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MEDICAL ACADEMY

FACULTY OF ODONTOLOGY

DEPARTMENT OF PREVENTIVE AND PAEDIATRIC DENTISTRY

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ROTARY VERSUS HAND INSTRUMENTATION IN PULPECTOMY OF PRIMARY MOLARS: A LITERATURE REVIEW OF CLINICAL, RADIOGRAPHIC AND SAFETY OUTCOMES

The Master's thesis of the Master's degree study programme "Odontology"

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Kaunas, 2026

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Kaunas, 2026

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1	Summary	Is summary informative and in compliance with the thesis content and requirements? Do the keywords match the essence of the thesis?	
2	Introduction	Are the novelty, relevance and significance of the work justified in the introduction of the thesis?	
3	Aim and objectives	Are the aim and objectives formulated properly and clearly? Are the aim and objectives interrelated?	
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5	Search method and strategy	Is the selection process of articles (screening, eligibility for systematic review or, if applicable, for meta-analysis) described? Is the process of data selection from articles described (types of research, participants, interventions, factors analysed, and indicators)? Were all the variables, for which data were searched and described, listed and described? What assumptions or simplifications were made? Were the key measurement indicators (relative risk, mean difference) described?	
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ABBREVIATIONS

PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analyses

RCT – Randomized controlled trial

RoB – Risk of Bias

PICO – Population, Intervention, Comparison, Outcome

MeSh – Medical Subject Headings

WT – Working time

NiTi – Nickel–Titanium

SSH – Stainless Steel Hand (files)

WLD – Working Length Determination

CS – Clinical Success

RS – Radiographic Success

PhD – Doctor of Philosophy

RPM – Revolutions Per Minute

ISO – International Organization for Standardization

EDTA – Ethylenediaminetetraacetic Acid

NaOCl – Sodium Hypochlorite

ROTARY VERSUS HAND INSTRUMENTATION IN PULPECTOMY OF PRIMARY MOLARS: A LITERATURE REVIEW OF CLINICAL, RADIOGRAPHIC, AND SAFETY OUTCOMES

SUMMARY

Background:

The development of rotary systems has raised concerns among paediatric clinicians regarding their efficiency, effectiveness, and safety relative to conventional stainless-steel hand files. In paediatric dentistry, rotary systems are primarily used for pulpectomy, the principal treatment for maintaining primary molars with necrosis or irreversible pulpitis.

Aim:

To summarise and compare evidence reported in published clinical studies regarding the clinical, radiographic, and safety outcomes of rotary versus manual instrumentation methods for pulpectomy of primary molars.

Materials and Methods:

A systematic review following PRISMA 2020 guidelines was conducted. Electronic databases, PubMed, Cochrane Library, and Wiley Online Library, were searched for randomised clinical trials comparing rotary and manual instrumentation in primary molars, and the data were analysed qualitatively, with risk of bias assessed using RoB 2.

Results:

Both rotary and manual instrumentation demonstrated high and comparable clinical and radiographic success rates, with no consistent differences between the techniques. Rotary systems were associated with shorter instrumentation time, while safety outcomes were similar for both methods.

Conclusion:

Rotary instrumentation systems may reduce treatment time while maintaining clinical, radiographic, and safety outcomes comparable to those of manual instrumentation techniques.

Keywords: pulpectomy, primary molars, rotary instrumentation, manual endodontic files, paediatric endodontics, NiTi rotary systems.

SUKAMŲJŲ MAŠININIŲ IR RANKINIŲ ENDODONTINIŲ INSTRUMENTŲ PALYGINIMAS ATLIEKANT PIENINIŲ DANTŲ PULPEKTOMIJĄ: KLINIKINIŲ, RADIOLOGINIŲ IR SAUGUMO REZULTATŲ LITERATŪROS APŽVALGA

SANTRAUKA

Problemos aktualumas:

Sukamųjų mašininių instrumentų sistemų kūrimas paskatino vaikų odontologus kelti klausimus dėl jų efektyvumo ir saugumo, lyginant su įprastais nerūdijančio plieno rankiniais instrumentais. Šios sistemos daugiausia naudojamos atliekant dantų pulpektomiją – pagrindinį gydymo metodą siekiant išsaugoti dantis, kuriems nustatyta pulpos nekrozė arba negrįžtamas pulpitas.

Tyrimo tikslas:

Apibendrinti ir palyginti publikuotuose klinikiniuose tyrimuose pateiktus duomenis apie sukamųjų mašininių ir rankinių instrumentų klinikinius, radiologinius ir saugumo rezultatus atliekant pieninių dantų pulpektomiją.

Medžiaga ir metodai:

Sisteminė apžvalga atlikta vadovaujantis PRISMA 2020 gairėmis. Elektroninėse duomenų bazėse, PubMed, Cochrane Library, ir Wiley Online Library ieškota klinikinių tyrimų, kuriuose lyginami darbo su sukamaisiais mašininiais ir rankiniais instrumentais klinikiniai bei radiologiniai duomenys, atliekant endodontinį pieninių dantų gydymą. Duomenys analizuoti kokybiškai, vertinant šališkumo riziką RoB 2 įrankiu.

Rezultatai:

Panašūs klinikiniai duomenys gauti dirbant tiek su sukamaisiais mašininiais, tiek ir rankiniais instrumentais. Jie parodė aukštus klinikinius ir radiologinius sėkmės rodiklius. Ženklių skirtumų tarp šių metodų nebuvo. Dirbant su sukamosiomis mašininėmis sistemomis, darbas buvo atliekamas greičiau. Abiejų metodų saugumo rezultatai statistiškai reikšmingai nesiskyrė.

Išvados:

Dirbant su sukamaisiais mašininiais instrumentais, gydymo laikas trumpesnis, o klinikiniai, radiologiniai ir saugumo rezultatai išlieka panašūs, kaip ir dirbant su rankiniais endodontiniais instrumentais.

Raktiniai žodžiai: Pulpektomija, pieniniai krūminiai dantys, sukamieji mašininiai instrumentai, rankiniai endodontiniai instrumentai, vaikų endodontija, NiTi sukamosios mašininės sistemos.

