

# Comparison of Clinical and Radiographic Success of Rotary with Manual Instrumentation Techniques in Primary Teeth: A Systematic Review

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## ABSTRACT

**Aim and objective:** A systematic review was planned to compare the clinical and radiographic success rate of pulpectomy in primary molars using a rotary system and hand files system.

**Study design:** The literature search was undertaken in electronic databases from January 2000 to December 2019 using keywords. Four hundred and forty-two studies were identified after applying limits. Three hundred and thirty-one irrelevant articles were eliminated. Among the 111 articles obtained, 90 articles were eliminated after reading the titles and abstracts. After assessing the full text, 18 articles were eliminated. Randomized controlled trials (RCTs) published in the English language on pulpectomy of primary molars, using hand files and rotary files and with a follow-up period of 12 months were included.

**Results:** Three RCTs comparing the clinical and radiographic pulpectomy success rates using rotary and hand files instrumentation were finally selected. Qualitative assessment with RoB 2.0 showed one study had a low risk of bias and two studies had a high risk of bias.

**Conclusion:** Pulpectomy procedures in primary teeth using rotary and hand files instrumentation techniques were equally effective in terms of success rates.

**Keywords:** Clinical and radiographic success, Manual technique, Primary teeth, Pulpectomy, Rotary technique.

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## INTRODUCTION

Dental caries is the most predominant chronic disease affecting children worldwide. Treatment options may differ according to the severity and degree of involvement of enamel, dentin, or pulp.<sup>1</sup> A tooth with extensive decay may necessitate pulp interventions. Based on the severity of pulpal involvement pulp capping, pulpotomy and pulpectomy can be done in primary teeth. Pulp therapy aims at maintaining the integrity and health of the teeth and its supporting tissues.<sup>1</sup>

Pulpectomy remains the treatment of choice in all primary teeth with irreversible pulpitis. This process retains the teeth with irreversible pulp pathosis in a symptom-free state till its natural exfoliation time, during its transition from primary to permanent dentition. The effective pulpectomy procedure for primary teeth presents a critical endodontic challenge because of the tortuous and bizarre tortuous root canals enclosed within the roots which undergo physiological resorption.<sup>2</sup>

The success of the pulpectomy procedure depends on effective cleaning, debridement of root canal space, and obturation. The process of cleaning and debridement has undergone a shift from the traditional methods using reamers, hand files, burs, and sonic instruments to the modern use of nickel-titanium (Ni-Ti) rotary file system. The root canal preparations using hand files are time-consuming and cause iatrogenic errors. Hence, much of the attention has been aimed toward the preparation technique using rotary instruments.<sup>3</sup> It is advantageous in pediatric dentistry as it improves patient co-operation by shortening chair-side treatment time.<sup>4</sup>

Pediatric dentists, who are not trained in using rotary systems, are still comfortable with hand files since they are satisfied with the success provided by the conventional method over the years. This

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raises the question of whether there is a difference in the success rate of pulpectomy procedures done with hand files and those done with rotary files. Hence, this current systematic review was planned to compare the clinical and radiographic success of the rotary system and hand files system in primary molar pulpectomy procedures.

## MATERIALS AND METHODS

This systematic review was performed using the Cochrane Handbook for Systematic Reviews of Interventions.

### Selection Criteria

A question was structured according to the PICOT format (Population—Children in need of pulpectomy in their

primary molars, Intervention—Pulpectomy done using rotary instrumentation technique, Comparison—Pulpectomy done using manual instrumentation technique, Outcome—Clinical and radiographic success, and Time period for follow-up—12 months). The present research was carried out to find out if there was a significant difference in the success rates of pulpectomies done using a rotary system and hand files system in primary molars.

Randomized controlled trials (RCTs) published in the English language from January 2000 to December 2019 with data on pulpectomy of primary molars, using hand files and rotary files were included. There should be a follow-up period of at least 12 months evaluating the success of treatment done based on the clinical symptoms and radiographic changes.

