial (RCT) was planned for a comparative evaluation of rotary and manual techniques in biomechanical preparation of primary molars to determine their effect in terms of cleaning and shaping efficacy, working time, quality of obturation, and postoperative pain.

Materials and methods: A randomized clinical trial study was conducted in 75 children aged 5–9 years requiring pulpectomy. Each tooth was randomly assigned to one of the three treatment groups: Kedo-S files, rotary K-Flex files, and hand instruments group.

Results: It was observed that Kedo-S files and rotary K-Flex files were more effective in cleaning and shaping of root canals compared to hand H/K files. The postbacterial count for hand files was higher compared to rotary files. Shorter working time was seen with rotary files (3.88–5.04 minutes) compared to hand files (15.68 minutes). Rotary files showed a reduced number of voids, with Kedo-S files in 92% of cases and rotary K-Flex files in 80% of cases. Apical seal and extent of fill were maximum with rotary files, having a grade C rating in 92% of cases. Kedo-S files and rotary K-Flex files showed a significant reduction in postoperative pain compared to hand files.

Conclusion: The present study showed a significant reduction in bacterial count, working time, quality of obturation, and postoperative pain with rotary files.

Keywords: Bacterial count, Biomechanical preparation, Clinical and radiographic success, Hand files, Kedo-S rotary files, Manual technique, Postoperative pain, Primary teeth, Quality of obturation, Rotary technique, Rotay-K flex files, Working time.

International Journal of Clinical Pediatric Dentistry (2024): 10.5005/jp-journals-10005-2949

INTRODUCTION

Pulpectomy is performed in deciduous teeth to maintain the normal physiomorphology of the teeth.¹ Conventionally, pulpectomy was performed using hand files in primary teeth, which takes a prolonged time.² Therefore, rotary files were introduced for cleaning and shaping of root canals in primary teeth to remove the debris in a shorter time.³ Bacteria in the root canal space are primarily responsible for infection. To eliminate them, the accepted procedure includes debridement, irrigation, mechanical instrumentation, and interappointment dressings in pulpectomy procedures. Combining all these procedures, the bacterial elimination percentage ranges from 90 to 100%.⁴

A delay during the pulpectomy procedure might be caused by its physiological and anatomical constraints, such as irregular physiological root resorption, proximity to the permanent tooth germ, and tortuous canals in primary teeth. To address some of these issues, Ni-Ti rotary files were introduced in endodontics to fulfill the objectives of efficiency, speed, patient well-being, and strain reduction for both the operator and the patient. Using rotary instruments for endodontic treatment in permanent teeth has simplified and expedited the process compared to manual systems, resulting in better cleaning and shaping of canals. Similarly, such methods of debridement and shaping using rotary instruments can be applied to primary teeth.^{5–7} There is very little literature available on this topic, so the aim of the current study was to evaluate the efficacy of biomechanical preparation in primary teeth using the rotary file system compared to the manual instrumentation technique.

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How to cite this article: Moudgalya MS, Tyagi P, Tiwari S, *et al.* To Compare and Evaluate Rotary and Manual Techniques in Biomechanical Preparation of Primary Molars to Know Their Effects in Terms of Cleaning and Shaping Efficacy. *Int J Clin Pediatr Dent* 2024;17(8):864–870.

Source of support: Nil

Conflict of interest: Dr Parimala Tyagi is associated as the National Editorial Board member of this journal and this manuscript was subjected to this journal's standard review procedures, with this peer review handled independently of this editorial board member and his research group.

MATERIALS AND METHODS

A randomized clinical trial study was conducted in 75 children aged 5–9 years requiring pulpectomy. Every tooth was randomly allotted

to one of the three treatment groups: Kedo-S files (group A), rotary K-Flex files (group B), and hand instruments (group C) (Fig. 1). After power analysis was executed, a minimum of 25 teeth were assigned to each group to establish a sufficient sample size to show 80% power and a 5% level of significance.

