



Original Research

A clinical comparison of instrumentation time, obturation time and radiographic quality of obturation using the rotary and manual file system for pulpectomy in primary molars

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ABSTRACT

Aim: To evaluate and compare instrumentation time, obturation time, and radiographic quality of obturation using rotary file system and manual file system in primary molar pulpectomy.

Materials and Methods: Forty-five primary molars from 42 children aged 5-7 were selected, and divided into 2 Groups: Group I (K-files), Group II (Pro AF Baby Gold Files). Single-visit pulpectomy was performed, and instrumentation time and obturation time were recorded during the procedure. Immediate postoperative radiographs were taken and evaluated for obturation quality. The results were tabulated and subjected to statistical analysis.

Results: Pro AF Baby Gold Files (Group II) required the least instrumentation time, and obturation time and showed superior quality of obturation than K-files (Group I).

Conclusion: Pediatric rotary files resulted in superior quality of obturation with minimal chair-side time, hence they form an integral part of pediatric dentist's armamentarium and can be considered as the standard of care in primary molar pulpectomies.

Keywords: K- files, Pro AF Baby Gold Files, Single visit pulpectomy.

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INTRODUCTION

Pediatric dentistry specializes in delivering crucial preventive and therapeutic oral healthcare designed specifically for infants, children, adolescents, and individuals with special healthcare needs.¹ A notable challenge within this field is the premature loss of primary molars, often caused by conditions such as dental caries or trauma. This loss can have detrimental effects on the dentofacial skeletal complex, impacting soft tissue support, occlusion, dentition development, and overall aesthetics. The involvement of dental pulp due to untreated caries is a significant concern, emphasizing the importance of pulpectomy as the preferred treatment for managing irreversible pulpitis in affected primary teeth.² The primary biological goal is to meticulously clean the root canal system, eliminating pulp tissue, bacteria, and toxins to promote optimal healing.³

Traditionally, stainless steel hand K-files have been the go-to tools for cleaning and shaping root canals in infected deciduous teeth. However, their aggressive cutting action and rigidity can lead to complications such as perforations, inadequate shaping, instrument deformation, and increased treatment time. This is especially challenging in narrow and curved canals, which can hinder effective obturation.⁴

In recent years, nickel-titanium (NiTi) rotary instruments have transformed endodontic procedures, including those for primary molars. Innovations like the Pro AF Baby Gold files, utilizing NiTi CM wire technology, have significantly improved treatment outcomes. These instruments offer enhanced flexibility and canal centricity while minimizing the risk of breakage. They facilitate conservative canal preparation and precise shaping through a series of sequential file combinations, making them particularly well-suited for pediatric rotary endodontic treatments.^{5,6,7}

Despite the widespread adoption of rotary endodontic techniques in permanent teeth, challenges persist with current systems when applied to primary teeth, primarily due to constraints in length and taper.⁸ The purpose of this present study is to evaluate and compare the time required for instrumentation, obturation, and the radiographic quality of obturation achieved using rotary file systems versus manual file systems for pulpectomy in primary molars to deliver superior obturation outcomes in pediatric dental care.

MATERIALS & METHODS:

Study design

The Ethical Review Committee and Institutional Review Board (EC/IRB NO: MDC KT 21205103003D) received the study protocol and approved it. Before the beginning of the study legal guardian of the child, participant signed the consent form – including the risks, benefits, alternatives of the given procedure. A total of 45 primary molars from 42 children among 5-7 years were selected and randomly divided into two Groups:- Group I- using K-files, Group II – using Pro AF Baby Gold files.

Inclusion Criteria:⁹

1. Children aged 5–7 years.
2. Patients with Frankl's behavior rating scale scores of 3 and 4 (positive and definitely positive).
3. Primary molars with at least two-thirds of remaining root length.
4. Sufficient tooth structure for rubber dam clamp application.
5. Primary molars diagnosed with chronic irreversible pulpitis.
6. Primary molars with at least one necrotic canal, abscess, or sinus tract.
7. Presence of radiolucent areas in the furcal or peri-radicular region.