### Literature Search

The literature search was conducted in the following electronic databases; Google Scholar, PubMed, MEDLINE, Cochrane database, Web of Science, EMBASE, IndMED, and Grey literature using the keywords—rotary endodontics, primary molars, *in vivo* trials, conventional technique, the success rate of pulpectomy, and Ni-Ti rotary system in alternating combinations. Strings of search (MeSH) terms, consisting of relevant text words and Boolean links, were constructed to search databases. All eligible studies were also hand searched for additional relevant studies. The following string of English search terms was used

(((((Rotary endodontics) OR NiTi rotary files) OR manual technique) OR hand files) AND pulpectomies) AND primary molars

((((((Rotary endodontics) OR NiTi rotary files) OR manual technique) OR hand files) AND pulpectomies) AND primary molars)) AND (clinical and radiographic success)) AND randomized controlled trials

((((((Rotary endodontics) OR NiTi rotary files) OR manual technique) OR hand files) AND pulpectomies) AND primary molars)) AND *in vivo* trials

((((((rotary endodontics) OR NiTi rotary files) OR manual technique) OR hand files) AND pulpectomies) AND primary molars)) AND follow-up

((((((cleaning and shaping) AND NiTi rotary files) OR Rotary files) OR hand files) OR manual technique) AND pulpectomies in molars) OR primary molars) AND clinical trials

((((((cleaning and shaping) AND NiTi rotary files) OR Rotary files) OR hand files) OR manual technique) AND pulpectomies in molars) OR primary molars) AND clinical trials)) OR Biomechanical preparation

### Data Extraction

This systematic review was done based on the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA)<sup>5</sup> guidelines. The steps involved in the search strategy have been shown in PRISMA Flowchart 1. Systematic screening of the literature and data extraction was done by two independent researchers. Any disagreements during the selection process and data extraction were solved by the third investigator. A total of 5,946 articles were obtained. Four hundred and forty-two studies were identified after applying limits. Around 331 articles that were duplicates, irrelevant and repeated, case series and case reports were eliminated. One hundred and eleven articles were obtained and were individually evaluated and checked if they fit into the eligibility criteria and 90 articles were eliminated after reading their titles and abstracts. After assessing the full text 18 articles were eliminated as they were

nonrandomized trials. Finally, three articles<sup>6–8</sup> were included for this systematic review and subjected to data collection.

### Quality Appraisal

All the studies were subjected to qualitative assessment using the Revised Cochrane risk of Bias Tool for randomized trials (RoB 2.0).<sup>9</sup> The quality of the study was assessed under five domains as shown in Table 1. Based on the risk of bias across the five domains, the overall risk of bias judgment was done (Table 1).

### RESULTS

Data collections done by independent authors yielded both descriptive and quantitative information. The extracted data from the individual studies are summarized in Tables 2 and 3. Among the three studies, the study by Morankar et al.<sup>8</sup> had a low overall risk of bias and the other two study by Vieyra and Enriquez<sup>6</sup> and Elheeny et al.<sup>7</sup> fell into the high-risk of bias category as they failed to provide details on whether the outcome assessors were blinded or not.

Two studies<sup>6,8</sup> had 24-month follow-up and one study<sup>7</sup> had 12-month follow-up postoperatively. Stainless steel K-file was used for manual root canal preparation in all three studies. Vieyra and Enriquez,<sup>6</sup> Elheeny et al.<sup>7</sup> compared two types of rotary systems to the manual technique. ProTaper was one of the rotary systems used in both studies. Morankar et al.<sup>8</sup> compared the Hyflex system and the manual technique.

Vieyra and Enriquez<sup>6</sup> and Morankar et al.<sup>8</sup> used modified Coll and Sadrian criteria and Elheeny et al.<sup>7</sup> followed AAPD 2009 guidelines for the evaluation of clinical and radiographic outcomes in the follow-up sessions.