Ethical clearance was obtained before the start of the study from the ethical review board of PCDS and RC. After obtaining written consent from the parents, an oral examination of the child was conducted, followed by the treatment procedure and evaluation of clinical and radiographic parameters in the PG section of the Department of Pedodontics and Preventive Dentistry, PCDS and RC. All pulpectomy procedures were performed by a single clinician.

Patients presenting with deep carious lesions with pulp exposure, the presence of any sinus tract, teeth that are restorable, and radiographically any lesion approximating the pulp, discontinuity of lamina dura, or furcation involvement with at least 2/3rd of the root present were included in the study.

Patients having nonrestorable teeth, physiological root resorption involving >2/3rd of the roots, any obliterated root canal, excessive internal resorption, internal calcifications, presence of perforations with cysts, patients with any systemic illness, or any history of allergy to antibiotics were excluded from the study.

Procedure

- Isolation with a rubber dam was done, and 2% lignocaine with 1:2,00,000 adrenaline (Lignox, Indoco Remedies Ltd., Mumbai) was used to anesthetize the tooth. All files and instruments were sterilized in an autoclave prior to the procedure.

Caries excavation followed by complete pulp extirpation was done, and the working length was determined. After pulp extirpation, a paper point was inserted to obtain preoperative root canal content. The root canals were then cleaned and shaped using Kedo-S files, K-Flex rotary files, and hand files. Irrigation with 0.2% chlorhexidine (CHX) gluconate solution and normal saline was done alternately throughout the biomechanical preparation. After completing the biomechanical preparation, postoperative root canal content was obtained and immediately transferred to a vacutainer containing 2 mL of transport media (i.e., brain heart infusion broth), which was then transported to the microbiology laboratory for bacterial count on BHI agar plates.

The entire procedure was performed in an ultraviolet (UV) chamber under fluorescent light. Inside the UV chamber, the tightly sealed vacutainer containing the paper point was opened, and 1 mL of the solution was taken out with a pipette. The sealed brain heart infusion (BHI) plate was then opened, and four drops of the solution were placed on the plate. Streaking was performed with a cotton swab, and the plate was immediately closed. After the procedure was completed, the UV chamber was closed, and the plates were incubated there for 24 hours. The next day, colony counting was performed using a digital colony counter (Fig. 2).

This initial procedure was the same for all three groups: group A with Kedo-S files, group B with rotary K-Flex files, and group C with hand files.

Postoperative radiographs were taken after the completion of the pulpectomy procedure, and the following parameters were evaluated:

- Presence or absence of voids with the following scoring⁸ (Fig. 3).
- Extent of fill and apical seal with the following grading.⁸

In the first visit, access opening was done, and working length was taken, followed by closure with a temporary restoration. The initial procedure was the same for all three groups.

Group A

Kedo-S files—($n = 25$)

- D1: 0.25 mm tip diameter with variable taper. Used in deciduous molars with narrow canals (in mandibular molars, it is used in mesial canals, and in maxillary molars, it is used in the distobuccal canal). (Tip size: #25)
- E1: Used in deciduous molars with wide canals (for mandibular molars, it is used in the distal canal, and in maxillary molars, it is used in the palatal canal). (Tip size: #30)
- U1: 0.40 mm tip diameter used for incisors in deciduous teeth. (Tip size: 40 mm)

In the second visit, biomechanical preparation was performed using Kedo-S rotary files following the crown-down technique.

For shaping the mesiobuccal and mesiolingual canals, the D1 rotary file was used.

For shaping the distal canals, the E1 rotary file was used.