Exclusion Criteria:

1. Patients diagnosed with systemic diseases.
2. Patients exhibiting disruptive behavior during procedures.
3. Teeth clinically deemed non-restorable, with pulpal floor perforation, excessive mobility, or dentoalveolar abscesses.
4. Presence of more than one-third of pathologic root resorption.

Treatment Procedure:

Single-visit pulpectomy was conducted for all included teeth by a single operator. Local anesthesia (2% lignox A, Indoco Remedies, Mumbai) was administered, followed by rubber dam isolation for all cases.

Access Cavity Preparation:

Cariou tissue was removed and access cavities were prepared using high-speed round and straight fissure burs (BR-41, SF-41). Following coronal pulp amputation, pulp extirpation was performed using #20 Barbed broach (Dentsply, Maillefer, USA). Pulp chamber irrigation was conducted using 3% sodium hypochlorite (Prime Dental, Maharashtra) and normal saline (Promea Therapeutics, Hyderabad).¹⁰ Working length was determined using the conventional Ingle's method, 1 mm short of the radiographic apex.

Biomechanical Preparation:

1. Group 1 (Manual): Root canal preparation was performed using stainless steel K-files, employing the step-back method and quarter-turn pull technique from #15 to #30.
2. Group 2 (Rotary): Root canal instrumentation was carried out using Pro AF Baby Gold files. Canal enlargement with K-files up to #15 preceded the use of sequential filing with B0 (#20/04), B1 (#25/04), B2 (#25/06), and B3 (#30/04) files in wider canals. Each file was disposed of after use in a maximum of three teeth.

Assessment Parameters:**Instrumentation Time:**

Based on pediatric endodontic system used, the duration from the start of instrumentation till completion of biomechanical preparation was recorded using a stopwatch.

Obturation & Obturation Time:

After final irrigation using 3% sodium hypochlorite followed by normal saline, drying of the canals was done using absorbent sterile paper points (Gapadent Co Ltd, Delhi) and obturation with Metapex (Meta Biomed, Korea) followed by restoration with Type IX GIC (GC India Dental Pvt Ltd, Hyderabad). Using a stopwatch the duration from drying of canals till the completion of obturation was recorded.

Immediate Radiographic Assessment:

Postoperative radiographs were evaluated by two blinded evaluators for obturation quality and length. Void presence was scored from 0 to 5¹⁰

- a. Score 0 – Complete absence of voids
- b. Score 1 – Presence of one void
- c. Score 2 – Presence of two voids
- d. Score 3 – Presence of three voids
- e. Score 4 – Presence of four voids
- f. Score 5 – Presence of five voids.

The extent of fill was graded from A to D based on:

- a. Grade A – Less than one-half of the canal obturated
- b. Grade B – Greater than one-half but less than optimal fill
- c. Grade C – Optimal fill
- d. Grade D – Extrusion of material beyond apex.

STATISTICAL ANALYSIS:

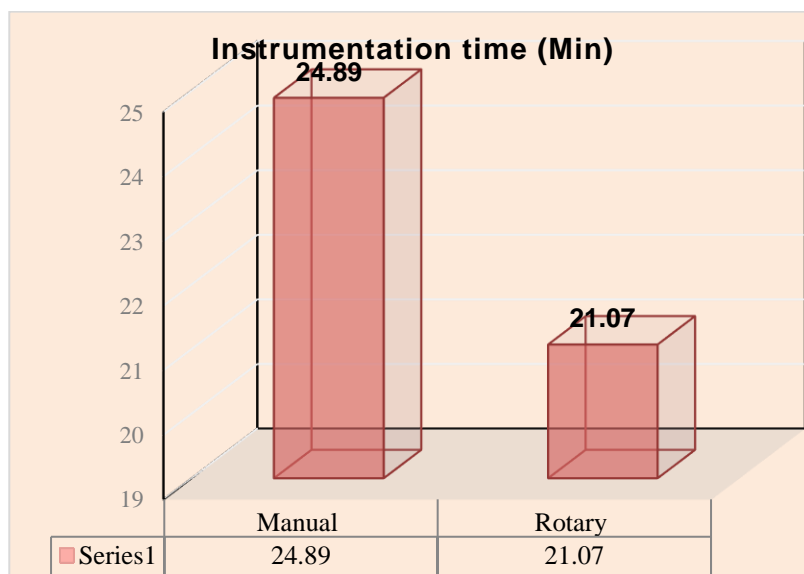
The collected data were organized into tables and subjected to rigorous statistical analysis using IBM SPSS software version 23. Independent t-tests and Mann-Whitney U-tests were utilized, with the Chi-square test employed to assess the void presence and the extent of fill, considering a significance level of $p < 0.05$.