### Clinical Success

Pulpectomy treatment was considered clinically successful when the tooth showed no symptoms of pain, tenderness to percussion, abnormal mobility, gingival swelling, or sinus tract formation.<sup>10</sup> In the study by Morankar et al.,<sup>8</sup> manual instrumentation techniques showed superior results ( $p = 0.55$  at 6 months), whereas, in the study by Elheeny et al.,<sup>7</sup> rotary instrumentation techniques showed superior results at 6 months ( $p = 0.60$ ). Morankar et al.<sup>8</sup> reported that the clinical success rates were 85.2 and 92.3% for rotary (Hyflex CM) and manual techniques, respectively, at 24-month follow-up with the  $p$  value of 0.41. Elheeny et al.<sup>7</sup> reported that the clinical success rates were 88% for ProTaper and 92% for RaCe in rotary techniques, whereas it was 84% for manual techniques at 12-month follow-up. RaCe rotary instruments produced a 100% success rate at 3 months which gradually decreased to 96 and 92% at 6 and 12 months, respectively. Vieyra and Enriquez<sup>6</sup> reported that overall success rates were 95% at the 12–24-month follow-up time.

### Radiographic Success

Pulpectomy treatment was judged as radiographically successful when the treated tooth did not show any signs of root resorption, newly developed radiolucency, and an increase in the size of preoperative radiolucency on follow-up visits.<sup>10</sup> In the study by Morankar et al.,<sup>8</sup> the manual instrumentation technique showed superior results at 6 months ( $p = 0.57$ ). He reported the radiographic success rates were 66.7% in the rotary technique and 65.4% in the manual technique at 24-month follow-up ( $p = 0.75$ ). The study by Elheeny et al.<sup>7</sup> had a radiographic success rate of 84% (ProTaper) and 88% (RaCe) among the rotary techniques and 80% in manual

Flowchart 1: PRISMA flowchart

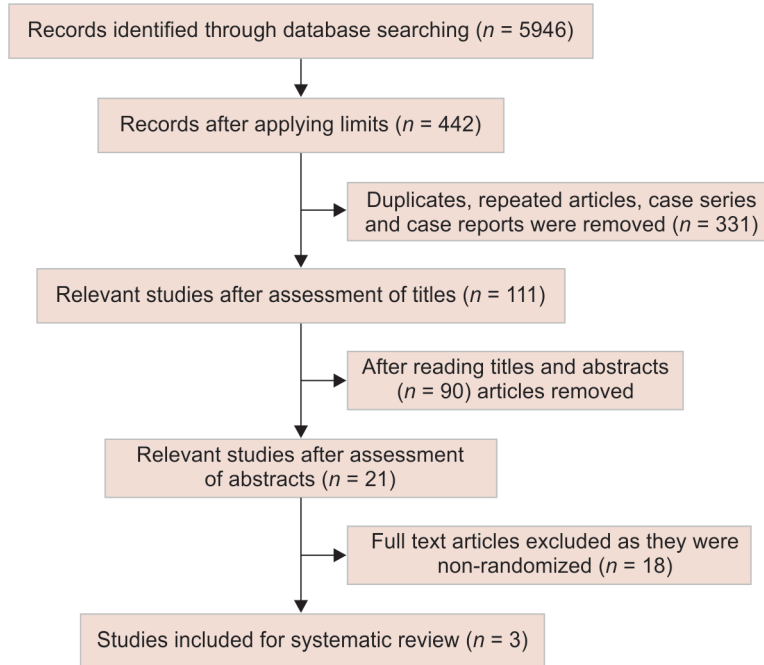


Table 1: Risk of bias tool for randomized trials (RoB 2.0)

| Author                     | Bias arising from the randomization process | Bias due to the deviations from intended interventions | Bias due to missing outcome data | Bias in measurement of the outcome | Bias in selection of the reported result | Overall bias |
|----------------------------|---|--|----------------------------------|------------------------------------|--|--------------|
| Vieyra and Enriquez (2014) | Some concerns                               | Low  | Some concerns                    | High                               | High                                     | High         |
| Elheeny et al. (2015)      | Some concerns                               | Low  | Low                              | High                               | Low                                      | High         |
| Morankar et al. (2018)     | Low   | Low  | Low                              | Low                                | Low                                      | Low          |