For preparation of the canals, 17% EDTA gel was used as a lubricating agent. The root canals were then dried with paper points



Fig. 1: Kedo-S, Rotary K-Flex, and hand files

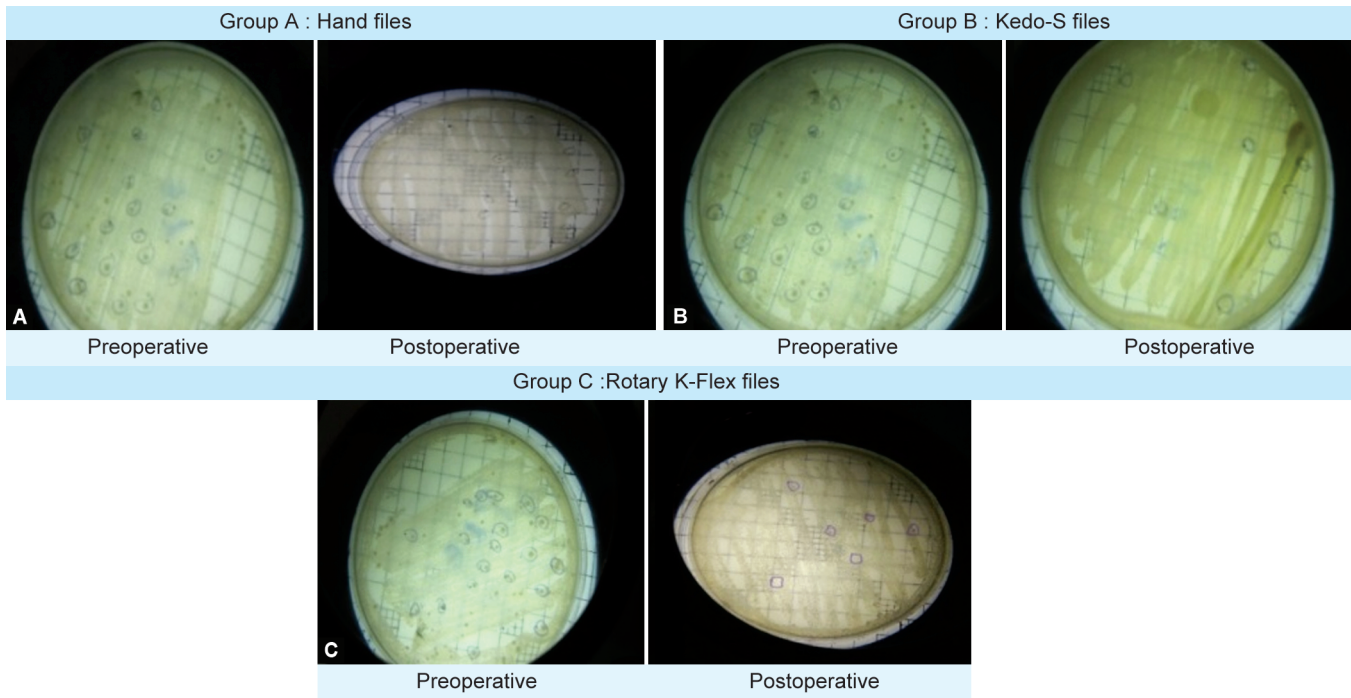


Fig. 2: Pre- and postbacterial counts

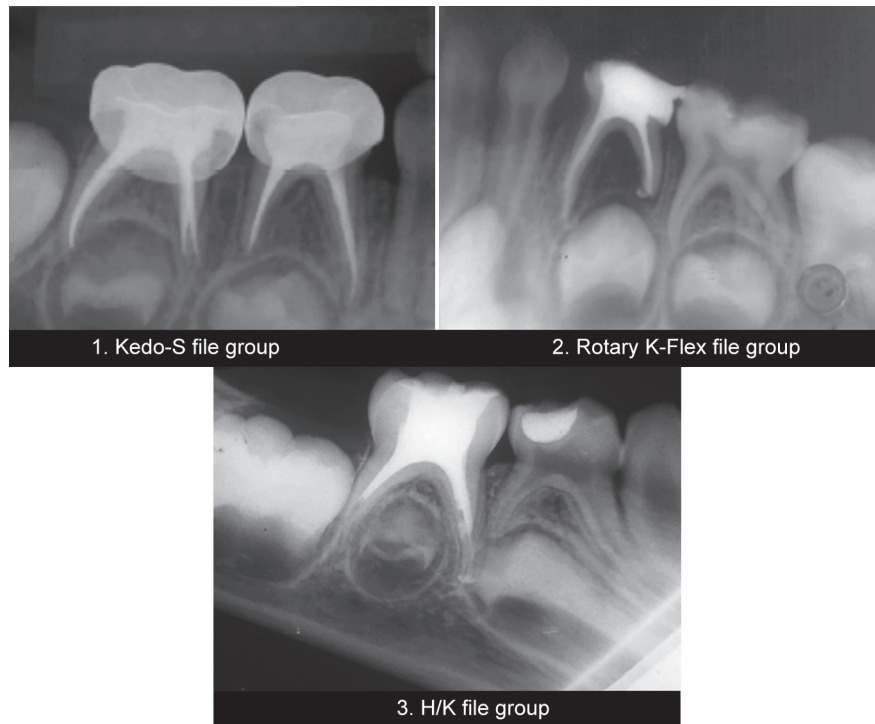


Fig. 3: Quality of obturation

and obturated with Metapex. Metapex was used as an obturating material to fill the canal spaces by pressing it down to the apex and then slowly removing it.

- Working time was noted for each patient while performing biomechanical preparation with the mentioned files.
- Postoperative pain was determined by calling each patient after 3 days.

Group B (Rotary K-Flex Files)

(n = 25) (2% Taper) (Tip Size—#30)

On the second visit, using a 15 no. rotary K-Flex file, canals were cleaned up to the predetermined working length. Extirpation of pulp tissue and dentinal debris using the K-Flex file in rotary motion was done, followed by irrigation with 0.2% CHX and normal saline alternately. Sequentially larger files (#20, #25, #30) were

used until the canals were cleaned and shaped completely. After biomechanical preparation, the canals were dried and filled with Metapex, and an immediate postoperative radiograph was taken.

Group C (Hand Instrumentation)

Hand instruments—K-File ($n = 13$) (2% Taper) (Tip Size—#30); H-File ($n = 12$) (2% Taper) (Tip Size—#30)

On the second visit, biomechanical preparation was done using the crown-down technique with hand K-files/H-files. Canals were located using an initial #10 file. Then, the canals were enlarged sequentially using larger files (#15, #20, #25, #30) and were irrigated with 0.2% CHX and normal saline in between. After biomechanical preparation, paper points were used to dry the canals, and Metapex was used as an obturating material.