RESULTS:

Table 1 and Graph 1 present a comparison between the two groups regarding instrumentation time, recorded in minutes. The mean time for canal instrumentation using K-files (Group 1) was 24.89 minutes, whereas with Pro-AF files (Group 2), it was 21.07 minutes. An independent t-test revealed a significant difference between the groups ($p < 0.05$). Pro-AF files demonstrated the shortest instrumentation time, while K-files via manual methods required the longest. Table 2 and Graph 2 display an intergroup comparison of obturation time, recorded in minutes. Group 1 required a mean obturation time of 5.79 minutes post-canal preparation, whereas Group 2 required 3.54 minutes. The Mann-Whitney U-test indicated a significant difference between Group 1 and Group 2 ($p < 0.05$), highlighting the superior efficiency of rotary file systems over manual K-files in completing the obturation process more swiftly. Table 3 and Graph 3 illustrate an intergroup comparison of void presence, analyzed using the Chi-square test. Group 1 exhibited 13.6% void-free canals, whereas Group 2 showed 39.1%. The difference was not statistically significant, indicating that rotary files resulted in fewer voids compared to manual files, but without reaching significance. Table 4 and Graph 4 present a comparison of radiographic obturation quality after instrumentation, analyzed with the Chi-square test. In Group 1, 27.3% of canals were optimally filled, whereas in Group 2, 56.5% were optimally filled, demonstrating a significant difference. This underscores the superior obturation quality achieved with Pro-AF files compared to K-files.

Groups	n	Minimum	Maximum	Mean	SD	t value	P value
Group 1	22	22.26	28.48	24.8936	1.91701	5.137	0.001*
Group 2	23	16.15	25.59	21.0757	2.93771		

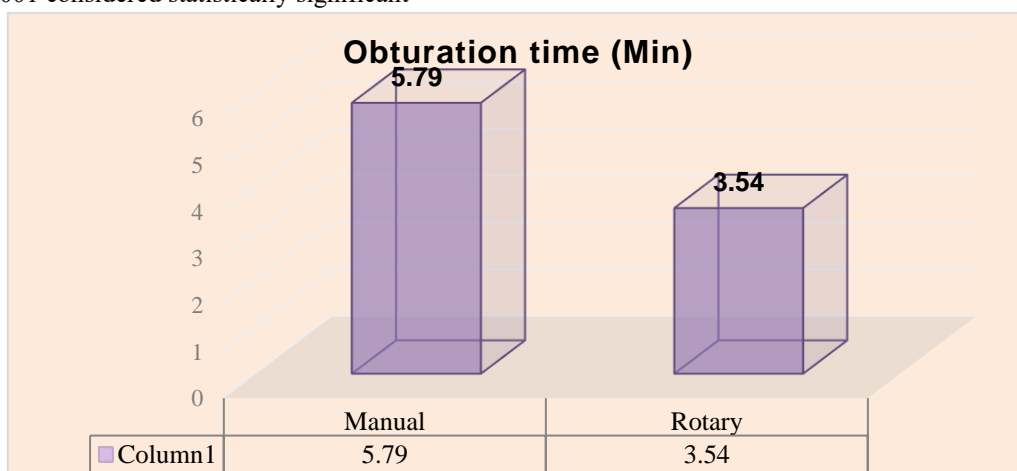
Table 1: Intergroup comparison of instrumentation time (minutes). n = Sample size, SD = Standard deviation, $p \leq 0.001$ considered statistically significant.