Table 2: Clinical and radiographic success of the included studies

| Author's name, year of publication, and place of study | Age (years) | Sample size | Type of instrument used          | Outcome measures                     |          |           |  |          |           |
|--|-------------|-------------|----------------------------------|--------------------------------------|----------|-----------|--|----------|-----------|
|  |             |             |                                  | Clinical success in time periods (%) |          |           | Radiographic success in time periods (%) |          |           |
|  |             |             |                                  | 95                                   | 95       | 95        | 95                                       | 95       | 95        |
| Vieyra and Enriquez 2014, Mexico                       | 4-7         | 45          | ProTaper Light speed LSX K-files | 12-24 (months)                       |          |           | 12-24 (months)                           |          |           |
|  |             |             |                                  | 95                                   | 95       | 95        | 95                                       | 95       | 95        |
| Elheeny et al. 2015, Egypt                             | 4-7         | 75          | ProTaper K-files                 | 3 months                             | 6 months | 12 months | 3 months                                 | 6 months | 12 months |
|  |             |             |                                  | 88                                   | 88       | 88        | 36                                       | 56       | 84        |
|  |             |             |                                  | 100                                  | 96       | 92        | 28                                       | 60       | 88        |
|  |             |             |                                  | 88                                   | 88       | 84        | 32                                       | 56       | 80        |
| Morankar et al. 2018, India                            | 4-7         | 60          | Hyflex CM K-files                | 3 months                             | 6 months | 24 months | 3 months                                 | 6 months | 24 months |
|  |             |             |                                  | 93.1                                 | 93.1     | 85.2      | 79.3                                     | 65.5     | 66.7      |
|  |             |             |                                  | 96.6                                 | 96.6     | 92.3      | 69                                       | 72.4     | 65.4      |

technique at 12-month follow-up. Vieyra and Enriquez<sup>6</sup> reported an overall success rate of 95% at the end of the 24-month follow-up.

**DISCUSSION**

There is a shift from extraction to the conservation of tooth as a treatment of choice in treating infected primary molars in children. It has been an important procedure in endodontics as it preserves the arch length and guides the underlying successor's eruption. Endodontic treatment for primary molars has moved forward from the use of Hedstrom files and Kerr files to the current rotary

systems. The superiority of rotary instruments in time efficiency is well-known; nonetheless, the effectiveness of rotary and manual instrumentation techniques in the success of pulpectomy procedures is still not well established.<sup>8</sup>

From the advent of rotary instruments, only limited information is available regarding the clinical performance and outcomes following pulpectomy. Root canal preparation on permanent teeth had shown that the instrumentation type has no considerable effect on the outcome of the treatment.<sup>11,12</sup> Apart from time efficiency, it is also important to establish the