RESULTS

Effectiveness of Cleaning and Shaping

When intergroup comparison was done for pretreatment, the following results were observed.

- Comparison of hand files and Kedo-S files groups showed no statistically significant difference.
- Comparison of hand files and rotary K-Flex files groups showed no statistically significant difference.
- Comparison of Kedo-S files and rotary K-Flex files groups showed no statistically significant difference.

When intergroup comparison was done for posttreatment, the following results were observed.

- Comparison of hand H/K files and Kedo-S files groups showed a statistically significant difference.
- Comparison of hand H/K files and rotary K-Flex files showed a statistically significant difference.
- Comparison of Kedo-S files and rotary K-Flex files showed a statistically significant difference (Table 1).

Working Time

When intergroup comparison was done, following results were observed.

- Comparison of hand H/K files and Kedo-S files showed a statistically significant difference.

- Comparison of hand H/K files and rotary K-Flex files showed a statistically significant difference.
- Comparison of Kedo-S files and rotary K-Flex files showed a statistically significant difference.

Overall, a statistically significant difference was observed in working time when comparing the three groups. The hand H/K files group had the highest value of 15.68 minutes, while the Kedo-S files group had the lowest value of 3.88 minutes (Table 2).

Quality of Obturation

Presence/Absence of Voids

Illustrates the minimum and maximum values of voids between the three groups. According to the scoring criteria for voids given by Khubchandani et al.,⁸ the following results were observed.