Graph 1: Intergroup comparison of instrumentation time (minutes)

Groups	n	Minimum	Maximum	Mean	SD	t value	P value
Group 1	22	5.23	6.47	5.7959	0.37057	-5.747	0.001*
Group 2	23	2.58	4.49	3.5443	0.50720		

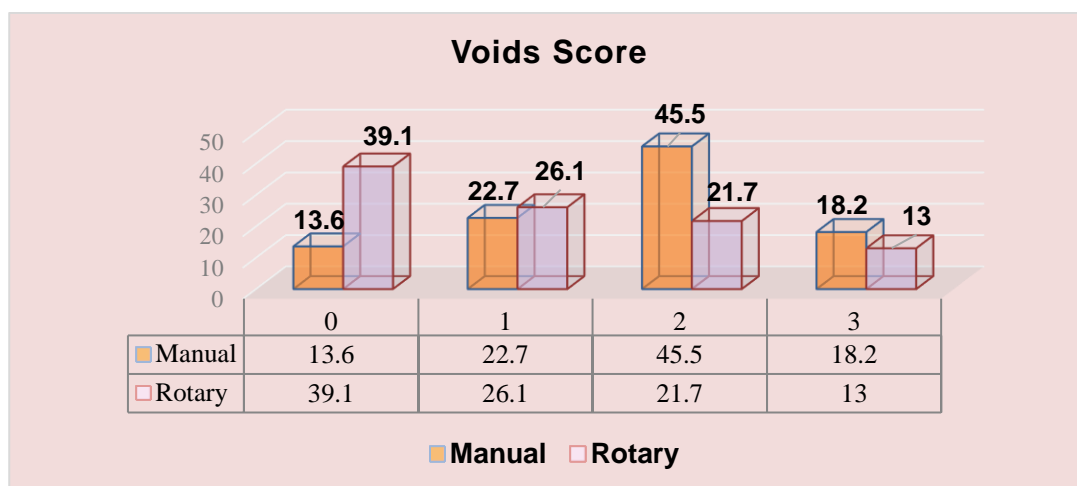
Table 2: Intergroup comparison of obturation time (minutes). n = Sample size, SD = Standard deviation, $p \leq 0.001$ considered statistically significant



Graph 2: Intergroup comparison of obturation time (minutes)

Voids score	Group 1		Group 2		Chi-square value	P value
	n	%	n	%		
0	3	13.6	9	39.1	4.881	0.181
1	5	22.7	6	26.1		
2	10	45.5	5	21.7		
3	4	18.2	3	13		

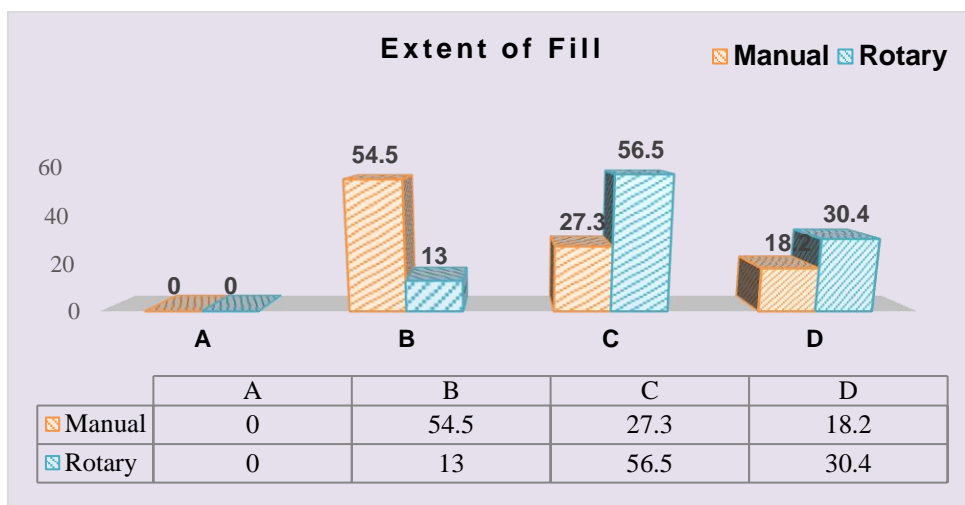
Table 3: Intergroup comparison based on the number of voids