**Table 3:** Summary of the included studies

|  | <i>Vieyra and Enriquez (2014)</i>   | <i>Elheeny et al. (2015)</i>  | <i>Morankar et al. (2018)</i>  |
|--|---|---|--|
| Type of publication                            | Article, randomized clinical trial  | Article, randomized clinical trial  | Article, randomized clinical trial   |
| Country of origin                              | Mexico  | Egypt   | India  |
| Aim  | To compare the instrumentation time efficiency of rotary and hand instrumentation performed on necrotic primary teeth   | (1) Evaluate the clinical and radiographic success of endodontically treated primary molars following instrumentation with two rotary systems (ProTaper and RaCe rotary instruments); (2) <i>In vitro</i> comparison of cleaning efficiency of ProTaper and RaCe rotary systems | (1) To evaluate the difference between manual and rotary canal instrumentation time, obturation time, quality of fill, and complications during instrumentation; (2) To compare the clinical and radiographic success between hand files and rotary files after 2 years  |
| Recruitment procedure                          | 45 teeth (19 maxillary and 26 mandibular teeth), 102 canals with completely formed apices, minimum 10 mm root length and with no radiographic sign of root resorption   | 75 primary molars in children selected from those attending the outpatient clinic, Pediatric and Community Dentistry Department, Faculty of Dentistry, Minia University   | 60 decayed primary mandibular second molars from children attending the Outpatient Unit of Pediatric and Preventive Dentistry at Oral Health Sciences Centre, Postgraduate Institute of Medical Education and Research, Chandigarh   |
| Details of randomization and allocation        | Details provided  | Details provided  | Details provided   |
| Age and gender                                 | 4–7 years, gender not mentioned   | 4–7 years, gender not mentioned   | 4–7 years, 32 males and 28 females   |
| Rotational speed of the rotary instrumentation | Not mentioned   | ProTaper: 300 rpm; RaCe: 500 rpm  | 500 rpm  |
| Groups   | Group I (M): K files; Group II (R): Light Speed LSX rotary instruments; Group III (R): ProTaper   | Group A (R): ProTaper; Group B (R): RaCe; Group C (M): K files  | Group I (M): K files; Group II (R): Hyflex CM  |
| Number of visits during root canal treatment   | Single-visit  | Not mentioned   | Single-visit   |
| Irrigants used                                 | 0.5% NaOCl using EndoVac system   | Not mentioned   | 2.5% NaOCl and normal saline   |
| Canal filling material                         | Calcium hydroxide and Iodoform paste  | Not mentioned   | Mixture of calcium hydroxide paste and zinc oxide powder   |
| Type of tooth restoration                      | Fuji IX for anterior teeth. Fuji IX or temporary metallic crown for posterior teeth   | Not mentioned   | Glass ionomer cement followed by stainless steel crowns  |
| Outcome of interest                            | <ul style="list-style-type: none"> <li>Instrumentation time</li> <li>Clinical and radiographic success</li> </ul>   | Clinical and radiographic success   | <ul style="list-style-type: none"> <li>Instrumentation time</li> <li>Obturation time</li> <li>Quality of obturation</li> <li>Clinical success</li> </ul>   |
| Follow-up                                      | Every 6 months for 2 years  | 3, 6, and 12 months   | Radiographic success 3, 6, and 24 months   |
| Results publication                            | Instrumentation time among three groups (minutes): Group I: $20.10 \pm 7.86$ , Group II: $9.37 \pm 2.19$ , Group III: $10.45 \pm 4.77$<br>No results of the clinical or radiographic success have been presented comparing the three groups | RaCe group exhibited a higher success rate over the two other systems   | <ul style="list-style-type: none"> <li>Mean instrumentation time significantly less in a rotary group</li> <li>Obturation time <math>5.23 \pm 0.91</math> minutes for manual instrumentation compared to <math>4.72 \pm 0.99</math> minutes for rotary</li> <li>No difference in the quality of obturation between the two groups</li> <li>Clinical and radiographic success did not reveal any significant difference between the two groups</li> </ul> |

final success of the treatment rendered. This systematic review provides evidence on the effectiveness of the instrumentation technique in clinical performance and outcomes following primary teeth pulpectomy. It is the first of its kind to compare

the success of rotary and manual instrumentation techniques in primary teeth pulpectomy.

The success of manual and rotary techniques in pulpectomy procedures of primary teeth has been evaluated only in three