INTRODUCTION

Pulpectomy is an important treatment for primary molars. When the pulp becomes necrotic or irreversible pulpitis occurs, pulpectomy helps preserve the tooth and prevents the spread of infection within the tooth and surrounding tissue. Maintaining primary molars is essential for paediatric patients because it is directly linked to arch stability, masticatory efficiency, speech development, and guidance of permanent tooth eruption [1,2]. Conserving primary molars until they exfoliate naturally is highly valuable for occlusal alignment, as it prevents crowding, preserves space, and contributes to overall oral function [3,4]. Primary molars can have complex and unique root and canal characteristics, such as accessory canals, ribbon-shaped canals, thin dentinal walls, and ongoing physiological root resorption, which make the prediction of treatment outcomes more challenging [5,6]. These anatomical factors may complicate pulpectomy procedures, especially during canal shaping and disinfection, potentially affecting the long-term success of the treatment.

Root canal preparations, including microbial removal, shaping, and irrigation, are performed during root canal instrumentation, making it a key factor influencing treatment outcomes. In earlier practice, root canal instrumentation was performed using manual stainless-steel K-files; however, this method has several limitations, which may lead to complications such as perforation, canal transportation, or ledging, especially in primary canals that are narrow, curved, or irregularly shaped, due to the structural rigidity of stainless- steel instruments [7,8]. Nickel-titanium (NiTi) rotary systems offer advantageous features, including their ability to maintain canal curvature and their flexibility and torsional resistance, which have positively transformed endodontic practice since their introduction [9,10]. Particularly in paediatric dentistry, rotary systems such as Kedo-S, Kedo-SG Blue, and Fanta Baby are designed specifically for paediatric use, with shorter lengths, reduced taper, and improved ergonomics, making them suitable for primary molar anatomy [11,12].

Although various rotary systems are being used more frequently, there remains ongoing debate about their safety and effectiveness in primary teeth. Some reported clinical concerns have caused practitioners to question potential complications, including over-instrumentation, file separation, reduced tactile control, and the risk of inappropriate canal shaping in teeth with physiological root resorption [13,14]. While several randomised controlled trials have compared rotary and manual instrumentation techniques, their findings are inconsistent. In addition, many studies have limited follow-up periods and use different outcome measures, which complicates direct comparison of results [15–18].

Therefore, it is important to evaluate available evidence from randomised clinical trials with adequate follow-up.

This review aims to compare rotary instrumentation systems with manual file systems in pulpectomy of primary molars, focusing on clinical, radiographic, and safety outcomes. This review may help clarify existing evidence and support clinical decision-making in paediatric endodontics.

Aim:

To summarise and compare evidence reported in published clinical studies on the clinical, radiographic, and safety outcomes of rotary versus manual instrumentation methods for pulpectomy of primary molars.

Objectives:

1. To compare reported clinical outcomes, including clinical success rates, pain, oedema, mobility, and discomfort following pulpectomy performed with rotary and hand instrumentation.
2. To summarise radiographic outcomes in terms of obturation quality and healing of periapical or furcal radiolucency.
3. To compare the reported instrumentation time between rotary and hand techniques.
4. To review safety-related incidents such as file separation and operational failures.

Expected Results of the Research Project:

Rotary instrumentation may demonstrate shorter instrumentation time while providing clinical, radiographic, and safety outcomes comparable to manual stainless-steel hand instrumentation in pulpectomy of primary molars.

1. SELECTION CRITERIA OF THE STUDIES, RESEARCH METHODS AND STRATEGY

1.1 Systematic Review Protocol

This literature review was conducted in accordance with the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [19]. A comprehensive review protocol was developed before initiating the study to specify the objectives, inclusion and exclusion criteria, search strategy, and methods for data extraction and synthesis.

Although the protocol was not registered in any public database, the review methodology strictly adhered to PRISMA 2020 recommendations [19]. The study was carried out as part of a Master's thesis project at the Lithuanian University of Health Sciences (LSMU).

The request for Bioethics Centre approval for a systematic literature review was submitted to the Lithuanian University of Health Sciences (LSMU), No. 2025-BEC2-1447 (annex 2).

The search of literature for this review was carried out through PubMed, Google Scholar, Wiley Online Library, and Cochrane Library (CENTRAL) from the 7th of November 2025, with the last search conducted on 27th of February 2026. The Medical Subject Headings (MeSH) controlled vocabulary was utilised, including relevant synonyms and related keywords.

The electronic databases PubMed, Cochrane Library (CENTRAL), Wiley Online Library, and Google Scholar were searched from their inception to 27 February 2026. No restrictions on database coverage start dates were applied. No attempts were made to contact the authors of the included studies for additional information.

Types of Publication

Studies included in this review were randomised controlled trials (RCTs) conducted on human subjects and published in English.

Information Sources

The electronic databases PubMed, Google Scholar, Wiley Online Library, and Cochrane Library (CENTRAL) were utilised.

Disease Definition

The soft connective tissue inside the pulp chamber and root canals of the tooth is called dental pulp. It contains nerves, blood vessels, and cells that provide nutrients, sensation, and protection for the tooth [20]. Pulpectomy is recommended for primary teeth with infected pulp that has advanced to

pulp necrosis or irreversible pulpitis, often caused by trauma or deep caries. The procedure involves preparing the access cavity, removing the infected pulp, cleaning and shaping the root canals, irrigating, and filling the canals with resorbable filling material [21, 22].

Literature Search and Screening

Following the literature search, titles and abstracts of identified studies were screened for relevance. Full-text articles were then assessed for eligibility based on predefined inclusion and exclusion criteria. Studies that met the eligibility criteria were included in the final analysis.

1.2 Inclusion and Exclusion Criteria

The research question was guided by the population, intervention, comparison, outcome, and study (PICOS) design framework shown in Table 1. Using the PICO structure ensured that the question was clear, focused, and well-organised, thus guiding the comprehensive design of the research, including the methodologies for data collection and analysis.