Graph 3: Intergroup comparison based on the number of voids 0- Complete absence of voids, 1-Presence of one void, 2- Presence of two voids, 3- Presence of 3 voids

Grade	Group 1		Group 2		Chi-square value	P value
	n	%	n	%		
A	0	0	0	0	8.779	0.012*
B	12	54.5	3	13		
C	6	27.3	13	56.5		
D	4	18.2	7	30.4		

Table 4: Intergroup comparison based on the extent of fill. n = Sample size



Graph 4: Intergroup comparison based on the extent of fill. A- Less than one half of the canal obturated, B- Greater than one half but less than optimal fill, C- Optimal fill, D- Extrusion of material beyond apex.

DISCUSSION

According to guidelines from the American Academy of Pediatric Dentistry, pulpectomy is recommended when primary teeth with carious pulp exposures show clinical signs of pulp inflammation (hyperemia) or necrosis of the root pulp, whether or not dental caries is involved. Advances in pulp therapy have not only enhanced the materials used but also refined techniques and instrumentation, leading to improved treatment outcomes. Effective endodontic procedures involve mechanical instrumentation and thorough canal irrigation to control infection and facilitate healing of periapical tissues.¹¹

Root canal preparation involves using various tools such as reamers, files, burs, sonic instruments, mechanical devices, and nickel-titanium (Ni-Ti) rotary file systems. Hand preparation methods, though traditional, can be time-consuming and prone to errors such as ledging, canal transportation, and blockage.¹² Negotiating and thoroughly instrumenting complex and tortuous canals, especially in roots destined for physiological resorption, pose significant challenges during pulpectomy.¹³

To address these challenges, Ni-Ti rotary instruments have gained popularity due to their efficiency which were introduced for primary teeth in 2000 by Barr et al., rotary instrumentation has demonstrated effective tapering, which improves the quality of obturation while reducing the risk of procedural errors. However, there are drawbacks to using rotary instruments, such as incomplete cleaning of isthmuses and fins in primary teeth due to the centered nature of rotary files in the root canal. To mitigate this issue, Drukteinis and Balciuniene suggested supplementing rotary instruments with H-files to thoroughly remove infected tissue from ribbon-shaped canals.¹⁴

Pro-AF Baby Gold files are advanced NiTi controlled memory (CM) wire instruments specifically designed for rotary endodontic procedures in pediatric dentistry. They are characterized by a consistent taper and reduced risk of breakage, offering enhanced cutting efficiency that is particularly beneficial in challenging cases involving primary teeth. These have a total length of 17 mm, with an active cutting length of 13 mm, and are operate at 300 rpm with a torque of 2 N.⁹

The Pro-AF Baby Gold files have a sharp cutting edge responsible for efficient canal shaping, supported by a well-polished surface achieved through advanced polishing technology. They also incorporate a non-cutting tip with precise tip grinding to facilitate safe and accurate instrumentation. This design minimizes the number of files typically required per canal, often reducing the preparation process to just two files. Overall, Pro-AF Baby Gold files have demonstrated their effectiveness in achieving superior canal shaping outcomes in pediatric endodontic treatments, highlighting their reliability and efficiency in clinical practice.¹⁵

The present study evaluated the instrumentation time and obturation time comparing rotary and manual techniques, specifically focusing on the efficiency of Pro-AF files compared to manual K-files. Consistently with previous research by Ochoa-Romero et al. (2011), Makerem et al. (2014), Vieyra and Enriquez (2014), Govindaraju et al. (2017), and Jeevanandan and Govindaraju (2018),^{3,11,16,17,18} we found that rotary systems significantly reduce instrumentation time compared to manual methods. This reduction is particularly beneficial in pediatric dentistry, where quicker procedures are essential for maintaining quality, safety, and minimizing patient and operator fatigue.¹⁹