- Comparison of the presence or absence of voids shows that hand H/K files have a predominance of scores 2, 3, and 4, accounting for 28, 24, and 32% respectively, while Kedo-S files have 92% of the cases with a score of 0, and rotary K-Flex files have 80% of the cases with a score of 0.

Overall, a statistically significant difference was seen with a p -value of <0.001 , indicating that Kedo-S files were the most prominent and effective, followed by rotary K-Flex files (Table 3).

Kedo-S files > Rotary K-Flex > hand files

Apical Seal and Extent of Fill

Illustrates the minimum and maximum values of apical seal and extent of fill between the three groups. According to the grading criteria for apical seal and extent of fill given by Khubchandani et al.,⁸ the following results were observed.

- Comparison of apical seal and extent of fill shows that hand H/K files have a predominance of grade A and grade B, accounting for 72% of cases, while Kedo-S files and rotary K-Flex files have a predominance of grade C, accounting for 92 and 88% of cases, respectively. This data is statistically significant with a p -value of <0.001 , revealing that rotary files are more efficacious than hand files (Table 4).

Kedo-S files = Rotary K-Flex > hand files

Table 1: Intergroup comparison of pre- and posttreatment bacterial count between hand file, Kedo-S file, and Rotary K-Flex file groups

<i>Post hoc test Tukey HSD</i>			<i>Mean difference</i>	<i>Standard error</i>	
Prebacterial counts	Hand H/K files	Kedo-S files	0.6	1.34	0.896
		Rotary K-Flex files	-2.4	1.34	0.18
	Kedo-S files	Rotary K-Flex files	-3	1.34	0.071
Postbacterial counts	Hand H/K files	Kedo-S files	11.240*	0.529	<0.001
		Rotary K-Flex files	8.880*	0.529	<0.001
	Kedo-S files	Rotary K-Flex files	-2.360*	0.529	<0.001
Difference in bacterial counts	Hand H/K files	Kedo-S files	-10.640*	1.098	<0.001
		Rotary K-Flex files	-11.280*	1.098	<0.001

Bold values indicate significance; *, statistically significant

Table 2: Intergroup comparison of working time between hand file, Kedo-S file, and Rotary K-Flex file group

<i>Post hoc test Tukey HSD</i>			<i>Mean difference</i>	<i>Standard error</i>	
Hand H/K files	Kedo-S files	11.800*	0.358	<0.001	
	Rotary K-Flex files	10.640*	0.358	<0.001	
Kedo-S files	Rotary K-Flex files	-1.160*	0.358	0.005	

Bold values indicate significance; *, statistically significant

Postoperative Pain (3 Days)

When intergroup comparison was done, following results were observed.

- Comparing hand files and Kedo-S files groups showed a statistically significant difference.
- Comparison of hand H/K files and rotary K-Flex files groups showed a statistically significant difference.
- Comparison of Kedo-S files and rotary K-Flex files groups showed a statistically significant difference (Table 5).

DISCUSSION

In pediatric dentistry, space loss is a major concern, making pulpectomy a treatment of choice. A successful pulpectomy is achieved when there is proper cleaning and debridement of root canals followed by an intact apical seal. Biomechanical preparation

using hand instruments is often tedious, which has led to increased emphasis on rotary instruments for biomechanical preparation due to their reduced time duration. Since the rotary system has been

Table 5: Overall significant difference in postoperative pain was seen with rotary files compared to hand files

Post hoc test		Mean difference	Standard error	p-value
Tuckey HSD				
Hand H/K files	Kedo-S files	0.480*	0.112	<0.001
	Rotary K-Flex files	0.400*	0.112	0.002
Kedo-S files	Rotary K-Flex files	-0.08	0.112	0.757