Table 1. PICOS table

PICO component	Description
Population	Paediatric patients with primary molars, undergoing pulpectomy.
Intervention	NiTi rotary or reciprocating instrumentation systems used for pulpectomy in primary molars.
Comparison	Manual instrumentation using stainless-steel or NiTi hand K-files.
Outcomes	Primary outcomes: Clinical and radiographic success rates. Secondary outcomes: • Procedure efficiency • Postoperative pain or adverse events. • Quality of obturation • Tooth survival
Study characteristics	Randomised controlled trials and prospective comparative clinical studies conducted in humans, published not older than 10 years, written in English.

Focus Question:

In paediatric patients undergoing pulpectomy of primary molars, does rotary instrumentation, compared with hand instrumentation, lead to better overall clinical, radiographic, and safety outcomes?

Articles were Selected According to the Following Inclusion Criteria:

- Articles published from 2015 to 2025.
- Articles composed in the English language.
- Full-text articles.
- Paediatric patients with primary molars undergoing pulpectomy.
- Randomised clinical trials (RCTs), controlled clinical trials, and prospective clinical studies.
- Studies conducted on humans.
- Studies that include at least one of the following: clinical success, radiographic success, and instrumentation safety.
- Studies with a follow-up period of at least 6 months.

Articles were Excluded According to the Following Exclusion Criteria:

- Articles without full text available.
- Systematic review articles, meta-analyses, case reports, editorials, theses, commentaries, PhD theses, pilot studies, *in vitro* micro-CT studies
- Studies conducted on animals.
- Studies published prior to 2015.
- Research conducted on permanent teeth.
- Articles published in languages other than English.
- Research on pulpotomy.
- Studies not reporting at least one of the following: clinical success, radiographic success, or instrumentation safety.
- No published outcome data available.
- No comparison between rotary and hand instruments.
- Studies with a follow-up period of under 6 months

1.3 Literature Search Strategy

The literature search and study selection were conducted by the author under the supervision of the thesis supervisor. In accordance with the PRISMA 2020 guidelines, a systematic literature search was conducted from 7th of November 2025 to 27th of February 2026. Searches were conducted in the LSMU electronic library databases, including PubMed, Google Scholar, Wiley Online Library, and the Cochrane Central Register of Controlled Trials (CENTRAL).

The PICO framework was used to structure the search strategy, including Medical Subject Headings (MeSH) and free-text keywords where applicable. The main keywords used were “pulpectomy”, “primary teeth”, “primary molars”, “deciduous teeth”, “rotary instrumentation”, “nickel–titanium (NiTi)”, “manual instrumentation”, “hand files”, and “K-files”. Boolean operators (AND/OR) were used to combine the keywords. The full search strings for each database are presented in Table 2. Filters were used to limit the search to clinical studies published between 2015 and 2025 and in English. Filters *“Clinical Trial”* and “English language” were used when available. Due to the large number of results retrieved from Google Scholar, only the first 100 results sorted by relevance were screened. Manual searches of reference lists and citation tracking were undertaken to identify additional relevant studies. The PRISMA 2020 flow diagram in Figure 1 summarises the overall study selection process.

Table 2. Search strategy and results across electronic databases

Database	**Search strategy**	**Number of records (n)**
Cochrane Library	pulpectomy AND ("primary teeth" OR "deciduous teeth") AND (rotary OR hand OR manual) AND instrumentation Filters: 2015–2025, clinical trials	47
Google scholar	"pulpectomy" AND ("primary molars" OR "primary teeth") AND (rotary OR "nickel titanium") AND (manual OR "hand files" OR "K-files") Filters: 2015-2025	100
PubMed	(pulpectomy OR "root canal treatment") AND ("primary teeth" OR "deciduous teeth" OR "primary molars") AND (rotary OR "nickel titanium" OR NiTi OR manual OR hand) Filters: 2015–2025, clinical trials, randomised controlled trials	12
Wiley Online Library	(pulpectomy OR "root canal treatment") AND ("primary teeth" OR "deciduous teeth") AND (rotary OR manual OR hand) AND instrumentation Filters: 2015–2025	188

1.4 Selection of Studies

Zotero Reference Manager was utilised to automatically eliminate duplicate articles. Under the supervisor's guidance, the reviewer independently screened the titles and abstracts of the extracted records, excluding those that did not meet the predefined inclusion and exclusion criteria. Furthermore, full-text reviews of each study were conducted to determine final eligibility for inclusion. Necessary data from the included studies were extracted and presented in Table 4, including authors' names, publication year, country, study design, age range, sample size, tooth type, and follow-up duration.

1.5 Variables, Assumptions, and Simplifications

The research conducted on the included articles was on paediatric patients of both genders aged 3 to 11 years who received pulpectomy treatment for primary molars. The comparison centred on rotary instrumentation systems versus manual hand instrumentation techniques in the pulpectomy procedure, aiming to identify differences in clinical and radiographic outcomes, procedure efficiency, and safety. The main variables analysed were the type of instrumentation system used, irrigation and intracanal materials employed, procedure working time, clinical and radiographic success, and the quality of obturation. Key assumptions include that similar outcome measurement techniques and clinical protocols were applied. The study simplified the analysis by grouping different rotary systems used in the studies into one category and manual hand instrumentation into another.

1.6 Risk of Bias Assessment

The Cochrane Risk of Bias 2 (RoB 2) tool was utilised to assess the risk of bias in the included randomised controlled trials. Each study was evaluated across the five RoB 2 domains. [20]. The risk of bias assessment was conducted by the author, and any uncertainties were discussed with the supervisor. A summary of the risk of bias was compiled and presented in Table 9, categorising articles as low risk, some concerns, and high risk.

2. SYSTEMIZATION AND ANALYSIS OF THE DATA

2.1 Article Selection

The initial search of the databases listed in Table 2 yielded a total of 347 records, with 2 additional records identified through manual search of reference lists.