studies. Vieyra and Enriquez<sup>6</sup> reported the overall success rate of pulpectomy procedures and did not report the success of the procedure based on the individual instrumentation techniques used. In addition to clinical and radiographic success between manual and rotary groups, Morankar et al.<sup>8</sup> also compared the instrumentation time, obturation time, obturation quality between these groups. The rotary instrumentation technique showed superior results only in terms of instrumentation time. In terms of obturation time, obturation quality, and success of outcome, both the groups were equally effective in performing primary teeth pulpectomy procedures. These results were consistent with the finding of Romero et al.<sup>13</sup> and Makarem et al.<sup>14</sup> The pulpectomy procedures performed by the rotary instrumentation technique had enormously increased success rate at the beginning which gradually decreased in later follow-up visits (93.1–85.2%). In contrast, pulpectomy procedures performed by manual instrumentation technique had minimal changes in success rate (96.6–92.3%) in the follow-up visits.<sup>8</sup> The response of each tooth to the treatment may vary and this could also be a reason for the variation in the success rate in the rotary groups in the subsequent visits. Elheeny et al.<sup>7</sup> performed an *in vitro* trial to compare the cleaning efficiency of ProTaper and RaCe rotary systems in addition to evaluating the success of the pulpectomy procedure with the type of instrumentation. RaCe group revealed better cleaning efficiency in the apical one-third root canal preparation than ProTaper and K-files. This might be the reason for the higher success rates of the RaCe group over the two other systems (92% clinically and 88% radiographically). Though there was a difference in the cleaning efficiency of the rotary and manual instrumentations, there was no difference in their success rates.

NiTi ProFile was the first rotary file used for pulpectomy of primary molars by Barr et al.,<sup>15</sup> which resulted in a uniform canal preparation and improved quality of filling. The same protocols for permanent teeth were adopted for the pulpectomy procedures in primary teeth. Usage of these files with increased taper for primary teeth with thinner, shorter, and curved ribbon-shaped roots resulted in lateral perforation.<sup>16</sup> Despite many advantages of rotary instrumentation, there are no clear guidelines or instructions for the suitable preparation technique of primary teeth. Hence, Kedo-S rotary file for pediatric patients was introduced with gradual taper, assisting in easy canal preparation and straight-line access to root canals. The design of rotary files enhances the engagement of the file edges to the root canal walls efficiently and produces smooth surfaces along with tapering of the canal toward the apex.<sup>17</sup> Hence, the design may also contribute to the higher success rates and better cleaning efficiency of rotary files compared to hand files.

The success of any endodontic treatment depends on many factors and the reduction or elimination of root canal flora is the most important one. Del Fabbro et al.<sup>18</sup> performed a systematic review in which they evaluated the effectiveness of NiTi instruments and stainless steel instruments in eliminating the bacterial load while performing pulpectomy procedures in primary teeth. Both the instrumentation types were equally effective in removing the residual bacterial load from the root canals. Thomas et al.,<sup>19</sup> Reddy and Fernandes,<sup>20</sup> and Chawla et al.<sup>21</sup> reported a higher clinical success rate of 80% and 100% for the pulpectomy procedures done using manual instrumentation. Kuo et al.<sup>22</sup> reported 95% clinical success of pulpectomy using the rotary instrumentation technique with a period of 12-month follow-up. The level of cooperation is dependent on the duration of the procedure and hence time plays an important role in the success of any treatment in children

(Appukkuttan et al.<sup>23</sup> Jamali et al.<sup>24</sup>), especially for those children with uncooperativeness and special healthcare needs. Thus, the rotary instrumentation might be an added advantage in those situations.<sup>25</sup>

One limitation of the present review is the inclusion of trials reported in the English language only. The certainty of evidence regarding the success rate was of moderate quality because of the limited number of articles available and the high overall risk of bias in the two studies. The present review identified the research gap in the available literature and suggests that many future clinical trials are needed comparing the outcome of the treatment procedure with the instrumentation type used.

It is pertinent to mention that the success of the pulpectomy procedure depends upon proper diagnosis, appropriate tooth selection, operator skills, standardization of technique, irrigation protocol, and the obturation material used. Based on the results of this systematic review, it can be concluded that both manual and rotary instrumentations are equally effective in the final treatment outcome. Thus, it is not possible to establish the superiority of one system over the other system in terms of the clinical and radiographic success of pulpectomy procedures. Rotary systems are more advantageous than manual systems only in reducing instrumentation time. If the operator is not comfortable with a rotary system even this advantage becomes null and void.

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