Bold values indicate significance; *, statistically significant

Table 3: Quality of obturation—presence or absence of voids

		Groups			Total	
		Hand H/K files	Kedo-S files	Rotary K-Flex files		
Quality of obturation (presence or absence of voids)	Score 0	Count	0	23	20	43
		% within group	0.0%	92.0%	80.0%	57.3%
	Score 1	Count	2	2	4	8
		% within group	8.0%	8.0%	16.0%	10.7%
	Score 2	Count	7	0	1	8
		% within group	28.0%	0.0%	4.0%	10.7%
	Score 3	Count	6	0	0	6
		% within group	24.0%	0.0%	0.0%	8.0%
	Score 4	Count	8	0	0	8
		% within group	32.0%	0.0%	0.0%	10.7%
	Score 5	Count	2	0	0	2
		% within group	8.0%	0.0%	0.0%	2.7%
Total	Count	25	25	25	75	
	% within group	100.0%	100.0%	100.0%	100.0%	
		Value	Degree of freedom		p-value (<0.05 is significant)	
Pearson Chi-square		65.564	10		<0.001	

Bold value indicate significance

Table 4: Quality of obturation—apical seal and extent of fill

		Group			Total	
		Hand H/K files	Kedo-S files	Rotary K-Flex files		
Apical seal and extent of fill	Grade A	Count	8	0	1	9
		% within group	32.0%	0.0%	4.0%	12.0%
	Grade B	Count	10	2	2	14
		% within group	40.0%	8.0%	8.0%	18.7%
	Grade C	Count	3	23	22	48
		% within group	12.0%	92.0%	88.0%	64.0%
Grade D	Count	4	0	0	4	
	% within group	16.0%	0.0%	0.0%	5.3%	
Total	Count	25	25	25	75	
	% within group	100.0%	100.0%	100.0%	100.0%	
		Value	Degree of freedom		p-value (<0.05 is significant)	
Pearson Chi-square		45.685	6		<0.001	

Bold value indicate significance



recently introduced for endodontic preparation in primary teeth, there are only a few studies available to determine its efficacy. Several factors contribute to the clinical success of pulpectomy, including biomechanical preparation, type of restoration, number of visits, and root canal filling material. The present study was designed to compare rotary and manual techniques in the biomechanical preparation of primary molars to assess their effects in terms of cleaning and shaping efficacy, working time, quality of obturation, and postoperative pain.

Effectiveness of Cleaning and Shaping

It was found that in the present study, comparing the rotary group with the hand file group showed a statistically significant difference in the cleaning efficacy of the canals. This is in contrast to the study by Ahlquist et al.,⁹ which concluded that hand instruments provided cleaner root canals than the rotary method, possibly due to the clinician's understanding and tactile sensation. Tan and Messer¹⁰ observed that both manual and rotary techniques did not achieve complete root canal cleaning in primary teeth, whereas our study showed a significant reduction in bacterial count due to wider apical preparation, which allowed better cleaning of the root canals. Mehlawat et al.¹¹ concluded that the rotary system provides more effective cleaning of canals compared to hand files in primary molars in less time, which is similar to our findings.

Working Time

In pediatric dentistry, decreasing anxiety in children is of utmost priority. Thus, a shorter duration of treatment helps reduce anxiety, which contributes to providing optimal treatment.¹² Therefore, the current study evaluates the shorter time duration and quality of obturation to analyze the treatment outcome with rotary files in biomechanical preparation. In the present study, the mean instrumentation time with Kedo-S rotary files and K-Flex files was found to be significantly less compared to hand files, which positively impacted the child's behavior. Rotary files facilitate easier orchestration of biomechanical preparation in deciduous molars, resulting in shorter treatment durations and making the procedure more manageable for both the operator and the child. This finding is consistent with the results of Romero and Gonzalez¹³ and Makarem et al.,¹⁴ who also reported a significant decrease in instrumentation time in deciduous molars using rotary systems compared to manual systems.