After removing the 60 duplicate records, 289 records remained for title and abstract screening. During the screening phase, titles and abstracts of 289 records were assessed for relevance to the predefined inclusion criteria. A total of 221 records that did not meet the predefined inclusion criteria were excluded. After this phase, 68 full-text articles remained, which were examined more closely to assess their methodological quality and the appropriateness of their outcome measures. During full-text evaluation, 61 studies were excluded due to insufficient follow-up information or for not presenting radiographic results, which were required for this review. Finally, seven studies met all inclusion criteria and were included in the qualitative synthesis. The summary of this selection is illustrated in Fig 1.

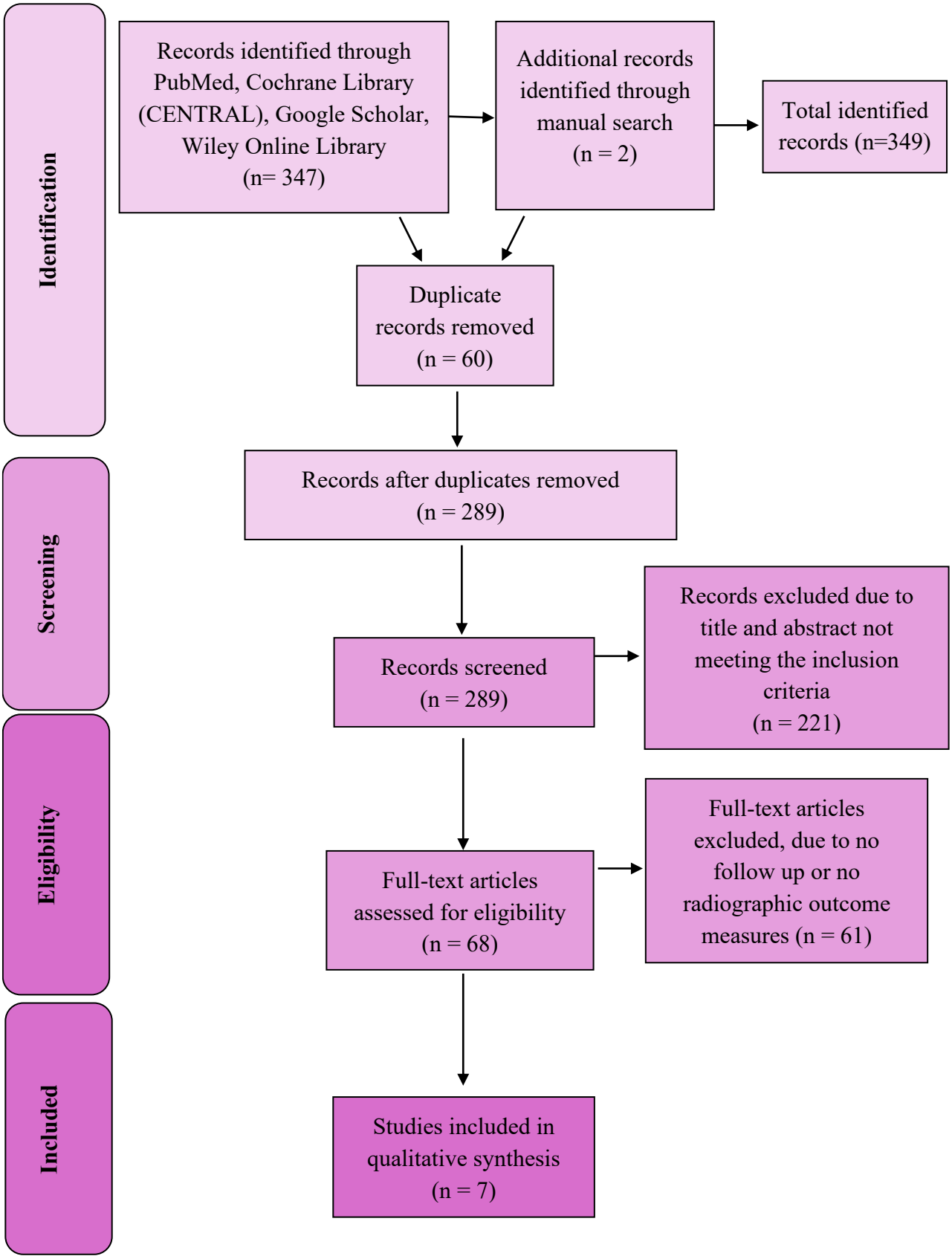


Fig 1. Prisma flow diagram

2.2 Characteristics of Studies

Seven studies met the inclusion criteria and were included in the qualitative synthesis. All included studies were RCTs identified through the four databases listed in Table 2. The studies were conducted in several countries: three studies from India [25, 26, 28], two from Egypt [24, 29], one from Brazil [27], and one from Thailand [30]. The age of participants ranged from 3 to 11 years. All studies were conducted on primary molars, and sample sizes varied. Follow-up periods ranged from 9 months, the shortest [28], to 24 months, the longest [25, 26]. The main features of the included studies are summarised in Table 4. Full author lists and corresponding journal names of the included studies are provided in Annex 1.

Table 4. Characteristics of the included studies

Nr.	Author/year	Country	Study Design	Age	Sample Size	Tooth Type	Follow-up
1	**Abd El Fatah YA et al., 2025 [24]**	Egypt	RCT	4-7 years	162 (54 per group)	primary molars	3, 6, and 12 months
2	**Al-Wesabi AA et al., 2025 [25]**	Egypt	RCT	4-6 years	46 (20 per group)	primary molars	3, 6, and 9, 12 months
3	**Amorim AC et al., 2022 [26]**	Brazil	RCT	4-11 years	40 (20 per group)	mandibular primary molars	3, 6, and 12 months
4	**Boonchoo K et al., 2020 [27]**	Thailand	RCT	3-7 years	37 (18 rotary 19 hand)	mandibular primary molars	6 and 12 months
5	**Girish Babu KL et al., 2024 [28]**	India	RCT	4-7 years	288 (96 per group)	primary molars	3, 6, 9, 12, 15, 18, and 24 months
6	**Morankar R et al., 2018 [29]**	India	RCT	4-7 years	60 (30 per group)	mandibular primary first and second molars	3, 6, and 24 months
7	**Rajain T et al., 2023 [30]**	India	RCT	4-7 years	60 (30 per group)	mandibular primary molars	3, 6, and 9 months