Achieving successful pulpectomy in primary teeth hinges on thorough cleaning and shaping of root canals to eliminate microorganisms and prevent procedural errors like instrument fracture or canal deformation.²⁰ Traditional stainless steel instruments often struggle to achieve the necessary tapered root canal shapes, especially in severely curved canals.^{21,22,23} Therefore, selecting the appropriate root canal filling material is crucial to effectively treat root canal infections in primary teeth. Ideal materials should resorb at a rate comparable to natural root resorption, be radiopaque, non-toxic, easy to apply, non-shrinking, and possess disinfectant properties.²⁴

Among the commonly used materials are zinc oxide eugenol and Metapex, a premixed paste of calcium hydroxide and iodoform renowned for its antibacterial properties and resorbability.²⁵ These materials play a critical role in achieving successful outcomes in pediatric endodontic treatments, ensuring effective infection control and promoting healing of primary teeth.

Various techniques for obturating root canals include the pressure syringe, Lentulo spiral, and specialized systems like the Pastinject paste carrier. Achieving high-quality obturation is crucial as improper filling can compromise the success of treatment. Rotary instrumentation has been demonstrated to improve obturation quality by reducing the number of voids compared to manual techniques.²⁶

In our study, we found that obturation time was significantly shorter with rotary instrumentation compared to manual techniques, consistent with findings from studies by Ochoa-Romero et al. (2011)³ and Babaji et al. (2019).²⁷ Conversely, studies by Makerem et al. (2014) and Gomes (2014) did not show notable differences in obturation time between rotary and manual instrumentation. Therefore, the use of rotary instrumentation can effectively reduce chair-side time.¹⁶

The success of pulpectomy depends on several variables, including the length of the root canal filling. Coll and Sadrian (1996) concluded that teeth with fillings extending completely to the apex or stopping just short of it had significantly better success rates compared to overfilled canals.⁹ Yacobi et al. reported that underfilled canals in vital teeth had significantly higher failure rates than adequately filled canals.²⁶ Thus, optimal root canal filling contributes to the higher success of pulpectomy procedures.

The majority of canals instrumented using Pro-AF files demonstrated optimal length of obturation,

whereas canals prepared with K-files often resulted in a higher incidence of underfilled canals as noted in this present study. Although our study did not find significant differences in the length of obturation between rotary and manual preparation techniques, similar findings were reported by Ochoa-Romero et al. (2011), Makerem et al. (2014), Govindaraju et al. (2017), Jeevanandan and Govindaraju (2018), Babaji et al. (2019), Panchal et al. (2019), Divya et al. (2019), and Lakshmanan et al. (2020).^{3,16,17,18,27,28}

The presence of voids within root fillings, both at the apical and coronal parts, is a critical concern as they can serve as pathways for leakage, potentially leading to post-treatment failures.²⁹ Factors influencing the formation of voids include the type, viscosity, and consistency of the filling paste, the method of application, operator skill, and the presence of moisture in the canals.⁹

In our study, we evaluated the quality of obturation by assessing the presence of voids using post-obturation radiographs, aiming to maximize visibility of the canals. This evaluation is crucial for identifying potential areas of concern and ensuring the overall success of the pulpectomy procedure.

The quality of obturation was assessed using digital radiographs, which provide two-dimensional images of a three-dimensional structure, representing a limitation of our study. Additionally, the lack of follow-up to determine the success or failure of the cases is an important factor in evaluating the overall success of endodontic therapy.

Although no significant difference was observed in obturation quality between rotary and manual techniques, rotary files demonstrated superior obturation quality with efficient chair-side time. Therefore, pediatric rotary files are essential tools in the armamentarium of pediatric dentists and can be considered the standard of care for pulpectomies in primary molars.

CONCLUSION:

Advanced NiTi rotary files such as Pro-AF contribute significantly to improving the efficiency and quality of pulpectomies in primary molars. These instruments streamline procedures chair-side, ensure precise canal cleaning and shaping, and enhance obturation outcomes, establishing themselves as pivotal in pediatric endodontics.

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Nil

CONFLICTS OF INTEREST

There are no conflicts of interest

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