The decrease in instrumentation time reduces both the operator's and the child's fatigue, thereby making the procedure easier and more feasible. In contrast, Madan et al.¹⁵ concluded that the use of rotary profiles increased the instrumentation time in deciduous teeth compared to hand files.

Quality of Obturation

Presence/Absence of Voids

Good canal preparation using the rotary method results in better flow of obturating materials into the canals, leading to fewer voids. Mesial canals are typically narrow, making their preparation more challenging with hand instruments. In the current study, a significant reduction in voids was noted with rotary instruments compared to manual instrumentation, where rotary Kedo-S files had 92% of cases with a score of 0, rotary K-Flex files had 80% of cases with a score of 0, and hand H/K files had the highest scores of 2, 3, and 4. These findings are consistent with Zuolo et al.,¹⁶ who reported that rotary instruments resulted

in fewer voids than hand files. Huang et al.¹⁷ and Kadhom and Hashimi¹⁸ reported that cleaning efficacy with hand files was greater in the coronal and middle thirds of the root canal, leading to more voids, whereas rotary files provided effective cleaning in all thirds of the canal (coronal, middle, and apical), resulting in fewer voids. These results align with the current study, where minimal voids were observed with rotary files compared to manual instrumentation.

Apical Fill and Extent of Fill

Many endodontic instruments and techniques have recently undergone changes to achieve improved cleaning and shaping efficacy. Most root canal preparation instruments, especially those working in the coronal direction, can cause apical extrusion of intracanal debris, irrigants, and microorganisms (Capar et al.).¹⁹ V²⁰ evaluated the presence of debris in primary molars using rotary and hand files and found better canal cleanliness and optimal obturation in the apical third, with results favorable to the present study. This investigation shows statistically significant differences between rotary files and manual techniques, resulting in optimal canal fill, which aligns with the study by Govindaraju et al.,²¹ where the quality of obturation with rotary files was found to be more acceptable than with manual systems. Ribeiro Madalena et al.²² assessed the extent of apical fill with rotary and manual files and noted that using rotary files is safe and efficient for root canal cleaning, with the debris count not significantly influenced by the type of procedure.

Postoperative Pain

Prevention and management of postoperative pain after a pulpectomy procedure is a crucial part of the treatment protocol. Informing parents about the expected postoperative pain before starting the treatment and prescribing medications to relieve the pain can enhance trust between patients, guardians, and the dentist, and help in developing a positive attitude towards future treatment. Topçuoğlu et al.²³ reported that hand files cause more intense postoperative pain compared to the rotary system during canal preparation. In deciduous molars, rotary systems could be considered a means to reduce the intensity of postoperative pain. Similarly, in the present study, postoperative pain associated with rotary instrumentation was significantly less compared to manual instrumentation. Nair et al.²⁴ evaluated postoperative pain with K-files and Kedo-S files after pulpectomy and found that chemomechanical preparation using the rotary system caused less pain compared to hand files, which aligns with the present study. The results of the present study are contrary to those of DiRenzo et al.,²⁵ where no significant differences in the occurrence of postoperative pain were observed when comparing rotary files with hand files.

CONCLUSION

- Significant reduction in bacterial count was reported with rotary K-Flex and Kedo-S files compared to hand files.
- The rotary system required less time for instrumentation and obturation compared to the manual endodontic method.
- The number of voids was notably fewer with the rotary system compared to the manual system.
- Optimal filling of root canals was achieved with rotary files in comparison to hand files.
- Canal preparation with hand files resulted in more extreme postoperative pain compared to the rotary file system.

- Though both rotary and hand files can be used for pulpectomy, rotary systems facilitate more effective biomechanical preparation compared to hand files. They yield satisfactory results when combined with proper irrigation using a side-vented needle and thorough drying of the canals, leading to fewer voids, optimal canal filling, and reduced chances of errors during the pulpectomy procedure.

More research is required to evaluate different aspects of Kedo-S rotary files and K-Flex rotary files. Further studies are needed to determine their efficacy and suitability for use in children.

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