RCT – Randomised clinical trial

2.3 Methodological Characteristics of Included Studies

Along with the general characteristics, the use of various instrumentation systems is observed across the included studies. Different rotary nickel–titanium systems, such as Fanta Baby, Hyflex CM, Hyflex EDM, Kedo-S, and S-NiTi WaveOne Gold, were compared with conventional manual stainless-steel K-files. Technical details regarding file sequences and instrumentation parameters are provided in Annex 3. The irrigation protocol involved sodium hypochlorite (NaOCl), EDTA gel, saline, or combinations of these solutions. The most common method for working length determination (WLD) was the radiographic technique. Furthermore, three obturation materials were used, including calcium hydroxide-based pastes, calcium hydroxide with zinc oxide, and calcium hydroxide with iodoform. A summary of the instrumentation systems, irrigation protocols, working length determination methods, obturation materials, and reported outcomes in the included studies is presented in Table 5.

Table 5. Data extraction of instrumentation, materials, and file systems from the included studies

Nr.	Author/ year	Intervention Group	Control Group	Irrigation Protocol	WLD methods	Obturation Materials	Outcome measures reported
1	**Abd El Fatah YA et al., 2025 [24]**	Fanta Baby Zuanba (Z)	stainless-steel K-files	1% NaOCl, 17% EDTA gel, and saline	radiographic method	iodoform-based calcium hydroxide paste	working time, clinical success, radiographic success
2	**Al-Wesabi AA et al., 2025 [25]**	Fanta Baby	stainless-steel K-files	EDTA gel (intervention group) and saline	radiographic method	calcium hydroxide with iodoform	working time, clinical success, radiographic success, postoperative pain, obturation quality
3	**Amorim AC et al., 2022 [26]**	Hyflex EDM	stainless-steel K-files	1% NaOCl and saline	apical foramen height minus two millimetres	calcium hydroxide thickened with zinc oxide	working time, clinical success, radiographic success
4	**Booncho o K et al., 2020 [27]**	S-NiTi WaveOne Gold	stainless-steel K-files	1% NaOCl	electronic apex locator (1 mm short of the apex	iodoform-based calcium hydroxide paste	working time, clinical success, radiographic success, obturation quality
5	**Girish Babu KL et al., 2024 [28]**	Kedo-SG Blue HERO Shaper	stainless-steel K-files	17% EDTA gel and saline	radiographic method	iodoform-based paste	clinical success, radiographic success, obturation quality
6	**Moranka r R et al., 2018 [29]**	Hyflex CM NiTi	stainless-steel K-files	2.5% NaOCl and saline	radiographic method	calcium hydroxide with zinc oxide	working time, clinical success, radiographic success, obturation quality, complications
7	**Rajain T et al., 2023 [30]**	Kedo-S	stainless-steel K-files	5% NaOCl, 17% EDTA gel, and saline	radiographic method	calcium hydroxide with iodoform	working time, clinical success, radiographic success, postoperative pain, obturation quality

WLD – Working length determination

NaOCl – Sodium hypochlorite

EDTA – Ethylenediaminetetraacetic acid

2.4 Outcomes of the included studies

2.4.1 Clinical outcomes

Clinical success rates ranged from approximately 82% to 100% across the included studies. Overall, both rotary and manual instrumentation demonstrated high and comparable clinical success, with no consistent superiority of one technique over the other. Evaluation of success rates was based on the following criteria: absence of pain, tenderness to percussion, swelling, sinus tract or fistula formation, and abnormal tooth mobility. Clinical outcomes summary is shown in Table 6.

Table 6. Clinical outcomes reported in the included studies

Nr.	Author/year	Clinical Success Criteria	Rotary Clinical Success	Manual Clinical Success
1	**Abd El Fatah YA et al., 2025 [24]**	Absence of tenderness to percussion, swelling and tooth mobility	FAF 96.3% Zuanba 96.3%	96.3%
2	**Al-Wesabi AA et al., 2025 [25]**	Absence of tenderness to percussion, swelling, fistula and tooth mobility; postoperative pain was also evaluated separately	82.6%	82.6%
3	**Amorim AC et al., 2022 [26]**	Absence of pain, tenderness to percussion, abscess or fistula formation, secondary caries, and tooth mobility	100%	100%
4	**Boonchoo K et al., 2020 [27]**	Absence of pain, swelling, sinus tract formation, pus exudate, and tooth mobility	100%	100%
5	**Girish Babu KL et al., 2024 [28]**	Absence of pain, tenderness to percussion, gingival swelling, sinus tract formation, and tooth mobility	100%	100%
6	**Morankar R et al., 2018 [29]**	Absence of pain, tenderness to percussion, gingival swelling, sinus tract formation, and tooth mobility	85.2%	92.3%
7	**Rajain T et al., 2023 [30]**	Absence of pain, tenderness to percussion and absence of swelling.	93.1%	92.9 %

2.4.2 Radiographic outcomes

All included studies evaluated radiographic outcomes. A variety of success rates were reported across different studies. The evaluation criteria included the absence of new or increased radiolucency, no signs of pathological root resorption, and evidence of healing or stability of

preoperative radiolucency. Two studies reported similar success rates for both the rotary and manual groups [29, 25]. Three studies achieved higher success rates with the rotary instrumentation system, with Rajain et al. (2023) showing the greatest difference in success rates [24, 28, 30]. Conversely, only two studies reported a significantly higher success rate in the manual group compared to the rotary group [26, 27]. Detailed results are presented in Table 7.

Table 7. Radiographic outcomes reported in the included studies

Nr.	Author/year	Radiographic success criteria	Rotary radiographic success (%)	Manual radiographic success (%)
1	**Abd El Fatah YA et al., 2025 [24]**	Resolving or stable preoperative radiolucency, no new radiolucency, and no internal/external root resorption	Fanta Baby: 96.3%, Zuanba: 92.6%	88.9%
2	**Al-Wesabi AA et al., 2025 [25]**	Reduction in preoperative radiolucency, no new radicular/furcation radiolucency, and no pathological root resorption	78.3%	78.3%
3	**Amorim AC et al., 2022 [26]**	No inter-radicular or periapical radiolucency, intact periodontal ligament space, and satisfactory root canal filling	66.7%	93.3%
4	**Boonchoo K et al., 2020 [27]**	Reduction in furcation/periapical radiolucency, visible lamina dura, and no pathological root resorption	66.7%	78.9%
5	**Girish Babu KL et al., 2024 [28]**	No increase in preoperative furcal or periapical radiolucency, no new radiolucency, no internal/external root resorption, and normal lamina dura/PDL space	Kedo-SG Blue: 97%, HERO Shaper: 91–97%	84–94%
6	**Morankar R et al., 2018 [29]**	No increase in preoperative radiolucency, no new radiolucency, and no internal/external root resorption	66.7%	65.4%
7	**Rajain T et al., 2023 [30]**	No furcation radiolucency, adequate obturation quality, and no pathological root resorption	69%	35.7%

Six studies reported optimal obturation quality, while one study did not include this outcome [24]. Overall, most studies reported better obturation quality in the rotary group than in the manual group. Amorim et al. (2022) and Girish Babu et al. (2024) observed significantly high rates in the rotary system [26, 27]. Morankar et al. (2018) was the only study that reported better obturation

quality in the manual group than in the rotary group [25]. Detailed optimal obturation rates are described in Table 8

Table 8. Optimal obturation quality reported in the included studies

Nr.	Author/year	Optimal obturation (%) – Rotary	Optimal obturation (%) – Manual
1	**Abd El Fatah YA et al., 2025 [24]**	Not reported	Not reported
2	**Al-Wesabi AA et al., 2025 [25]**	47.8%	39.1%
3	**Amorim AC et al., 2022 [26]**	mesial: 80%, distal: 75%	mesial: 65%, distal: 70%
4	**Boonchoo K et al., 2020 [27]**	mesial: 50% distal: 55.6%	mesial: 47.4% distal: 52.6%
5	**Girish Babu KL et al., 2024 [28]**	Kedo SG: 75-84.4% HERO Shaper: 68.8-78.1%	53.1–56.3%
6	**Morankar R et al., 2018 [29]**	61.7%	68.3%
7	**Rajain T et al., 2023 [30]**	68.96%	53.57%

2.4.3 Instrumentation time

All studies that evaluated instrumentation time reported significantly shorter preparation times for rotary systems compared with manual instrumentation. These differences were statistically significant in all reported cases. One study did not report instrumentation time. A summary of the instrumentation results is presented in Table 9.

Table 9. Instrumentation time reported in the included studies

Nr.	Author/Year	Rotary Instrumentation Time (min)	Manual Instrumentation time (min)	p-value
1	**Abd El Fatah YA et al., 2025 [24]**	Fanta Baby: 10.52 ± 1.13 Zuanba: 9.46 ± 1.12	14.65 ± 1.85	$p < 0.001$
2	**Al-Wesabi AA et al., 2025 [25]**	12.05 ± 2.09	17.14 ± 2.17	$p < 0.001$
3	**Amorim AC et al., 2022 [26]**	11.30 ± 3.23	20.24 ± 5.16	$p = 0.001$
4	**Boonchoo K et al., 2020 [27]**	3.23	7.38	$p = 0.001$
5	**Girish Babu KL et al., 2024 [28]**	Not reported	Not reported	Not reported
6	**Morankar R et al., 2018 [29]**	9.37 ± 4.94	25.71 ± 3.84	$p < 0.001$
7	**Rajain T et al., 2023 [30]**	8.03 ± 0.82	11.27 ± 0.93	$p = 0.001$

2.4.4 Safety outcomes

The only study that reported adverse events, specifically instrument fracture, was Morankar et al. (2018) [29]. The instrument fracture occurred in 2 cases (6.7%) during rotary instrumentation, whereas no procedural errors were reported with manual techniques. The remaining six studies reported no procedural errors or adverse events. However, the very low incidence of reported adverse events limits the ability to draw strong conclusions regarding the comparative safety of the instrumentation techniques.

2.5 Risk Assessment of Systemic Errors

The results of the risk of bias assessment are presented in Table 10. The overall RoB 2 score across all studies raised some concerns, indicating moderate methodological quality, and no study was classified as having a high risk of bias. This assessment is crucial for analysing the methodological quality of the studies, identifying potential sources of bias, and gauging the level of confidence in the findings.

Table 10. Risk of bias assessment

Nr.	Study	D1	D2	D3	D4	D5	Overall RoB-2
1	**Abd El Fatah YA et al., 2025 [24]**	Some concerns	Low risk	Some concerns	Low risk	Low risk	Some concerns
2	**Al-Wesabi AA et al., 2025 [25]**	Some concerns	Low risk	Low risk	Low risk	Low risk	Some concerns
3	**Amorim AC et al., 2022 [26]**	Low risk	Low risk	Low risk	Low risk	Some concerns	Some concerns
4	**Boonchoo K et al., 2020 [27]**	Some concerns	Low risk	Some concern	Some concerns	Some concern	Some concerns
5	**Girish Babu KL et al., 2024 [28]**	Low risk	Low risk	Some concerns	Some concerns	Some concerns	Some concerns
6	**Morankar R et al., 2018 [29]**	Low risk	Low risk	Some concerns	Low risk	Some concerns	Some concerns
7	**Rajain T et al., 2023 [30]**	Some concerns	Low risk	Low risk	Some concerns	Some concerns	Some concerns

D – Domain, RoB – Risk of Bias; D1 – Bias arising from the randomisation process; D2 – Bias due to deviations from intended interventions; D3 – Bias due to missing outcome data; D4 – Bias in measurement of the outcome; D5 – Bias in selection of the reported result. Judgements were classified according to the Cochrane Risk of Bias 2 (RoB 2) tool as low risk of bias, some concerns, or high risk of bias [20].

3. DISCUSSION

The objective of this literature review was to evaluate rotary and manual instrumentation techniques in pulpectomy procedures of primary molars and to compare their clinical, radiographic, and safety outcomes. All included studies were primarily characterised by their randomised clinical trial design, which is a key strength.

Across seven included studies, both methods consistently demonstrated high clinical and radiographic success rates, which may indicate that the biological outcome of pulpectomy is largely preserved regardless of the instrumentation system used [24–30]. However, rotary systems appear to offer advantages in efficiency and canal shaping, although these benefits are often accompanied by different risks and costs.

The clinical success rate for both rotary and manual techniques was similarly high and statistically comparable, often exceeding 90%. Studies by Abd EL Fatah et al. (2025), Girish Babu et al. 2024), and Rajain et al. (2023) have shown improved healing with rotary systems, possibly due to better canal shaping and cleaning [24, 28, 30]. However, no study documented a statistically significant difference in overall radiographic success rates. These findings are consistent with previous studies by Chauhan et al. (2019), Manoharan et al. (2024), and Suresh et al. (2023), which suggest that the type of instrumentation technique typically does not influence the overall clinical or radiographic results [31, 32, 33].

A recent review by Natchiyar et al. (2021) also found no significant difference in success rates between rotary and manual instrumentation in primary molars, reinforcing the idea that the instrumentation system by itself may not determine long-term outcomes [34].

Aside from the overall clinical and radiographic success rates, six included studies suggested improved obturation quality with rotary instrumentation [24–28, 30], although the study by Morankar et al. (2018) reported better outcomes in the manual group without statistical significance [29]. Studies by Amorim et al. (2022) and Girish Babu et al. (2024) also indicated that obturation quality may be associated with treatment outcomes, as optimal filling was linked to higher success rates and a lower incidence of periapical complications [26, 28].

The findings across the seven included studies suggest that rotary systems appear to provide improved shaping ability, producing more centralised and tapered preparations along with improved obturation fit [24–30]. These findings are supported by previous *in vitro* studies, which have demonstrated that rotary systems significantly reduce root canal transportation and help preserve dentin integrity [9, 35]. A previous study by Divya et al. (2019) reported that manual instrumentation may be linked to a higher risk of underfilled canals [36], as it can create narrow,

irregular spaces that hinder the flow of obturating material, increasing the risk of infection. In contrast, rotary files may sometimes overfill, possibly because of reduced tactile feedback or the greater taper or length of the files [13].

Regarding debris extrusion and safety, two recent laboratory studies involving primary teeth by Suresh et al. (2023) and Kaushal et al. (2022) have shown that manual hand files extrude significantly more apical debris than rotary systems [33, 37]. As apical debris extrusion is a recognised predictor of postoperative pain and inflammatory complications, these findings may provide a mechanistic explanation for the improved postoperative comfort observed in clinical studies by Western et al. (2017) and Talekar et al. (2025) [38, 39]. File separation appears to be a rare event in paediatric pulpectomy trials. In this review, only Morankar R et al. (2018) reported two fractures in the rotary group [29]. A previous study by De Pedro-Muñoz et al. (2024) suggested that reciprocating motions reduce cyclic fatigue compared to continuous rotary motion, which may influence the safety of instrumentation in primary teeth [40].

Reduced working and instrumentation times were among the main advantages of the rotary system across all seven included studies, offering shorter working times and faster canal preparation [24–30]. In paediatric dentistry, minimising chair time is especially important because children often have limited attention spans and behavioural management issues [41]. These findings are consistent with a recent scoping review by Swaminathan et al. (2025), which reported a 63% decrease in instrumentation time and 68% decrease in obturation time when comparing rotary to manual techniques in primary teeth [13].

The findings across the included studies suggest that, although rotary instrumentation reduces treatment time and may decrease postoperative pain, its effect on patient behaviour remains variable [24–30]. The study by Al-Wesabi et al. (2025) reported that children in the rotary group showed substantially more negative behaviour than those in the manual group, which was potentially linked with noise and vibration [25]. A previous study on paediatric patients' behaviour by Nissan et al. (2017) has shown that instrumentation noise and mechanical vibration can influence a child’s emotional response and cooperation during dental procedures [42]. In contrast, Boonchoo K et al. (2020) reported that rotary systems may reduce postoperative discomfort, thereby positively influencing patient cooperation [27]. Consequently, although rotary systems possess the potential to enhance efficiency and decrease discomfort, behavioural management strategies remain indispensable when working with young patients [34, 41].

One of the included studies by Abd El Fatah et al. (2025) performed a cost-effectiveness analysis comparing rotary and manual systems [24]. The results showed that the rotary system, especially Zuanba and Fanta AF Baby, was more cost-efficient than manual K-files in the long run, due to reduced working time and improved efficiency, suggesting that improved efficiency can compensate for the higher initial costs of different file systems over time [24].

The seven included studies have notable limitations, including small sample sizes and short follow-up periods [24–30], with only two studies by Al-Wesabi et al. (2025) and Amorim et al. (2022) providing 24-month follow-up [25,26]. This greatly limits the ability to assess long-term outcomes, which are generally more reliable for determining final success rates. Additionally, most radiographs were two-dimensional, restricting the evaluation of factors like obturation quality and early periapical changes. Furthermore, the nature of the interventions made blinding difficult, adding to the study's limitations. Variations in treatment protocols and external factors, such as recruitment challenges and patient attrition during follow-up—particularly during the COVID-19 pandemic—also contributed to inconsistencies. These issues highlight the necessity for future research with improved design, larger sample sizes, standardised protocols, longer follow-up periods, and advanced imaging techniques to strengthen evidence comparing rotary and manual instrumentation in pulpectomy of primary teeth.

Nevertheless, this review also has certain limitations. The number of eligible studies was relatively limited, and notable heterogeneity was identified across instrumentation systems, outcome assessments, and follow-up periods. Moreover, due to this heterogeneity, a meta-analysis was not performed, thereby constraining the capacity to offer quantitative comparisons of the outcomes.

Overall, the findings of this literature review indicate that, compared with manual stainless-steel hand (SSH) files, the rotary instrumentation system may result in significantly shorter working times and improved shaping efficiency, while safety outcomes appear similar between the two systems.

CONCLUSION

1. **Clinical outcomes:**

   Both rotary and manual instrumentation techniques showed similarly high clinical success rates, with no consistent or statistically significant differences in postoperative pain, swelling, mobility, or patient discomfort.

2. **Radiographic outcomes:**

   Radiographic outcomes were mostly comparable between the two techniques, although rotary instrumentation may be associated with improved obturation quality in some cases.

3. **Instrumentation time:**

   Rotary instrumentation systems consistently resulted in shorter instrumentation time compared with manual techniques, representing a clear clinical advantage, particularly in paediatric patients.

4. **Safety outcomes:**

   Both techniques showed a similar safety profile, with a low incidence of procedural errors and no consistent differences in the occurrence of file separation or other complications.

PRACTICAL RECOMMENDATIONS

1. Paediatric rotary or reciprocating file systems (e.g., Kedo-S, Kedo-SG Blue, Fanta Baby, or sNiTi) may be considered as an alternative to manual stainless-steel hand files, as they may reduce instrumentation time while delivering comparable clinical and radiographic results.
2. Clinicians should carefully control the working length, avoid excessive forces during instrumentation, and use suitable lubricants such as EDTA gel to reduce the risk of procedural errors and instrument fracture during procedures.
3. Using appropriate obturating materials, such as iodoform-based calcium hydroxide pastes or Endoflas®, may improve treatment outcomes. Achieving optimal canal filling should remain a primary goal.
4. Placement of a well-sealed coronal restoration is recommended, preferably a stainless steel crown, to protect the treated tooth and support its long-term prognosis. Regular clinical and radiographic follow-up should also be performed to evaluate treatment success.

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ANNEXES

Annex 1. Full author lists and journal names of included studies

	Authors	Journal Name
1	Abd El Fatah YA, Elheeny AA, Abd-Elsabour MA, Khattab NM	BMC Oral Health
2	Al-Wesabi MA, Elsewify K, Al-Ashry AM, Ahmed F	Brazilian Dental Science
3	Amorim AC, Caldeira AV, Sampaio SC, Lourenço Neto N, Oliveira TM, Nogueira DA, Moretti ABS, Sakai VT	Journal of Applied Oral Science
4	Boonchoo K, Leelataweewud P, Yanpiset K, Jirarattanasopha V	Clinical Oral Investigations
5	Babu KL, Hebbar PG	Pediatric Dental Journal
6	Morankar R, Goyal A, Gauba K, Bhatia SK, Kapur A	Pediatric Dental Journal
7	Rajain R, Gupta P, Jaiswal N, Jaiswal S, Walia TP, Deep A	Journal of International Society of Preventive and Community Dentistry

Annex 2. Bioethics Centre approval for a systematic literature review

LIETUVOS SVEIKATOS MOKSLŲ UNIVERSITETO
BIOETIKOS CENTRAS

Medicinos akademija (MA) Nr. 2025-BEC2-1447
Vientisųjų studijų programa - Odontologija (anglų kalba)
5 k. studentė: Pariya Charmchy Kargardoust
Darbo vadovas: Asistentas Živilė Kristina Matulaitienė
Burnos priežiūros ir vaikų odontologijos klinika

DĖL PRITARIMO TYRIMUI

LSMU Bioetikos centras, įvertinęs pateiktus dokumentus, moksliniam-tiriamajam darbui tema „Rotary versus hand instrumentation in pulpectomy of primary teeth: a systematic review of clinical, radiographic, and safety outcomes“ P R I T A R I A .

dr. Aušra Urbonienė 2025-12-23 10:05:56

** Pastaba: šis pritarimas neatleidžia tiriamąjį mokslinį darbą vykdančių asmenų nuo prievolės laikytis Bendrojo duomenų apsaugos reglamento nuostatų ir nuo atsakomybės gauti nacionalinio arba regioninio bioetikos komiteto leidimą, jei toks leidimas būtinas pagal LR Biomedicininių tyrimų etikos įstatyme numatytus reikalavimus.*

Annex 3 Instrumentation and file system details of the included studies

	Author/year	Intervention Group Details	Control Group Details
1	**Abd El Fatah YA et al., 2025 [24]**	1. Fanta Baby (FAF) 2. Zuanba (Z) used according to manufacturer's recommended sequence. Operated by X Smart Plus Endomotor	SSH K-files: up to #35 K-file. Initial negotiation #10 K file
2	**Al-Wesabi AA et al., 2025 [25]**	Fanta Baby: Orifice opener 17/.08. #20/04, #25/04 and #30/04 file. used at 350 RPM	SSH K-Files: K-file #15 to #35
3	**Amorim AC et al., 2022 [26]**	Hyflex EDM files: 25/.12, 10/.05 (Glidepath), and 25/~ variable taper. Files at 500 rpm or 300 RPM for Glidepath	SSH K-Files: K-file #15 to #30. Initial negotiation K-file #10
4	**Boonchoo K et al., 2020 [27]**	S-NiTi WaveOne Gold: ISO tip 20, taper 0.07	SSH K-Files: K-file #15 to #30
5	**Girish Babu KL et al., 2024 [28]**	Orifice opener: Endoflare Kedo-SG Blue: Files D1, E1, U1 Used at 150–300 rpm HERO Shaper: Files in ISO #20, #25 and #30	Manual NiTi K-files; H-files: Files enlarged up to three times the size of the initial file
6	**Morankar R et al., 2018 [29]**	Hyflex CM NiTi: Orifice opener 08/25, Shaping files 04/20, 04/25, 04/30 used at 500 RPM, up to #30 file	SSH K-Files (2% taper): K-file #15 to #30
7	**Rajain T et al., 2023 [30]**	Kedo-S: Files D1 and E1, Files #15 to 35. Motor at 300 RPM	SSH K-Files: K-file #15 to #35; Initial negotiation K-File size 10